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Submitted as a Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in the Department of Economics at the University of Durham

October 1990

Abstract

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Stability in exchange rates has been the objective of several international monetary agreements since the early twentieth century. Thus the par value of currencies was determined in terms of a specified amount of gold, under the gold standard, whilst, the Bretton Woods agreement and the Smithsonian agreement defined the value of each currency in terms of the dollar, where the dollar was defined in terms of gold. Nevertheless, all these various systems have failed to eliminate the arguments between the proponents and the opponents of flexible and fixed exchange rate regimes. Although the major industrial countries have adopted a relatively flexible exchange rate regime, most developing countries have held their currencies pegged to the currency of a major industrial country, or a basket of currencies, with the aim of meeting a particular macroeconomic criterion.

The choice of pegs tends to be influenced by trade shares, however, adopted according to the objective function the domestic authorities aim to fulfill. The literature has defined several macroeconomic objectives of a peg but found no particular peg to be universally adopted by all developing countries.

An examination of the contract invoicing literature shows that, international trade involves incurring of risk by firms, exporters and importers. This risk is partly determined by the choice of currency denomination of contracts, which firms are expected to seek means of minimizing. With respect to currencies used to invoice contracts, there is overwhelming evidence to suggest that it is the currency of the exporter which tends to be used to denominate trade contracts. However, on an

ad hoc basis, certain commodities and raw materials were found to be invoiced in vehicle currencies, such as the dollar. Moreover, the choice of currency invoicing is found to be influenced by many factors. In particular, inflation differentials were essential. Low inflation currencies are generally preferred by trading partners. A major issue of concern discussed in the literature is the potential effect of exchange rate fluctuations on the volume of international trade. The evidence on this has gone both ways. Some have argued that these fluctuations are of less concern because firms can use the forward market as means of reducing their impact.

The analytical framework presented in the present thesis deals with an important issue for the member states of the Gulf Cooperation Council (GCC). These economies depend on oil revenues as the main source of income. Consequently, both government and private spending rely heavily on the oil sector. However, analyzing this invoicing policy without considering the behavior of the exchange rates between the currencies of these countries and those of their major trading partners, would be misleading. Thus, the present model adopts an integrative approach aimed at choosing a currency or a basket of currencies for invoicing oil, and determining how the choices of the same arrangements or alternative arrangements adopted for pegging the domestic currencies can affect the welfare function adopted for the choice of currency(s) for invoicing oil. This welfare function, as it is argued in the thesis, is based on stabilizing the real, rather than the nominal, value of oil revenues.

The historical perspective has demonstrated close correlations between inflation rates, money growth rates and oil revenues in the GCC economies. Moreover, the dependence of these economies on oil revenues as the major source of income, has been argued to be the decisive factor that has resulted in their currencies being pegged to the dollar. The results from the estimation, however, do not support a peg to the dollar, nor invoicing oil in dollars. Nonetheless, other single currencies have failed to fulfill the optimality condition, thus favoring pegging to a trade-weighted basket of currencies, and an invoicing scheme for oil which is based on a basket of currencies. Trade shares prove to be important, since deviations from purchasing power parity are passed via them. Despite the different levels of stability resulting from alternative combinations of peg and invoice choices, statistical evidence concludes that there are no significant differences amongst the resulting variances of the real value of oil revenues in terms of the domestic currencies of the GCC member states. Accordingly, it may be argued that if the sole objective of the authorities in these countries is to stabilize the real value of oil revenues, any choice of the alternatives considered in the present thesis would yield the same result in terms of stability.

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Statement of Copyright

Acknowledgment

I wish to express my sincere appreciation and thanks to professor D. P. O'Brien for his interest, continuous guidance and constructive comments throughout the research, without which this thesis just would not have been the same.

My appreciation for financial assistance from the Government of Qatar is acknowledged, without which the job would have been a burden.

To my wife Hamda, my sons Mohammad and Abdulla and my daughter Mariam,

I would just say thank you for the endless patience and support throughout a long time which seemed endless.

I. Introduction

The growth of international trade has led to an increase in the degree of interdependence in the world, which has imposed a greater degree of uncertainty in both the goods and the money markets. The interdependence of nations has undoubtedly caused foreign decisions to have implications on the domestic economy of a given country. The repercussions of foreign supply or demand shocks may affect the domestic demand for imports and import substitutes, while domestic exports can be affected as foreign demand for the domestic country's export changes. However, since for many countries the demand for currencies is mostly a function of trade transactions, the relative price of currencies will be affected by trends in the goods market. Such interdependence has to be recognized as a fact once trade crosses the national borders of a country. Furthermore, it has imposed a need to implement a balance between the internal and the external sectors of the economy, which requires the adoption of a dynamic process of adjustments as domestic and foreign environments vary. Indeed, a major source of variations may originate in the exchange rates market. Thus, several attempts have been made to reduce the instability in the exchange rates.

However, the problem facing most nations has not limited itself to either the goods or the money (foreign exchange) market; rather it has manifested its spirit in both areas. This makes the cause of the problem difficult to define, and the diagnosis of potential solutions rather imperfect.

It may be the case that a conflict may arise between suggested policies designed to countering disequilibrium in the goods market, and to those tailored to affect the exchange rates market. Such a conflict is expected to be even worse for countries with limited economic power to affect the world markets. Such a situation is a characteristic of the majority of developing countries. While they may have control over their supplies of raw materials, output, exports and imports, this control is severely confined to quantities rather than prices. Changing world supply of and demand for a developing country's imports and exports introduces uncertainty in the expected costs of its imports and in the expected revenues from its exports. However, having limited power to affect the market, many developing countries have sought refuge in trade barriers, exchange control, tariffs and quotas, capital flow control and other similar impediments to trade and foreign exchange. Nevertheless, these distortions have not alleviated the potential costs on the domestic economies of changes in world markets, although they may have succeeded in diverting the costs and the benefits from one sector of the economy into another.

Alternatively, some developing countries have aimed to reduce exchange rate risk by fixing the value of their currencies relative to other major currency(s). This is viewed as an alternative to capital controls and is designed to diminish potential risks associated with trade flow. Although this determination on the part of the official monetary authorities may fulfill its objectives in the foreign exchange market, by stabilizing the relative price of the domestic currency, it has little effect on curtailing the transmission of foreign policies and on shocks originating in the goods market. Pegging (fixing) the value of the domestic currency to another currency or a basket of currencies, would have little effect on the foreign supply of goods and demand for domestic products, as long as demand and supply are affected by factors other than exchange rates. For example, a real price shock originating in a foreign country which trades with the domestic country will have effects on domestic prices, whatever the exchange rate arrangements adopted domestically. Moreover, for developing countries which depend on a single source of foreign exchange, i.e. a country exporting a single commodity, the problem is rather serious. Trends in the market for that product constrain revenues, impose constraints on domestic expenditure, hinder development plans, reduce growth and may cause political unrest. Since revenues are a function of quantity, price and the exchange rates between the domestic currency and the currency(s) in which the export is invoiced, the authorities would have to deal with a wider range of issues than when there is a single potential source of uncertainty. Indeed, even though unexpected price and quantity changes by exporters who have market power (measured as a percentage of their market share) tend to have impact in the short run, market forces have been shown to prevail and to curb monopolistic behavior in the international market. Thus cartel behavior will not protect such an exporter. Accordingly, it is necessary to investigate the possible arrangements available to a single-commodity based economy with respect to the currency in which its export is invoiced.

As economies which depend on oil as their major source of income, member states of the Gulf Cooperation Council (GCC) have experienced the consequences of declines in both the nominal and the real values of oil revenues. After the periods of rising revenues from oil exports which dominated much of the second half of the 1970's and the early few years of the 1980's, both the dollar receipts of exports and the purchasing power of these receipts have shown a similar downward trend. In contrast to the years of rising oil revenues, the governments' budgets currently suffer from deficits, which have forced these governments to be frequent borrowers in the money market. Furthermore, reduction in governments' spending and investment has rippled through the domestic economies with increasing negative effects. This has raised questions about the continuing dependence on the public sector to uphold, rather than stimulate, the economy. The authorities have blamed their inability to sustain the expenditure patterns they long have adopted on the decline in the purchasing power of oil revenues.

It can be argued that the authorities are concerned with the real value of oil revenues, expressed in terms of the domestic currencies. However, there are four major factors which may influence this value. Firstly, the share of the quantity of oil exported. This is assumed to be determined by either official or unofficial agreement between the member states. Secondly, the world market's price of oil, which has been shown to be a function of the world supply of and demand for oil, and thus exogenous to the GCC economies. Thirdly, the exchange rates between the currencies of the GCC member states and the currency in which oil is invoiced. Fourthly, a price index which can be used as a proxy to determine the real value of oil revenues, i.e. the purchasing power of those revenues.

Since the GCC economies rely heavily on imports to fulfill domestic aggregate demand, a method of relating oil revenues to the currencies which are used to denominate imports could prove to be vital to minimize fluctuations in the real value of oil revenues. Moreover, fixing the value of the domestic currencies in terms of the currency in which oil is invoiced will eliminate the exchange risk attached to the domestic currencies' nominal value of oil revenues. However, as long as there exist channels which allow imports to be denominated in other currencies, the above peg would be unable to eliminate problems arising from exchange rate changes between the domestic currencies of the GCC member states and the currencies of the countries from which they import. This would therefore leave the real value of oil revenues vulnerable to potential changes in the exchange rates.

It is the purpose of this thesis to provide a framework within which a method is developed that relates the exchange rate arrangements adopted by the GCC member states to the currency in which oil is invoiced. Explicitly, an analytical model is constructed in which the objective function is to find the optimal currency invoicing for oil, based on minimization of the variance of the real value of oil revenues. It is argued that this value is a function of a weighted price of imports, where this price index is a function of the relationship between the exchange rates of the domestic currencies of the GCC member states and those of their trading partners. Indeed, a main feature of the model is its integrative approach to two issues relevant to the GCC economies, namely the decision to choose a currency or a basket of currencies to which the domestic currencies are to be pegged, and the determination of that choice in relation to stabilization of the real value of oil revenues, if oil is invoiced in alternative currencies as well as baskets of currencies.

It is hypothesized in this thesis that the currency invoicing scheme for oil, where the dollar is used, constitutes a non-optimal choice, according to the welfare function proposed. This may be attributed to the fact that trade is not entirely invoiced in dollars, but in a range of currencies. Accordingly, if oil is invoiced in a trade-weighted basket of currencies, and the domestic currencies of the GCC member states are pegged to a basket as well, stability in the domestic currencies' real value of oil revenues may be achieved.

Reviewing the literature reveals no trace of a model which has made a similar attempt, although there has been an extensive discussion of the question of the optimal currency peg. A major assumption proposed by the analysis is that oil may be invoiced in another currency than the U.S. dollar, or in a basket of currencies. The thesis does not investigate the practical day to day mechanism of such invoicing. Nonetheless, it may be argued that, once the assumption of rationality is postulated, it may not be unwise to expect exporters to demand other types of payments if the alternative proves to be superior according to a particular welfare function. However, their ability to implement such a payment scheme would depend on many factors, such as their market power and the reaction of their trading partners.

Nonetheless, this model may be extended to evaluate the performance of the same objective function by countries exporting a single commodity other than oil, and if the exchange rates between their currencies and other currencies in the world are fixed to some extent, the present model will be of greater relevance.

Throughout the thesis, references are made to interviews conducted by the researcher in the six GCC member states. These interviews were carried out in the period from the 10th of February 1990 to the 10th of March 1990. Examples of people interviewed include bankers, foreign exchange advisors both at the commercial banks and the central banks, officials at central banks, such as the governor of the Central Bank of the United Arab Emirates, the governor of Qatar Monetary Agency, the deputy governor of Bahrain Monetary Agency, and the directors of the economic and research departments at the Saudi Arabia Monetary Agency, the Central Bank of Oman and the Central Bank of Kuwait.

After this introductory Chapter, the rest of the thesis is divided accordingly. Chapter II will review the development of the international monetary system, with emphasis on the emergence of the currency pegging arrangements. The review will examine the major features of the international monetary agreements such as the

Gold Standard, the Bretton Woods Agreement and the Smithsonian Agreement. The advantages and disadvantages of flexible and fixed exchange rates will be discussed. The proposal of a unified peg is analyzed in the literature on the Optimum Currency Areas, where several countries may establish a joint peg between them. Chapter III examines the issue of the optimal currency peg, reviews the literature, and further examines the welfare functions of a currency peg proposed by each model. The impact of changes in prices and exchange rates on trade and potential effects on importers and exporters will be examined in the Chapter IV. It is shown there that the choice of the currency denomination of international contracts can have impacts on the parties involved. In general, they would attempt to minimize the potential negative impacts, by choosing to denominate contracts in their own national currencies. However, for exporters of particular commodities, such as internationally traded raw materials, the currency of invoicing is determined on an ad hoc basis. After these theoretical chapters, the model is presented in the Chapter V. A distinctive feature of this model is embodied in its integrative approach to the problem, where the choice of the optimal currency invoicing for oil is designed to be related to the optimal currency peg of the domestic currencies of the GCC member states. The findings obtained from estimating the model are presented and analyzed in Chapter VI. A summary of the thesis and its major findings are cited Chapter VII, where recommendations are also presented. Toward the end of the thesis, Appendix 1 provides tables of the data used in the estimation, whereas Appendices at the end of particular chapters provide some explanations and derivations of certain technical aspects of the model.

II. Historical Development of International Monetary Systems

Long before recent times, traders in goods and financial assets sought stability for the value of an exchanged currency. Throughout history, precious metals have been used to provide a form of assurance, a policy which was adopted by nations until the third decade of the present century. The gold standard, as it is known, dominated the fixed exchange system which was adhered to by major trading countries in the world. It may be argued that this was helped by the control of a vast part of the globe by a limited number of countries, who controlled resources and implemented policies that were effective at the international level. However, the emergence of statehood which started to spread over the world after the First World War, and the growth of a more sophisticated trade, together with the emergence of wage and price inflexibility, contributed to the demise of the gold standard.

Later, in 1944, there was an attempt to restore order in the international monetary arena, and the Bretton Woods agreement came about. It proved capable of surviving the emergence of even more sophisticated trade, as well as the growth of greater interdependence in the world economy. However, the system collapsed in 1971. Several attempts were made to salvage its spirit; nonetheless, they were deemed to fail. One of those attempts was the Smithsonian Agreement, which finally collapsed as a result of its abandonment by the major industrial countries. Since then, the currencies of these countries have been floating, although not freely, while small developing countries have in general chosen to fix their currencies in terms of the currencies of the industrial country(s).

This chapter will explain the mechanism of the gold standard, and summarizes the factors which contributed to its abandonment. Then, in the second section, a review of the adjustable peg of the Bretton Woods will be presented, with a discussion of its mechanism and its major weaknesses. In the third part, a brief look at the Smithsonian agreement will be given. In the fourth section, the fixed and flexible exchange rate regimes are discussed. An analysis of the optimum currency area theory will be presented in the fifth section. Finally, a look at the pegged exchange rate regime and the available schemes within this regime will be presented.

II.1. The Gold Standard

The era before the First World War was characterized by gold as the numeraire to which countries fixed the value of their currencies. Under this standard, the participating countries fixed the value of their currencies in terms of a specified amount of gold and stood ready to exchange their currency units for gold. Consequently, the exchange rate was determined as the rate between any two currencies plus transportation costs of gold. This fixed exchange system insulated the relative price of currencies from changing; however, it left the balance of payments to absorb changes in prices as well as in the demand for imports and supply of exports.

The fixed exchange rate ensured interdependence in the world economies. For example, a decline in the price level in, say, country A, would encourage demand for its exports. Thus, gold will flow into country A to pay for the rising demand for its exports. However, as the inflow of gold occurs, money supply in country A increases, putting upward pressures on the price level until equilibrium in the balance of payments is restored. Conversely, a deficit would result in gold outflow as demand for foreign goods rises. However, the outflow of gold reduces domestic money supply and price would decline until equilibrium in the balance of payments is achieved.

The proceeding analysis depends crucially on the assumptions embodied in the classical monetary model. Real money supply is hypothesized to depend on the reciprocal of money velocity, V, and income, Y. That is:

$$M^s/P = (1/V)Y$$

where $1/V$ is assumed to be constant and income is expected to fluctuate around its long run equilibrium level. Thus, if the right hand side of the equation is stable, then for the equality to hold, a rise in money supply would lead to a proportionate increase in the price level. Consequently, if the money supply rises, the price level will rise as well. This would be the case if demand for exports in a country increases. Under the gold standard, gold will flow into the surplus countries, increasing the money supply, thus raising the price level. However, the opposite occurs in the deficit countries, where gold flows out of the country contracting the money supply and reducing the price level.

This role of the price level, known as the price-specie flow mechanism, assures that gold will cease to flow as prices are equated internationally. However, for the mechanism to operate efficiently, certain conditions must be met. Firstly, in order to react to price changes, there must be no barriers to trade. Secondly, the elasticities of imports and exports would have to be sufficiently high so that producers and consumers respond to price changes, i.e. the Marshall-Lerner condition must be met. Thirdly, for the flow of gold to affect the domestic and the foreign price levels, the central banks must not sterilize those flows. For example, on the one hand, in an attempt to keep the interest rate low, a deficit country may increase the money supply so as to offset the outflow of gold. On the other hand, a surplus country, with rising reserves of gold, may try to avoid increasing the growth of the money supply, impeding the rise in its price level. Fourthly, prices and wages have to be flexible in both directions. This is essential since the whole operation of the gold standard depends on the mechanism of the price level. Indeed, if prices do not respond to the outflow and the inflow of gold, the chain of transmitting disequilibrium and initiating equilibrium is lost, and deficits and surpluses would continue to persist.

On the other hand, there were some noted advantages associated with the gold standard. The stability of the exchange rates amongst the countries in the world was recognized by far as the most important advantage of the system. It is often argued that such a stability would encourage trade through its reduction of exchange rate risk. Furthermore, if the rules of the system were adhered to by all participating members, there would be an incentive for countries to have stable money growth rates, because instability may mean a demand for gold in exchange for currencies. Consequently, as the classical equation of money supply implies, prices would be stable.

These advantages, however, failed to insulate the system from collapsing in the early 1930's. It was abandoned by the U.K. in 1931 and by the U.S. in 1933. Basically, it can be argued that the participating countries could no longer honor the sweeping demand of currency holders to exchange their currencies for the equivalent value of gold.

II.2. The Bretton Woods System

Toward the end of the Second World War, an agenda to reform the international monetary system was introduced. The aim of the system was to organize and monitor rules via which exchange rates would be determined, as well as to establish a mechanism by which incentives to engage in competitive devaluations may be curbed. However, as was the case under the gold standard, member states were expected to adhere to the rules established by the International Monetary Fund, the IMF. Mainly, surplus countries were expected to alter the fixed exchange rates for their currencies in an upward direction, whilst deficit countries would devalue their currencies, after consulting the IMF. The mechanism was so delicate that the relevant authorities at the IMF were supposed to distinguish a situation of a ' fundamental disequilibrium ' amongst many situations where countries were eager to change or to preserve the relative values of their currencies.

The participating members who met in Bretton Woods in the U.S., agreed in 1944 to fix the value of the dollar in terms of gold, while the other members fixed the value of their currencies in terms of the dollar. Although the system allowed for bands of the exchange rates within one percent (up or down), and the operation of the system was supplemented by the International Monetary Fund, the Bretton Woods agreement was abandoned in 1971.

The collapse of this agreement may be attributed to many factors, but the growth of the U.S. outstanding dollar liabilities was the major one. By the late 1960's, the U.S. deficit had grown at an alarming rate relative to the U.S. holdings of gold reserves. The U.S. ratio of debt to its gold stock accelerated from 0.39 in 1950 to 1.18, 2.10, and 4.24 in 1960, 1965 and 1970, respectively[1]. Consequently, doubt was cast on its ability to honor the foreign holding of dollars, which were increasingly being exchanged for gold. Moreover, the growth in the U.S. deficit, which was financed through international borrowings, was seen to export inflation to surplus countries. This was an undesirable consequence of the Bretton Woods agreement. Many countries resisted this inflationary impulse; they accused the U.S. of using the rest of the world as an absorber of its fiscal and monetary policies.

One may add that the special status awarded to the dollar under the Bretton Woods agreement has contributed to its eventual decline. Being the country of the reserve currency, the U.S. was in the position to receive seigniorage, the difference between the costs and the benefits of creating money. This was seen by many countries, especially France, as a means by which the U.S. was capable of maintaining deficits, with little incentive to restrain its consumption pattern. Consequently, the French had attempted to exchange dollars for gold, therefore inflicting greater pressures on the U.S. gold reserves and increasing the supply of the dollar. For example, in 1962 France began to exchange dollars for gold, a move which was interpreted by many economists on both economic as well as political grounds (Yeager (1976), p. 480-481. Levi (1983), p. 141). In 1965, France converted about one billion of its dollar reserves into gold[2], continuing the campaign to show a distaste for the U.S. status of gaining seigniorage under the Bretton Woods international monetary agreement.

Although the U.S. policies may have contributed to the downfall of the adjustable peg system of Bretton Woods, it may be argued that with increasing

[1]Graham Bird, *World Finance and Adjustment: An Agenda for Reform* (London: The Macmillan Press Ltd., 1985), p. 57.

[2]LeLand B. Yeager, *International Monetary Relations: Theory, History, and Policy.* 2nd edition (New York: Harper and Row Publishers, 1976), p. 481.

world trade and the consequent rise in demand for a vehicle currency, the system of backing the U.S. dollar (which was increasingly being used as a vehicle currency in trade) with gold, of which the supply was fixed in the short run, was found to collapse.

Despite the shortcomings of the system, an attempt was made in December of 1971 to salvage what remained from the international monetary agreement of the Bretton Woods.

II.3. The Smithsonian Agreement

In an attempt to rectify the principal defects of the Bretton Woods agreement, the Smithsonian exchange rate mechanism, agreed upon in 1971 called for a rise in the U.S. dollar value of gold, from $35.00 to $38.02 per ounce of gold. Implicitly, this meant a revaluation of the domestic currencies of the participating countries against the dollar. Furthermore, the newly established band around the value of a given currency against the dollar was wider than its counterpart that characterized the previous international monetary agreement. The present system allowed for 2.25 percent movement on either side of the fixed par value. However, this agreement failed to restore confidence in the internationally negotiated system of exchange rates. Bird (1985) argued

> Basically they [the reasons for the failure] are that the agreement was not only unable to restore confidence in the stability of central values, but also insufficiently flexible to allow exchange rates to move toward their equilibrium values where these had failed to be established by discretion. The view that the rates chosen in 1971 were inappropriate is supported by the observation that balance of payments disequilibria remained uncorrected after the agreement. Failure to select equilibrium exchange rates and uncertainty and instability to which this gave rise

dictated a move towards floating as a matter of expediency[3].

Moreover, the unique features of trading countries, their differing economic targets and the unequal effects of world price shocks have contributed to varying inflation rates in the world. Since inflation affects the relative purchasing power of currencies, there was a continuing decline in demand for weak currencies. Most countries found the Smithsonian remedy to be too costly and ineffective. In the end, the currencies of major industrial countries such as the dollar and the pound began to float, although not freely, ending an era of fixed exchange rate arrangements.

II.4. Fixed and Flexible Exchange Rates Regimes

The move toward a regime of flexible exchange rates brought forward the traditional debate between those favoring flexible exchange rates and those advocating the fixed exchange rate alternative. Based on the notion that exchange rates under a perfectly flexible system would reflect market forces, i.e. supply of and demand for currencies, the proponents of this system argued that the relative values of currencies would be capable of correcting balance of payments disequilibria. For example, assuming a world of country A and country B, where their currencies float against each other, a reduction in demand for country A's export tends to result in a balance of trade deficit in this country. Under a flexible exchange rates regime, this will affect the derived demand for currency A and currency B where currency B will appreciate vis-á-vis currency A. As a result, the demand for B's export will decline and its surpluses should be eliminated.

Alternatively, had the exchange rates been fixed, country A would have passed through a recession before equilibrium had been restored. Then the deficit described above would reduce prices and real wages in country A, resulting in unemployment and a reduction in output. However, country B will experience a boom

[3]Graham Bird, *World Finance and Adjustment: An Agenda for Reform* (London: The Macmillan Press Ltd., 1985), p. 59.

in its output, accompanied by a rise in its inflation rates and its wages. How could a situation like this be corrected in a world of fixed exchange rate regimes ? The proponents of flexible exchange rates argue that the cost of restoring equilibrium under the assumption of fixed exchange rates is both high and likely to be resisted by many sectors in the economy. Given that the exchange rates do not adjust, relative prices of exports of countries A and B will have to compensate for that. That is, prices in country A will have to decline and so should wages, where this latter decline is expected to encounter resistance in the economy. On the other hand, rising prices in country B should constitute a legitimate concern for the authorities in country B. Thus, although equilibrium may be reached, it is only through a painful process of adjustment.

A major problem with the fixed exchange rates regime stems from the fact that, under this regime, economies tend to be interdependent, so the authorities lose control over their monetary policy. For example, assume that the numeraire currency is the dollar, against which the currency of the domestic country is fixed. Then, if the U.S. inflates at a faster rate than the domestic price level, there will be a tendency for the dollar to depreciate, as demand for U.S. products declines; while the domestic currency would be under pressure to appreciate, as demand for domestic output rises. But the rate is fixed. This would occur unless the domestic country is willing to run inflation rates equal to those of the U.S. It is only then that equilibrium will be restored. Thus, under fixed exchange rates, inflation can easily be transmitted between countries. However, had the currencies been subject to the market mechanism, the rise in the U.S. price level will result in a decline in the relative value of the dollar in terms of the domestic currency, thus eliminating the need for the domestic rate of inflation to be consistent with that of the U.S.

The proponents of fixed exchange rates argue that the ability to have independent monetary policy is actually a drawback of the flexible system. For countries with an unstable monetary policy, the fixed exchange rate system will enforce discipline on these economies. Assume that the domestic monetary authorities increase the domestic money supply by expanding domestic credit. Then, under a system of fixed exchange rates, the result will be a disequilibrium in the money market, where money supply is greater than the demand for it. This will result in a deficit as reserves flow out of the domestic country, as a result of people adjusting their desired holdings of cash balances to the new level of money supply. The loss of reserves will reduce money supply, thus contracting the available balances and resulting in a deflationary outcome. Hence, it is more likely that the expansion of credit will be self-destroying under the fixed exchange rate system. Dunn (1983) has disputed the ability of individual countries to pursue an independent monetary policy in the actual world. Dunn wrote:

> The earlier belief that flexible exchange rates would free monetary policy from international constraints assumed that central banks and governments were prepared to accept whatever exchange rates resulted from domestic or foreign monetary-policy shifts. That assumption no longer holds. Domestic monetary policy again faces an international-payments constraint: it must approximate the monetary policy being pursued abroad in order to avoid large exchange-rate movements[4].

But, as Sohmen (1961) and Mundell (1963) argued, with flexible exchange rates, an expansionary monetary policy by a country would not result in a deficit in its balance of payments; rather its currency will depreciate, thus allowing it to maintain equilibrium.

Another argument against flexible exchange rates arises from the fear that flexibility will result in fluctuations and in lack of confidence in currencies. Furthermore, this will stimulate speculation, which can be destabilizing, i.e. it exacerbates the problems of a depreciating currency by inducing further depreciation. Friedman (1953) discounted the importance of this type of speculation by arguing that speculators would lose money if they speculate on a change in the exchange rates in a wrong direction, and only those speculators who guess it right will stay in the market. Furthermore, Friedman saw a limit to speculation in the resources

[4]Robert Dunn, The Many Disappointments of Flexible Exchange Rates. *Essay in International Finance*, no. 154 (Princeton: Princeton University Press, December 1983), p. 11.

available to speculators, and defended the view that even speculators should not be expected to speculate on a change in the value of a currency greater than what is expected to occur in the long run. Putting it differently, speculation, if it is in the direction of long run equilibrium, will smooth out the expected change in the exchange rate over time, and thus be stabilizing.

In addition, flexible exchange rates are believed to cause uncertainty over the future relative value of currencies thus deterring trade and investment. Corden (1972) argued that the exchange rate variations would affect the utility associated with having money as a store of value, because the general price level is no longer stable. Moreover, since domestic prices are expected to be less variable than foreign prices due to the exchange rate risk, a bias against foreign trade may result. A counter argument is put forward by the proponents of the flexible system, who argue that if the exchange rates can adjust, then there is no need to impose restrictions on trade. Furthermore, forward exchange rates can be employed to avoid potential exchange risk[5].

Another argument offered by the supporters of flexible exchange rates hinges on the need to hold international reserves. Unlike the case of the fixed exchange rate system, where the authorities may have to use their holdings of foreign reserves to intervene in the foreign exchange market, this need is eliminated under the flexible exchange rate system. That is because the authorities have no policy to restrict the behavior of the exchange rates in certain paths. The holding of international reserves entails an opportunity cost to the holder. The reserves could be used to finance additional present consumption, but holding them foregoes this, although it results in receiving a yield. Lanyi (1969) has disputed the absence of the need to hold reserves in the practical sense, casting doubt on the reality of the total absence of governmental intervention in the foreign exchange market. Realistically, Lanyi argued, what is relevant to the argument of holding international reserves is the potential size and cost of this holding under the alternative exchange rate regimes.

[5]This issue is explored further in Chapter IV.

Bird (1985) carried the debate against fixed exchange rates further, by arguing that although the rates are fixed at some initial time, there is a possibility that the economies will undergo structural changes, which would require review of the pre-set parities. However, frequent alterations to the fixed exchange rates may actually encourage speculation. Moreover, the officially set parities are likely to diverge from the market-determined rates, at least over time. That is because the latter rates are dynamic in nature and reflect the dynamism of the underlying forces of supply and demand in the economies. Bird wrote:

> The main ...[problem] arises when the officially fixed rate is not the same as the free market rate or the fundamental equilibrium rate. Trading will then be conducted at a disequilibrium set of relative prices. The wrong price signals are given to consumers and producers and the pattern of demand and production adapts in ways that do not make the best use of scarce global resources, i.e. inefficiency is the outcome. But is this likely to be the case ? The answer must be that it is. Even if authorities were initially able to identify accurately what the equilibrium set of exchange rates were at a particular point of time, these rates are unlikely to remain equilibrium ones for long[6].

However, there is a further possibility. If a flexible exchange rate is not optimal and can cause any of the problems cited above, then joint flexibility of a group of countries may diminish the risk of being exposed to those drawbacks. Furthermore, the merits of fixed exchange rates may be retained if this group of countries keeps the rate fixed amongst their currencies. However, a joint float or flexibility can not be established on ad hoc grounds. What determines the optimality of establishing and joining such an alternative is the purpose of the contribution of Robert Mundell (and others) to the literature on exchange rate systems.

[6]Graham Bird, *World Finance and Adjustment: An Agenda for Reform* (London: The Macmillan Press Ltd., 1985), p. 246.

II.5. Optimum Currency Areas

Based on the theoretical framework presented by Mundell (1961), a group of countries may, under certain conditions, fix their currencies with respect to each other, whilst floating with respect to other currencies in the world, thus creating a currency area which may or may not be optimum. Since then, a number of criteria upon which the optimality of a currency area may be judged, have emerged.

Mundell argued that if factors of production (labor and capital) are mobile between countries, the countries will benefit by a monetary union. Assume that there are two countries in the world, country A and country B. At time t, both enjoy a balance of payments equilibrium. However, at time t+1, demand for product A, produced by the first country, declines, thus leading to a balance of payments deficit. Country B experiences a surplus, as demand shifts away from A. The question is, can equilibrium be restored in both countries' balances of payments ? Mundell argued that, if labor and capital can and are willing to move between these countries, then the unemployment occurring in A will reduce wages and prices in country A, while the surplus in country B would raise wages and prices, as demand for product B increases. Then labor will move to country B, reducing real wages there, while increasing them in country A. In addition, the price level tends to rise in country B as demand for product B rises and decreases in country A as demand for product A declines. This process will continue until equilibrium is restored. If this were the case, then there would be no need for the exchange rate between currency A and currency B to change, and thus we have a case for a currency area, which is to be composed of both currencies fixed in terms of each other. Note that this argument assumes labor is homogenous and can move as well as is willing to move between these countries, i.e. reallocation costs are compensated for by expected higher wages in country B. Moreover, labor and capital are assumed to be used in the same technical ratios in both countries. If this were not the case, then even though these factors move between countries, there is a possibility that some labor or capital may still be unemployed in this world.

However, if factors of production were not willing to move or unable to relocate so as to restore equilibrium, then this restoration must be achieved by other means. In the present example, assuming labor and capital immobility, relative prices could have adjusted to the changes in demand. That is, as demand for product A declined, its price should have decreased. Furthermore, wages should have declined in country A relative to that in country B. So, unlike the above case where the analysis allowed for mobility of factors of production, in the present one, relative price changes would restore demand and, consequently, balance of payments equilibrium. Alternatively, exchange rate flexibility could replace price flexibility. Country B's currency would appreciate relative to that of country A. Thus, flexible exchange rates would reflect the economic changes which country A and country B are undergoing.

Mundell characterized countries between which factors of production do not move and relative prices are not allowed to adjust as unsuitable to form a currency area, because exchange rates would have to be allowed to adjust, so as to eliminate balance of payments equilibrium.

The assumption of labor and capital mobility has been criticized by Lanyi (1969), Dunn (1971) and Fleming (1971). The latter argued that capital may not be sensitive to changes in the economic environment in the short run. Assume a balance of payment disequilibrium has occurred between two countries which are members of a currency area. A potential source of this disturbance may be a shift of demand from the product of country A to that produced by country B. The consequent outcome of this would be an emergence of unemployment in country A, compared to a rise in the level of employment in country B. A possibility of restoring equilibrium may be seen in the implementation of a policy which could reduce demand in the latter country whilst encouraging demand for product A. Such a policy is expected to raise the level of unemployment in country B, resulting in a slowdown of economic activities. On the other hand, the increase in demand in country B would stimulate employment and economic activities, as the incentive to invest rises in country B and declines in country A. Fleming argued that the level of saving will decline in country A, whereas country B will experience a rise in its level of saving. The role of capital in affecting production and employment depends on the sensitivity of investors in country B to move to country A. If the incentive to invest in country A declines by more than the decline in saving in this country, and rises more than saving in country B, unemployment would persist in country A and inflation will rise in country B. Thus, capital will flow in favor of the latter country against the former. A possible outcome of this behavior is a worsening of the balance of payments disequilibrium.

Another criticism was made by the other authors who argued that labor mobility tended to be limited by the costs of migration and barriers of entry at the inter-industrial levels. Moreover, even if labor is mobile between member countries of a currency area, it must be mobile at the inter-industrial level. Lanyi (1969) has argued that the latter mobility is normally hindered by the downward rigidity of money wages, which must fall for firms so as to induce them to hire additional labor. In addition, one may argue that the reallocation of resources from the production of the commodity for which demand has declined depends on the adaptability of these resources to the production of the same commodity in the other country.

Another criterion upon which countries may join to form a currency union was proposed by McKinnon (1963). A small, open economy, defined according to the proportion of tradable goods to total output, is likely to suffer from fluctuations in the domestic price of tradables, if it adopts flexible exchange rates, in McKinnon's view. Furthermore, since the share of tradables is large in the domestic price index for most small open economies, domestic prices are expected to fluctuate. This will make the return on holding domestic currency uncertain and economic agents may substitute foreign currencies for the domestic currency. To some extent such currency substitution may produce further uncertainty. It is mainly for this reason that countries which are small and open, in the economic sense, are likely to avoid such undermining of the domestic currencies and fluctuations in domestic prices by joining a major currency.

It is worth noting that, implicitly, McKinnon assumed that foreign currencies provide a stable alternative in terms of their relative values. Ishiyama (1975) argued that there is no evidence to support the assumption of stability in the exchange rates amongst the large trading countries in the world. Thus, even if the domestic currency is defined in terms of a major currency, it is very likely that fluctuations in the exchange rates between the domestic currency and the other trading partners would remain volatile (though this may be minimized in the case of a basket peg as we shall see in a later section).

A third criterion was proposed by Kenen (1969), where he argued that a low degree of product diversification provides an incentive for forming a currency area. Countries which have concentrated trade both in terms of commodities and geography, where their economies are likely to be affected more than the diversified economies by exchange rates fluctuations, constitute an optimum currency area(s). For example, consider an economy which is diversified in terms of its imports and another which is not diversified. A shock originating in the external market will have a smaller impact on the more diversified economy, since, on average, the components of the domestic price index tend to rise for some goods while declining for others (diversified source of imports). Thus, the exchange rates do not need to vary to be able to accommodate the external shock. However, for the less diversified country, the same shock would have a greater impact on domestic prices and employment. Consequently, there will be greater exchange rate changes required to correct for the shock in the latter country. In this case, creating a currency area with respect to the currency of the trading country with which trade is concentrated may diminish the severity of the shock on the domestic economy.

A final criterion rests on the fact that similarities of macroeconomic objectives amongst countries tend to facilitate and encourage the creation of optimum currency areas (Haberler 1970, Fleming 1971). Since such unions imply surrender of an independent monetary policy, similarity of macroeconomic conditions and objectives, which raises doubts about the independence of monetary policy, encourages countries to enter a currency union. One may argue in addition that countries which face similar economic shocks have a tendency to eliminate an additional source of shocks, namely variations in exchange rates, thus pooling resources to encounter the common shocks. For example, if country A and country B view variability of their currencies vis-á-vis a third currency as excessive, and both economies aim at reducing this variability, then a joint resistance may reduce the impact of the third currency on their individual currencies. One may argue that this has been one of the objectives of the European Monetary System (EMS), primarily against the dollar.

Although the theory of optimum currency areas presents a theoretical framework which may be adopted to determine the desirability of a country joining a currency area, it is left to that country to weigh the benefits and costs associated with such a decision (Ishiyama 1975). The benefits side includes the elimination of exchange rate transaction costs (these costs are not eliminated even under fixed exchange rates) associated with converting currencies, and the elimination of speculative capital flows (based on expected changes in the exchange rates). One may argue that, for countries with limited markets, a monetary union may enhance the prospect of large scale industries which are encouraged by the opening of markets. For example, for the Gulf Cooperation Council member states, a fixed currency area with capital mobility has the potential to make many types of industries profitable, assuming that these industries require large demand.

Moreover, Williamson (1974) argued that monetary integration is likely to accelerate fiscal policy integration, thus moving the concerned economies toward economic integration. Corden (1972) maintained that a complete exchange rate union where there is complete pooling of foreign exchange reserves and a major role for a union central bank, requires coordination of both monetary and fiscal policies. Corden wrote:

> A common foreign-exchange pool makes an exchange-rate union pos-

sible technically. But, in the absence of further measures, it does not make it practical. If each country conducted its own monetary policy, and hence could engage in as much domestic credit creation as it wished, surplus countries would be financing deficit countries without any incentives for the deficit countries to restore equilibrium. If one country ran a large deficit, the common exchange rate would depreciate, but this might put other countries into surplus. If wage rates were rising in the member countries at different rates, while productivity growth did not differ in such a way as to offset the effects on relative prices, those countries with the smaller inflation of wage rates would be permanently financing other countries[7].

On the costs side, as mentioned above, there will be a loss of independence in monetary policy and the monetary authorities will lose another instrument that may affect the internal market, namely the exchange rate. For example, an increase in the rate of growth of the money supply in a member country will involve a reduction in the interest rate, so that money market clears, leading to a capital outflow. This will result in a subsequent reduction in the money supply (defined as the sum of domestic credit and international reserves) and eliminate the effectiveness of the initial change in money supply. Another cost associated with a currency area is referred to by Johnson (1971), Hirsh (1972-a), Hirsh (1972-b) and Williamson (1973), among others. It is argued that since capital can move freely between countries, it is possible that some regions will prosper whilst others stagnate. It seems that for this factor to have a potential effect, mobility of labor or the desire for mobility must be limited in the long run. However, if both labor and capital are mobile and there are incentives to reallocate to depressed regions or countries, it may be possible to overcome this problem, particularly in the long run.

As 1992 is approached, the European Monetary System has emerged as a cur-

[7]W. M. Corden, Monetary Integration. *Essay in International Finance*, no. 93 (Princeton: Princeton University Press, April 1972), p. 5-6.

rency area with a degree of co-ordination in monetary policies and where factors of production will be free to move amongst the participating countries. To some extent, the trade-off between unemployment and inflation has received a similar attention by all participating members (especially those who participate in the Exchange Rates Mechanism, ERM). However, as of October 1989, there have been 12 changes (realignments) in the exchange rates amongst the participating members in this exchange rates mechanism, raising the possibility noted by Bird earlier that even fixed exchange rates amongst a number of currencies may prove to be responsive to changes. Accordingly, even the creation of currency areas does not preclude fluctuations in exchange rates, although the evidence shows that it has minimized these fluctuations[8].

Currency areas of the kind established in Europe have not appealed to most developing countries. This may be attributed to the divergence in the policy objectives or simply to their rejection on the basis of political sovereignty. At least the latter argument has been central to the issue of potential monetary unification of the member states of the Gulf Cooperation Council[9]. However, many developing countries have chosen to peg their currencies in terms of either a single currency or a basket of currencies, aiming at achieving similar objectives to those hoped for in the optimum currency area.

II.6. Pegged Exchange Rates

The uncertainty which surrounded the international financial community after the collapse of the Bretton Woods system has provided smaller countries with two major alternatives. One is to adopt the newly emerging floating exchange rate scheme. The second is to fix the value of their respective currencies in terms of a major world currency, or a basket of currencies. Central banks play a prominent

[8] Policy Coordination in the European Monetary System. *IMF Occasional Paper*, no. 61 (Washington: International Monetary Fund, September 1988).

[9] Personal interview with Abdel-Malik Al-Hamer, Governor, Central Bank of the United Arab Emirates, Abu-Dhabi, 3 March 1990.

role when a pegged exchange regime is adopted. Compare the situations depicted in the next three figures. Figure (1) depicts an equilibrium at the fixed exchange rate E^*, with the demand for and the supply of foreign exchange reflected by D_1 and S_1, respectively. Assume that demand has increased to a new level, D_2, thus resulting in an excess demand for foreign exchange at the fixed exchange rate, E^*, which equals the distance $X_1 - X_2$. This excess demand must be fulfilled by either the domestic central bank or the foreign banks, so as to maintain the exchange rate at its initial point. Note that market forces tend to raise the relative value of the foreign currency, i.e. pressure is put on the domestic currency, h, to depreciate relative the foreign currency, f. It may very well be the case that, although the equilibrium exchange rate is moving over time, the authorities maintain the initial rate, thus forcing them to intervene frequently in the foreign exchange market.

Figure (2) shows the role of the central bank in the case where the equilibrium exchange rate is lower than the rate at which the domestic currency is fixed in terms of a foreign currency. At E_1 there is an excess supply of foreign exchange and there is a tendency toward the equilibrium exchange rate, E^*. However, the authorities stand ready to exchange the overvalued foreign currency in terms of the undervalued domestic currency. Thus there is intervention in the foreign exchange market by supplying the excess foreign exchange, $X_2 - X_3$, with the aim of keeping the domestic currency undervalued. Alternatively, had the market forces been allowed to operate freely, the exchange rate would have moved to the equilibrium rate, E^*, leading to an appreciation in the domestic currency.

Figure (3) depicts a situation in which the equilibrium exchange rate, E^*, is higher than the rate fixed by the authorities, E_1. At this fixed rate, there is an excess demand for foreign exchange, $X_2 - X_3$. Indeed, had the exchange rate been allowed to emerge as a market outcome, the domestic currency, h, will depreciate vis-á-vis the foreign currency, f and market forces will yield an equilibrium exchange rate at E^*.

As can be seen from these situations, maintenance of a fixed exchange rate will

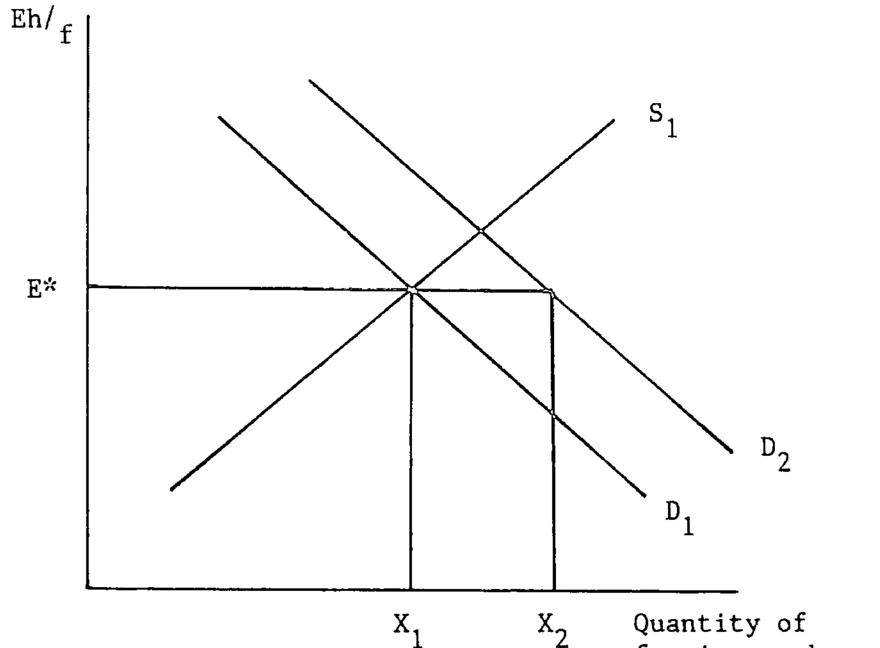


Figure (1) : Pegged exchange rate with excess demand

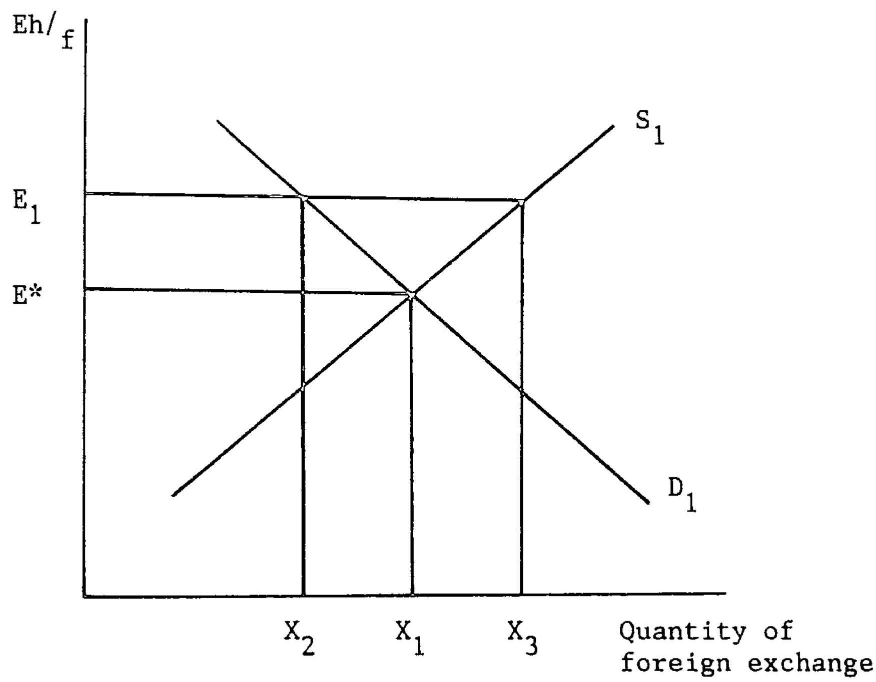


Figure (2) : Pegged exchange rate with undervalued domestic currency

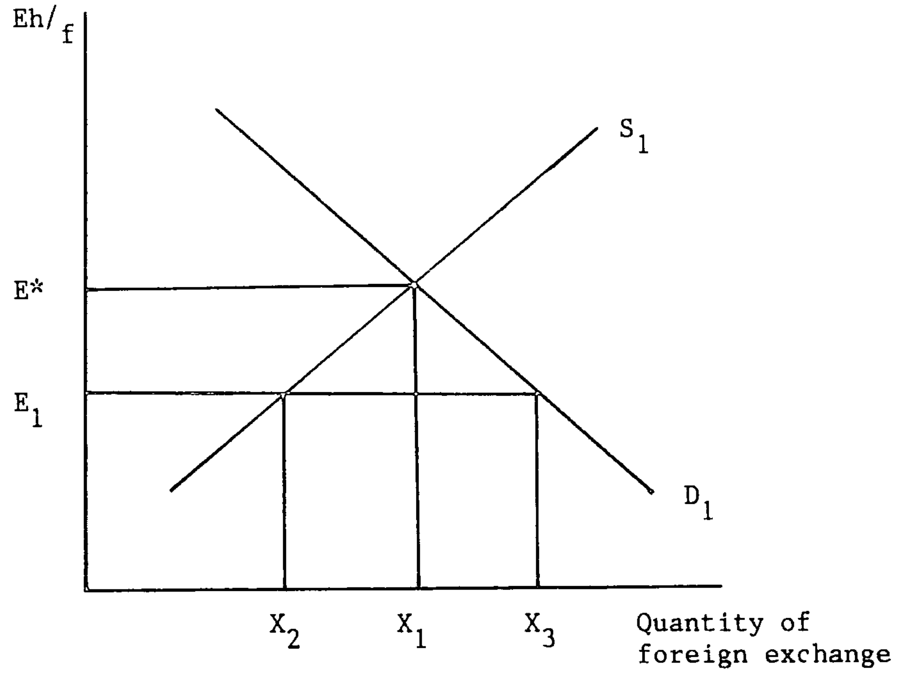


Figure (3) : Pegged exchange rate with overvalued domestic currency require holding international reserves to allow intervention in the foreign exchange market, when required. However, an obstacle may obstruct the authorities in their attempt to determine the size of the differences between the equilibrium and the fixed exchange rates. A means of avoiding frequent intervention is to allow for bands around the exchange rates.

In spite of its shortcomings, many central banks in the modern world adopt a fixed exchange rate target, although the degree of rigidity of the exchange rate and the level of intervention may vary. Indeed, an overwhelming majority of them choose to adopt a new fixed value relative to another currency (or a basket of currencies), or to maintain the relative value of the currencies in terms of the U.S. dollar. For example, the number of countries which had adopted a single currency peg regime as of October 31, 1978, according to the International Monetary Fund, was 64, 41 of whom pegged to the dollar, while 18 countries adopted customized baskets[10]. However, there seems to be a movement away from a single currency peg and a rise in the number of customized basket peggers. According to the IMF, as of 30 September 1989, 33 countries were pegged to the dollar, with an additional 4 showing limited flexibility vis-á-vis the dollar, out of the total 52 countries which pegged their currencies to a single currency. On the other hand, 32 countries pegged their currencies to a customized basket of currencies, with only 7 countries pegged to the Special Drawing Rights (SDR), compared to 13 countries in 1978[11].

A theoretical review of the issue of currency pegging will be presented in Chapter III. This will be followed by a similar presentation of the currency denomination of contracts, in Chapter IV. The methodology to be adopted in choosing an optimal currency invoicing for oil is outlined in Chapter V. An empirical estimation of the model is provided in Chapter VI. Chapter VII concludes the main body of the thesis, with concluding remarks as well as recommendations.

[10] *International Financial Statistics*, vol. 31, no. 12 (December 1978), p. 11.
[11] *International Financial Statistics*, vol. 43, no. 2 (February 1990), p. 22.

III. Review of the Literature of the Optimal Currency Peg

Following a decision by a developing country to peg its currency to either a single currency or a basket of currencies, a choice of peg has to be made. For a basket peg, both the number of currencies and their relevant weights have to be selected. The choice of either alternative tends to be closely associated with the criteria a choice of a peg is expected to satisfy. Defined as welfare index, or welfare function, such criteria may include, stability of domestic income, minimization of instability in terms of trade, stabilization of the trade balance or the domestic allocation of resources, stability in monetary policy, minimization of the variability of inflation rates and the distribution of income.

III.1. Nature of the Currency Peg

Subsequent to the collapse of the Bretton Woods and the Smithsonian agreements, many developing countries adopted the strategy of fixing the value of their individual currencies to that of a major currency of an industrial country, or, alternatively, to a basket of currencies. The decision of these countries to peg their currencies may be justified on the following grounds. Black (1976) argued that most developing countries lack a developed and integrated financial market, which is a prerequisite for an efficient floating exchange rate regime. Moreover, the small size of the financial markets that exist in many developing countries implies that fewer traders in foreign exchange would be willing to hold the currency of a small country, since investment opportunities would be small as well. Thus, a peg to a major currency would expand the investment opportunities available to investors and provide the confidence that is required to induce them to hold that currency. Klein and Melvin (1982) examined the importance of confidence in money and argued that confidence, which is built only over time, is an essential inducement for economic agents to hold a currency. On the one hand, consumers gain confidence in a currency by measuring its real purchasing power over time, and tend to avoid currencies which have the habit of frequent fluctuations. On the other hand, once consumer confidence is shattered, the ability of the government to generate seigniorage may be lost, because the public would decline to hold the issued currency.

Furthermore, Mundell (1973) argued that a peg would induce a domestic country to hold international reserves, which may be used to affect the internal market. This implies that the central government can expand domestic credit or contract it, and increase aggregate demand or even reduce it, using reserves accumulated via pegging the domestic currency. Real economic shocks at home, such as a harvest failure or strikes, can cause a loss of real income. A government may react to this potential loss by stimulating domestic demand, a policy which may be fulfilled by an expansion of domestic credit. Although the authorities would be under no constraint to expand the domestic credit, if a flexible exchange rate system is assumed, the relative value of the domestic currency in terms of the foreign currencies may fall, thus resulting in a depreciation of the former currency. In contrast, under a fixed or a pegged exchange rate regime, the holdings of international reserves can be used for some time to cushion the expansion in the domestic credit, thus easing the pressure of depreciation on the domestic currency.

On more general grounds, Crockett and Nsouli (1977), Bird (1979) and Lipschitz and Sundararajan (1980), argued that there are real costs associated with fluctuations in the exchange markets, which may be undesirable for the small economies of the developing countries. Such fluctuations may induce capital outflow and create uncertainty in the domestic currency and the economy. Once uncertainty is embodied in the domestic currency (the confidence argument), economic agents would seek a way out of holding that currency by substituting stronger currencies for it. To counter these consequences, therefore, a peg to a major currency or a basket of currencies is expected to have beneficial effects for developing countries.

Crockett and Nsouli (1977) argued that the greater the stability of the exchange rate of a currency with respect to a numeraire, the greater the level of trade in that currency, because the demand for the exports of developing countries would be more stable. Moreover, a rise in the production of exported goods should lead to an increase in capital inflow. In addition, a peg is seen to shield the domestic economy from shocks to the price level caused by exchange rate fluctuations. Thus, if most trade is concentrated with a particular trading partner, a peg to the currency of that country would provide the required protection. It seems that this argument is important, because unless developing countries peg their currencies to a major trading partner or partners, the exchange rate will transmit inflation. This may be caused by exchange rate changes and affect their domestic economies via trade, although real price shocks will be transmitted whatever the exchange rate arrangements. It may indeed be argued that economies which depend heavily on trade are more vulnerable to importing inflation that originated in the countries of the trading partners. McKinnon (1963) has argued that the variability of a floating exchange rate may cause fluctuations in the price of traded goods within a country, if the country under consideration is a price taker. Consequently, the domestic monetary authorities would be able to affect only the price of non-traded goods, while the prices of traded goods would be exogenously determined.

Given these factors, which may contribute to the decision of a small developing country to peg its currency, the choice of the appropriate peg is not clear cut. In what follows, a discussion of the available possibilities is provided.

III.2. Types of Currency Pegs

After a decision to peg the domestic currency of a developing country is taken, a choice between a single currency peg and pegging to a basket of currencies must be made. A single currency peg is adopted if the domestic currency price of one other currency is fixed at some value. On the other hand, fixing the value of the domestic currency in terms of a weighted sum of more than one currency, is known as a basket peg (see Appendix III.A at the end of the present chapter for the technical aspects of a single peg and a basket peg).

The choice of the currency to which the domestic currency is to be pegged, for a single currency peg, may be based on trade related arguments or historical links. In relation to trade, the domestic currency may be pegged to the currency in which most of the its trade is denominated. This may refer to the volume of imports or exports which is denominated in that currency, or to the total trade. Alternatively, the choice may be based on the percentage of trade conducted with a country. According to this argument, the domestic currency would be pegged to the currency of the country with which the domestic country trades the most. Some analysts (for example, Connolly 1983) have argued that a choice of peg may be based on historical links between any two currencies. Thus, for example, if the domestic currency had been pegged to the dollar for a long time, a breakdown of this relationship may destroy confidence in the domestic currency.

However, if a basket peg is chosen, more issues require consideration before the choice is implemented. Eventually, the number of currencies and which currencies would be included in the basket have to be defined on some basis. Furthermore, the weight assigned to each currency must be determined.

It has been argued that the weighting scheme of the basket may reflect trade patterns, where the currencies of most trading partners would be included, and weighted according to the percentage of trade conducted with each partner. Alternatively, the trade weights may reflect the percentage of trade denominated in each currency. Like the single currency peg, the basket of currencies peg may utilize import shares, export shares or total trade shares as its weights.

The choice of the currencies and their respective weights in the basket may be defined in terms of the Special Drawing Rights (SDR) weighting scheme, or the European Currency Unit (ECU) weighting scheme. In both cases, the weights and the included currencies are predetermined with no consideration of the trading pattern of the domestic country.

Accordingly, a single currency peg may be defined as (change in logarithm is represented by lower case letters):

$$e_{h/i} = 0$$

where

$e_{h/i}$ = percentage change in the price of country i's currency in terms of the domestic currency h (defined as: $100[\ln(E^{t}_{h/i}/E^{t-1}_{h/i}]$, where t refers to time).

Thus, if the domestic currency is pegged to currency i, then there would be no change in the exchange rate between the domestic currency and currency i. However, the domestic currency will float against all other currencies which are not pegged to currency i. For example, consider the case where the domestic currency, h, is pegged to the currency of country 1, where

$$E_{h/1} = 4.00$$

Meanwhile the relative value of the currency of country 2 in terms of that of country 1, is given by

$$E_{1/2} = 2.00$$

which implies that

$$E_{h/2} = 8.00.$$

It follows then that if the authorities in the domestic country peg currency h rigidly to currency 1, there will be no change in the exchange rate between the domestic currency and currency 1. If we assume that currency 1 has appreciated vis-á-vis currency 2 by 50 percent, then as a result of the peg, the domestic currency must appreciate by 50 percent vis-á-vis currency 2, so as to keep the exchange rate between the domestic currency and currency 1 fixed. An appreciation by a smaller or a larger rate will violate the peg condition (see Appendix III.A at the end of this chapter for further discussion of this mechanism).

On the other hand, a basket peg may be represented by:

$$\alpha_1 e_{h/1} + \alpha_2 e_{h/2} + \alpha_3 e_{h/3} + \cdots + \alpha_n e_{h/n} = 0$$

where

α_i = weights assigned to each currency in the basket, i = 1, 2, 3,..., n

$e_{h/i}$ = percentage change in the domestic currency price of currency i, where i = 1, 2, 3, ..., n.

The value of the basket in terms of the domestic currency may be expressed as:

$$V_h = N_1(E_{h/1}) + N_2(E_{h/2}) + N_3(E_{h/3}) + \cdots + N_n(E_{h/n})$$

where

N_i = number of units of currency i included in the basket, where i= 1, 2, 3,..., n

$E_{h/i}$ = the domestic currency price of currency i

$N_i = \alpha_i(V_i)$

V_i = the basket value in terms of currency i.

Since the number of units of any currency that is included in the basket is constant, the exchange rate $e_{h/i}$ would have to be adjusted if the exchange rate between any two currencies that are included in the basket changes, so as to keep V_h constant. To illustrate this point, consider a domestic currency which is pegged to a trade-weighted basket of three of its trading partners, call them countries 1, 2, and 3. Assume that the initial situation which is reported in Table (1) prevails at time t.

Where

W_i = weight of currency i in the basket

$E_{h/i}$ = the exchange rate between currency h and currency i, defined as units of h per unit of i

N_i = number of units of currency i included in the basket

N_i^h = value of the number of units of currency i in terms of currency h.

Currency	N_i	$E_{h/i}$	N_i^h	W_i
1	0.360	0.4975	0.1791	0.1791
2	0.400	0.5624	0.2250	0.2250
3	0.845	0.7052	0.5959	0.5959

Table 1: Configuration of the basket at the initial time

Using the definition of V_h provided earlier, it may be shown that the value of the basket in terms of the domestic currency is unity (see Appendix III.A at the end of the present chapter for a detailed derivation of this).

Then, at a later time, assume that currency 1 had appreciated by 20 percent and 40 percent vis-á-vis currencies 2 and 3, respectively. This will result in changes amongst the exchange rates of these trading partners and consequent impacts on the exchange rates between the domestic currency and each of its trading partners. Therefore, since the domestic currency is pegged partially to each individual currency, the appreciation of currency 1 vis-á-vis currency 2 would result in an appreciation of the domestic currency vis-á-vis currency 2 by $W_1(0.20)$, and vis-á-vis currency 3 by $W_1(0.40)$. However, since the domestic currency is pegged to currencies 2 and 3, which have depreciated vis-á-vis currency 1, the domestic currency will depreciate vis-á-vis this currency by a total of

$$W_2(0.20) + W_3(0.40).$$

Thus, as demonstrated in Appendix III.A, the value of the basket in terms of the domestic currency will be unaffected.

Given these alternative currency pegs, the literature has developed several indices upon which the performance of a peg may be judged. These constitute an essential part of the analysis, because a peg was adopted in the first place to meet a particular target set by the authorities in the domestic country.

III.3. Choice of Welfare Function

There appears to be no general consensus in the economic discipline on the appropriate choice of criterion upon which a currency peg scheme would be chosen.

Black (1976) considered the optimal currency peg policy available to Less Developed Countries (LDC's) with the assumption of the adoption of a floating exchange rate regime by developed countries, and argued that stabilization of the relative price of tradable goods (the ratio of the price of traded goods to non-traded goods) is the appropriate target of a peg. In general, developing countries are price takers for their imports and exports and accordingly they have little market power to affect the relative price of their tradable goods. Assuming that the domestic currency is pegged to a basket of currencies, this would imply that the prices of imports and exports may fluctuate as a result of either a real price shock to these goods, or because of changes in the exchange rates amongst the domestic country's trading partners. A peg to a trade weighted basket, in which the weights used are those derived from the definition of the effective exchange rate, EER (nominal exchange rates weighted by trade shares with each country), may minimize fluctuations in the relative domestic price of tradable goods if these fluctuations originate from changes in exchange rates amongst the trading partners of the domestic country. However, changes in world prices of tradable goods that are not a result of changes in exchange rates, i.e. real price shocks, will be passed through to the domestic economy, even if the domestic currency is pegged to a basket of currencies utilizing the EER weights (reflecting trade in goods as well as services).

A broader welfare function was proposed by Flanders and Helpman (1979), who argued that for a small developing country, the relevant objective function should include minimization of instability in both its balance of trade and the level of real income. The rationale behind this stems from the fact that changes in the exchange rates amongst the trading partners of the domestic country may exert an influence on the domestic balance of trade, through the effects of terms of trade. Defined as the ratio of the price of exports to the price of imports, a lower price of exports would worsen the terms of trade, although improving the trade balance, and domestic welfare would be lost due to the fact that more exports have to be exchanged for the same amount of imports. Exchange rate changes may affect the domestic cost of imports and exports, thus affecting the level of real income.

Branson and Kasteli-Papafstratiou (1980) set up a model in which they argued that the welfare function should be based on reducing variations in the terms of trade. The argument states that terms of trade have an influence on the determination of domestic income since they are related to the world market price of the domestic country's exports and imports, the domestic country's price of its exports and imports and exchange rate fluctuations.

Addressing the issue of the optimum currency peg in a monetary framework, Connolly (1982, 1983) and Connolly and Yousef (1982) argued that an appropriate welfare index would be the minimization of the variance in the imported component of the domestic rate of inflation. This is chosen because of the potential undesirable effects which instability in the imported component of the domestic price level may have on the domestic economy. (This issue is explored further in Chapter V.)

A macroeconomic model was constructed by Turnovsky (1982), who assumed stabilization of domestic real income to be the relevant welfare criterion.

Lipschitz (1979) suggested stability in the real effective exchange rate to be the appropriate welfare function. The reasoning behind this choice is derived from the effects of fluctuations in the real effective exchange rate (EER deflated by a price index) on domestic relative prices, the real value of assets, investments, production, imports and exports. Furthermore, such fluctuations have impacts on the domestic pattern of resource allocation and consequently on the internal distribution of income.

An extended version of the previous model was presented by Lipschitz and Sundararajan (1980), in which they considered minimizing the variance in the real effective exchange rate, subject to keeping the equilibrium value of this exchange rate within some defined range.

Lipschitz and Sundararajan (1982) specified a welfare function of a peg to include trade related variables, such as stabilization of terms of trade or balance of trade.

Bhandari (1985-a) assumed the authorities in developing countries to be interested in minimizing the instability in the real effective exchange rate and income. In a subsequent analysis of the choice of the optimal currency peg, Bhandari (1985-b) derived empirically simulated conclusions, based on the assumption that a welfare index was to include minimization of the variance of the domestic output around its expected value, minimization of the variance of the domestic output around its full-information level, minimization of the variability in the domestic money supply and minimization of the variance of the real effective exchange rate.

III.4. Analysis of Reviewed Models

Before we proceed to examine the relevant literature, and since stability of the price level is either explicitly or implicitly targeted in several studies, it would seem a suitable point at which to consider.

Stiglitz (1972) has shown that if the principle of diminishing marginal utility of income holds, then we would expect individuals to attach less value (utility in money terms) to increases in income due to favorable price outcomes than to losses in income due to unfavorable outcomes. Accordingly, if we assume consumers to be averse to risks, then they would favor small variances in prices as long as the cost associated with their behavior of seeking such a reduction does not exceed the expected benefits from the reduction. Similarly, from a firm's point of view, Sandmo (1971) has demonstrated that if prices follow a random process, then firms are expected to produce less output than they would produce when prices are less variable. Thus, higher variances are expected to have negative effects on production compared to smaller variances. However, if this reaction to uncertainty is considered across the economy, it is evident that stability in prices is both desirable and a target which governments do pursue.

Building upon this argument, Black (1976) argued that the appropriate welfare index is stability in the relative domestic price of traded goods. This ratio of traded to nontraded goods is affected by internal factors, that affect the price of nontraded goods, and by external forces that work through the price of traded goods. Although the first may be manageable by the domestic government, it is the stability of the latter which is difficult for small developing countries to control. Indeed, in order to diminish the potentially undesirable negative effects of fluctuations in the price of traded goods, a small developing country would be better off pegging its currency to a trade-weighted basket in which the weights are those of the EER. Consequently, a stabilization of the effective exchange rate should diminish the variability in the relative domestic price of tradables. Furthermore, Black argued that a peg to the SDR would prove to be optimal in the present context only if the weights of the currencies included in the SDR approximate those in the EER.

Dynamically, the domestic country's trade patterns may vary, and there may be prolonged deviations between the rates of inflation in the domestic country and those of its trading partners. Black supported the view that the value of the peg may be adjusted so as to neutralize the inflation differentials and to promote the competitiveness of the domestic country.

In general, Black favored a basket peg rather than a single currency peg, because, according to the author, a basket peg is more efficient in insulating the domestic economy from external shocks. Also the choice of which single currency to adopt is not always clear. However, for a single currency peg, both the variance of the candidate currency and its covariances with the currencies of the other countries with whom the domestic country trades should be considered. Assume that the chosen currency to which the domestic currency is to be pegged has a low variance relative to the other potential currencies and that it is negatively correlated to their variance. Then the choice could not be optimal, because, although its variance is low, it tends to fluctuate more when fluctuations in the other currencies are diminishing. Thus, the total variation is higher. On the other hand, when the currencies of the other trading partners experience higher levels of variation, the chosen currency would fluctuate less. But, if they were positively correlated, then the chosen currency, with its low individual variance, would be a superior choice. Note that the relativity of the covariance terms depends on the trade shares with each of the trading partners. To see this, assume the extreme case where the domestic currency trades solely with one trading partner. Then if it pegs to the currency of that partner, covariations between other currencies in the system and that of the trading partner are irrelevant to the domestic country. Black argued that these complications do not point to the adoption of a single currency peg.

However, the ultimate choice should be considered and evaluated according to its potential costs and benefits. Costs such as reserve holdings, basket management, communication and dealing in foreign exchange markets and institutional settings are important factors in the analysis.

Constructing a more formal model, Flanders and Helpman (1979), argued that the relevant criteria upon which a peg is chosen includes both stability of balance of trade and the level of real income. That is, in the first case the aim of the domestic policy is to minimize variability in the balance of trade, which may arise due to fluctuations in exchange rates amongst trading partners, or to keep variability below some upper value. In the second case, the variance of real income is minimized whenever this variance is kept around a particular expected value.

The authors favored a basket peg in which elasticity weights are utilized. However, if the objective is to improve the trade balance, then greater weight should be assigned to currencies that are expected to depreciate than to those that are expected to appreciate. Assume the domestic country trades with country B, whose currency has depreciated, then domestic terms of trade will improve, worsening the domestic balance of trade. Consequently, the domestic country would be better off from the point of view of the trade balance, had it pegged to a basket in which currency B received more weight. This would prove to be optimal particularly if the domestic country trades less with country B, whereas it competes more with it for other markets.

If the aim is to minimize variability in real income, the choice of peg depends on shares of import from trading partners, the trade multiplier and the elasticity of demand for domestic exports with respect to prices in the currencies of the trading partners. An appreciation of the currency of a trading partner would reduce domestic welfare, while domestic production should be stimulated. The latter effect would raise the level of employment, thus improving welfare. However, the outcome depends crucially on the domestic country's position in the market compared to that of its trading partner. In summary, the greater the domestic economy's imports from that partner and the less they compete in a third market, the greater the likelihood there is that any improvement in domestic employment will fall short of compensating for the loss in domestic welfare through deterioration in the terms of trade, whenever the currency of the trading partner appreciates. To clarify this, assume currency B has appreciated. The domestic price of imports would rise, leading to deterioration in the terms of trade and improvement in the trade balance. Nevertheless, the rise in the relative value of currency B has reduced welfare, and since competition with country B is limited, employment in the domestic economy is not expected to rise, since domestic output is not a substitute for that produced by country B. Therefore, the domestic currency needs to depreciate so as to encourage domestic production and increase employment. According to Flanders and Helpman, this may be achieved by assigning a low (or even negative) weight to currency B in the basket of currencies to which the domestic currency is pegged[12].

To sum up, the choice of the weights in the basket depends to a large extent on balancing the potential loss and gain in welfare, with changes expected to arise in the employment sector.

In spite of the valuable contributions of the previous two models, they approached the choice of the currency peg in a less general framework than the work presented by Branson and Kasteli-Papaefstratiou (1980). The authors set up a model in which they discussed the role of the terms of trade (the ratio of the price of export to the price of import) as a relevant and influential factor in determining income stability, and proceeded to show how exchange rate policy may be used to

[12] Lipschitz and Sundararajan (1980) argued that negative weights are difficult to be interpreted in the context of the currency composition of an optimal basket.

reduce variations in the terms of trade.

The argument states that fluctuations in the terms of trade can be related to movements in any or all of the following: i) the world market price of the domestic country's exports and imports; ii) the domestic market's price of imports and exports; iii) exchange rate fluctuations.

The analysis proceeds as follows. Assume a small developing country, call it j, which has market power over the supply of its exports. As it will be evident, market power is a necessary condition for the domestic country to influence the terms of trade. Using some compact notations relative to those presented in the model, changes in terms of trade may be defined as:

$$
\begin{aligned}
tot \;=\; & [(k-k^1)r + k\sum_{i\neq j}\alpha_i J_i - k_1\sum_{i\neq j}\beta_i J_i] + [k\sum_{i\neq j}\alpha_i q^0_{xi} - \\
& k^1\sum_{i\neq j}\beta_i q^0_{mi}] + [(1-k)P^0_x - (1-k^1)P^0_m]
\end{aligned}
$$

where

tot = percentage change in terms of trade

k = an index of export-side market power (as $k \rightarrow 1$), no market power

k^1 = an index of import-side market power (as $k^1 \rightarrow 1$), no market power

r= percentage change in the exchange rate of the numeraire (dollar) in terms of the domestic currency

J_i = percentage change in the exchange rate of the dollar per currency i

α_i = export weights

β_i = import weights

q^0_{xi} = percentage change in world price of country j's (domestic country) export

q^0_{mi} = percentage change in world price of country j's import

P_x = percentage change in country j's price of export

P_m = percentage change in country j's price of import.

For simplicity, the components in the above definition may be broken into smaller terms. Let the following represent the terms of trade equation:

$$A = (k - k^1)r$$

$$B = k\sum_{i \neq j} \alpha_i J_i$$

$$C = k\sum_{i \neq j} \beta_i J_i$$

$$D = k\sum_{i \neq j} \alpha_i q_{xi}^0$$

$$E = k\sum_{i \neq j} \beta_i q_{mi}^0$$

$$F = (1 - k)P_x^0$$

$$G = (1 - k)P_m^0.$$

Accordingly, the terms A, B and C reflect the influence of exchange rate movements on terms of trade. Specifically, the term A reflects changes in the domestic currency price of the numeraire (the dollar). The terms B and C represent the dollar price of currencies J. Note that if the domestic currency is pegged to the dollar, then r would vanish from the terms of trade equation. However, fluctuations in the dollar value would have impact on the terms of trade via changes in the dollar exchange rates vis-á-vis the other currencies in the system. In the commodity market, the terms D and E capture the effects of shifts in export demand and import supply conditions in all other i such that $i \neq j$. Internal market disturbances and conditions are represented by the terms F and G.

Consequently, it may be argued that fluctuations in terms of trade may be reduced via a single term or all of the terms defined above. However, Branson and Kasteli-Papaefstratiou argued that developing countries rarely have market power to affect world terms of trade. Thus the terms D and E, which represent the impact of fluctuations in world market conditions on terms of trade, cannot be reduced by the domestic country. Nevertheless, developing countries are more likely to have market power over their exports than over their imports, Therefore they are expected to perform better in implementing policies in the export sector aiming at stabilizing terms of trade.

Of greater interest is the ability of changes in the exchange rates to reduce variability in terms of trade. Here the relevant terms are A, B and C. Assume the domestic currency is to be pegged to a basket of currencies and let the weights used in the basket to be defined accordingly as:

$$\sum_{i=1}^{n} w_i = 1$$

where

w_i = weight of currencies in the basket.

Assume also that the sum of movements in the exchange rate of the domestic currency price of the other currencies is zero (i.e. a basket peg holds). Some obvious possibilities for these weights are import and export shares, α_i and β_i, respectively. In summary, using export weights would reduce the terms A, B and C to:

$$k^1 \sum_{i \neq j} (\alpha_i - \beta_i) J_i.$$

Adoption of an import weighting alternative would reduce the same terms to:

$$k \sum_{i \neq j} (\alpha_i - \beta_i) J_i.$$

If one assumes that the domestic country has market power in its export sector, then k is expected to be less than k^1. Then a peg to a basket in which weights correspond to import shares is expected to reduce fluctuations in terms of trade. This is seen from the fact that:

$$[k \sum_{i \neq j} (\alpha_i - \beta_i) J_i] < [k^1 \sum_{i \neq j} (\alpha_i - \beta_i) J_i].$$

This implies that the domestic currency should be pegged to a basket in which the weights used are those of the sector in which it has the smallest market power, if stabilization of terms of trade is the objective. To derive the optimal set of weights, w_i, assume that the $q^0_{xi}, q^0_{mi}, p^0_x$ and p^0_m are constant. Then terms of trade may be expressed as:

$$tot = \sum_{i \neq j} [(k^1 - k) w_i + k\alpha_i - k^1 \beta_i] J_i.$$

Then, solving for the set of exchange rate weights w_i that would eliminate the effect of exchange rates on the terms of trade, i.e. minimizing the above equation with respect to J_i, yields:

$$\sum_{i \neq j} [(k^1 - k) w_i + k\alpha_i - k^1 \beta_i] = 0.$$

Solving for w_i implies

$$w_i = [k\alpha_i - k^1 \beta_i] / [k - k^1].$$

Since $\sum \alpha_i = \sum \beta_i = 1$, then $\sum w_i = 1$.

Note that, according to the present analysis, there is no prior restriction on the value of an individual w_i. For example, if the domestic country is assumed to have market power in its exports, then $k < 1$ and $k^1 = 1$; the optimal weighting scheme will reduce to:

$$w_i = (\beta_i - \alpha_i k)/(1 - k)$$

where currencies of those countries with whom the domestic economy engages in large scale of trade, i.e. α_i is large, may be assigned negative weights.

Although this latter model addresses the basket peg issue when the domestic country has market power, the next model assumes that developing countries are small and their economies are characterized by a lack of market power. Connolly (1982) constructed a partial equilibrium model for a small open economy in which attention is directed toward a monetary framework.

The explicit aim of the model is to provide answers to two questions. Firstly, to which currency should a given small economy peg its currency, and secondly, is a basket peg superior to a single peg ? The analysis was performed on the assumption that the welfare function of a peg is to minimize the imported component of the domestic inflation rate. Wickham (1985), in considering the rate of imported inflation as a criterion wrote:

> It can, however, be argued that if the average externally given inflation rate is significantly positive and variable, a domestic target for a lower and more stable inflation rate is likely to be regarded as a legitimate objective of policy[13].

Connolly argued that pegging the domestic currency to the single currency of one of its trading partners will not insulate the domestic inflation rate from price fluctuations that are passed through the exchange rates from all of its trading partners. For example, assume the domestic country trades with the U.S. and the U.K., whilst its currency is pegged to the dollar. Then, two major sources of disturbance can affect the domestic price level. Firstly, the inflation rate in the

[13]Peter Wickham, " The Choice of Exchange Rate Regime in Developing Countries," *IMF Staff Papers*, vol. 32, no. 2 (June 1985), p. 262-263.

U.S. and secondly, deviations in purchasing power parity caused by differentials in inflation rates in the U.S. and the U.K.

Thus, with this approach a peg must be chosen according to its contribution to the variance of the domestic rate of inflation, which in turn is affected by the variability in the purchasing power parity relationship. Rather than a single peg, the domestic country may peg its currency to a weighted basket of currencies of its trading partners. In this case it would import an average of the change experienced in the price levels in those countries. It is expected that deviations in the purchasing power parity would have, as random variables, an expected value of zero.

An empirical application of this theoretical model was conducted by Connolly and Yousef (1982) and by Connolly (1983). In the latter case, Connolly utilized data from Latin American countries and found a single currency peg to the dollar to be optimal for most countries. Based on historical examination of variability in their domestic rates of inflation, it was reported that countries which pegged to the dollar experienced lower and more stable rates than those which pegged to an alternative arrangement. Several arguments were put forward for favoring a dollar peg. Firstly, a dollar peg would promote confidence in local currencies, where this confidence was built over a long time and had a psychological value attached to it. Simply, according to Connolly, individuals in those countries view the dollar as the " best " currency and thus tend to denominate trade and conduct financial transactions in dollars. Secondly, a dollar peg would restrain domestic money growth (which is closely related to the price level in a monetary model), although this characteristic is not unique to the dollar. Thirdly, a dollar peg would, ultimately, overcome competitive devaluation amongst the Latin American countries, which may arise if different pegs were adopted by them. Fourthly, economic downturns may be of less consequences if domestic economies have dollar reserves, which consequently may be used to promote economic growth during recessions.

The empirical results of the fitted data satisfied Connolly that a dollar peg is optimal. Furthermore, the results have strengthened the significant role trade patterns played in the stability of the domestic inflation rate. For example, the German mark was found to be a better peg than the dollar for Latin American countries which traded with Germany more than the U.S. Connolly also considered trade-weighted and SDR-weighted basket pegs. The results favored trade-weighted baskets. However, Connolly warned that abandoning the dollar peg may destroy consumers' confidence in the domestic currencies, may undermine the domestic currencies and may lead to currency substitution and capital outflow.

Further testing of Connolly's model was conducted by Connolly and Yousef (1982). Using data for Arab countries, several conclusions may be derived from the results obtained in the estimation of the model. Firstly, for oil exporting countries, a dollar peg was optimal. Secondly, for countries with the majority of their trade with the U.S., a dollar peg proved optimal. Thirdly, for countries with the majority of their trade with France, a franc peg was optimal. Comparing basket pegs, to include import-weighted and total trade-weighted baskets, and the SDR-weighted basket, greater stability in imported inflation was achieved by adopting these pegs rather than a single currency peg.

Although all models complement each others in some aspects, the previously discussed frameworks and findings have some common factors embodied into them. Among these are: a) exogenity of exchange rates for a small country compared to the rest of the world; b) a partial equilibrium setting; c) international capital flows were not allowed to play a role in the models; d) expectations of exchange rates were ignored; d) immobility of financial assets was assumed.

Relaxing these assumptions to some extent, Turnovsky (1982) constructed a macroeconomic model in which a small country trades with other countries in goods and bonds. This country is assumed to be interested in stabilizing domestic real income. After specifying the model in an analytical framework and conducting some algebraic manipulations, real income is defined as:

$$Y_t = \{\gamma[X_t + (d_3^2 - d_2\delta_2 - (d_3^1 + d_3^2 + \delta_0 d_2)\lambda_2)V_t] + Z_t\}/D$$

where

Y_t = domestic real income

X_t = a measure of random fluctuations in the domestic demand for domestic output originating from fluctuations in foreign variables

V_t = a measure of differential movements in foreign nominal interest rates

Z_t = a measure of disturbances of domestic origin

$D = \gamma(1 - d_1) + d_3^1 + d_3^2 + d_2(1 - \delta_1 - \delta_2) > 0$

d_2 = the interest elasticity of the domestic demand for domestic output

d_3^i = price elasticity of domestic demand for output in country i

$\gamma = \gamma_1 + \gamma_2$ = elasticity of domestic output to domestic prices

$\delta_0 = (1 - \delta_1 - \delta_2)$ = elasticity of domestic overall price index (cost of living) to foreign prices of imported goods.

From this equation, it can be inferred that as long as $V_t \neq 0$, then fluctuations in domestic output depend upon the relative weights of currencies in the basket, λ_1 and λ_2. However random fluctuations in Y_t would be independent of the composition of the currency basket if $V_t = 0$.

Suppose this small country pegs to a basket of two currencies, then it must select the appropriate weights so that the variance of the above equation is minimized with respect to the weights chosen. This operation yields:

$$\lambda_2 = [(d_3^2 - d_2\delta_2)\sigma_v^2 + \sigma_{xv}]/[(d_3^1 - d_3^2 + d_2\delta_0)\sigma_v^2]$$

(note that in the case of two currencies, $\lambda_1 + \lambda_2 = 1$).

Consequently, the composition of the optimal basket depends upon several factors. Firstly, the variance of the differential in foreign interest rates, σ_v^2. Secondly, the covariance between the first factor and the disturbances in the demand for domestic output, σ_{xv}. Thirdly, the effect of a change in the domestic currency price of currency 2 on the demand for domestic output. Fourthly, the effect of a simultaneous unit increase in the exchange rates between the domestic currency and each of its trading partners.

The considerable role trade shares play, as indicated by most models in this review, is minimized in the present model. Since trade shares were found to affect the optimal choice of weights through the interest rate, if demand for domestic output is interest inelastic, then trade shares do not affect the choice of weights. Furthermore, Turnovsky argued that there is no compelling reason to restrict all currencies included in the basket to have positive weights. This was found to depend greatly on the variance of the differential in interest rates amongst the trading partners, and on the covariance term σ_{xv}. Depending on the degree of correlation between the price levels amongst the trading partners, it is argued that the domestic currency should be pegged to the currency of the country which experiences the least instability in its rate of inflation, if there is no correlation amongst their prices. However, if prices are correlated, but the correlation is not perfect, then a case may be presented for pegging the domestic currency more heavily to the currency of that trading partner which experiences greater stability in its inflation rate. In general, if the rate of inflation in a trading partner is less stable than that of another, the weight of the currency of the latter trading partner should be increased in the basket. Nevertheless, Turnovsky argued that if there are no deviations in the purchasing power parity relationship, and no random shocks affect the capital markets, so that $V_t = 0$, then the choice of the optimal weights is indeterminant. Accordingly, any set of weights would provide the same level of stability in the variance of real income.

Since exchange rate fluctuations can affect the purchasing power of money balances, through their effect on prices, there are distributional impacts embodied in changes in those rates. Lipschitz (1979) proceeded by arguing that exchange rate changes affect relative prices which, in turn, are of significant impact on real variables in the domestic economy. These include real value of assets, investments, production, imports and exports. Explicitly, the model presented by Lipschitz focused on the effects of the choice of pegging policy on, firstly, the internal distribution of income, and secondly, on internal relative prices.

Indeed, exchange rate fluctuations affect the real rate of return on capital, as well as real wages. Furthermore, since the internal relative price index is a composite of the prices of traded and nontraded goods, changes in these prices are expected to have an impact on domestic resource allocations.

Consider a small developing economy for which imports and exports are invoiced in the currencies of its trading partners. Furthermore, assume that the domestic economy consists of import, export, and import-competing sectors. Then, domestic real income may be affected in many ways. Consider the case where the domestic currency is pegged to an export-weighted basket. An appreciation in the currency of the country from whom the domestic economy imports would raise the price of its imports, while inflicting no changes in either the price of its exports or nontraded goods. However the domestic relative price index would rise, reducing the labor real wage and consequently the labor real income would decline. On the contrary, the rise in the domestic currency price of imports would stimulate the production of goods in the import-competing sector. To sum up, labor is expected to incur losses whilst capitalists gain.

However, with the same appreciation, capitalists would suffer more had an import-weighted basket been adopted as a peg. In this case, prices of imports in the domestic currency would not change, while export prices would fall. As a result, internal terms of trade would decline, so real wages would rise, leading to a similar rise in labor real income. Unlike the case when the domestic currency was pegged to an export-weighted basket, in the present case, capitalists would incur losses due to both the fall in export prices and the rise in their wage bills.

More frequently, owners of resources respond to changes in relative prices, particularly, if they are assumed to behave as profit maximizers. Hence, if the argument proceeds by considering an appreciation in the relative value of the currency of the domestic country's exporter, then adopting an export-weighted basket would result in a rise in import prices. Consequently, resources would be reallocated from the production of nontraded goods and export- orientated plants toward import-competing goods. By contrast, a peg to an import-weighted basket has the tendency to reallocate resources toward domestically consumed goods and away from exports. Nonetheless, these effects may diminish if the domestic currency is pegged to an average basket of both currencies. In addition, this choice tends to have no reallocative impact on domestic resources.

Relative prices affect the performance of the domestic economy and its competitiveness. A measure that is commonly utilized to assess the ability of an economy to compete in the international market is the real effective exchange rate. By definition, the real effective exchange rate is given by:

$$REER = \sum_{i=1}^{n} \alpha_i E_{h/i}(P_i/P_h)$$

where

α_i = trade shares

$E_{h/i}$ = exchange rate between the domestic currency and those of its trading partners, domestic units per foreign unit

P_i = price index in country i

P_h = price index in the domestic country.

Eventually, as the rates of inflation differ between the domestic country and its trading partners, the nominal effective exchange rates ($E_{h/i}$) would have to change to maintain the same REER, otherwise REER would change. Thus, total variability of the real effective exchange rate is affected by changes in individual components' variances, that is the variance of $E_{h/i}$ and the variance of P_i/P_h, as well as by the extent to which changes in either of these are damped or exacerbated by changes in the other. Consider a rise in the domestic rate of inflation that is not offset by changes in the exchange rates. Then, the real effective exchange rate would appreciate (REER term declines), reducing the competitiveness of the domestic economy. The same would occur if the foreign price level declines. However, if the domestic country aims at stabilizing the real effective exchange rate at some desirable base value, it would be necessary to change the nominal exchange rates. In summary, if there is either a rise in P_h or a fall in P_i, leading to an appreciation in REER, the domestic currency must be depreciated relative to currencies i, if REER is to be kept constant. Nevertheless, the opposite should be done if either P_h declines or P_i rises.

Evidently, exchange rates may have to be adjusted to new competitive rates if the inflation rates of the domestic economy and its trading partners differ significantly. This would imply that it is the real effective exchange rate, REER, rather than the nominal effective exchange rate, NEER, which it is important to stabilize. Lipschitz and Sundararajan (1980) consider a model in which the aim is to choose currencies with weights in an optimal basket peg, where the objective function is minimization of variations in REER. Basically, the aim is to investigate whether the predetermined currency weights defined in the real effective exchange rate would remain optimal whenever there are relative price index changes in response to exchange rate fluctuations.

Assuming the initial weights chosen for the currencies of the trading partners, that are defined in the definition of REER, are elasticity weights[14], the analysis concludes that, in general, elasticity weights are not optimal. This conclusion is reached whenever the assumption of fixing the relative price index is relaxed, which has now introduced into the analysis the importance of variances and covariances of prices and exchange rates.

Indeed, elasticity weights will be optimal whenever exchange rates are not responsive to movements in relative prices (in the definition of the REER). Since the aim of the policy is to minimize instability in REER, the best result may be attained by allowing the variance of the real effective exchange rate to follow that of the relative prices. Note that any changes in the exchange rates will raise the variance of the real effective exchange rate.

Furthermore, the analysis examines the conditions under which a single currency peg may be optimal. In general, the derivation suggests that if the covariance

[14]These weights measure the responsiveness of the domestic country's balance of trade with respect to changes in its trade pattern with each of its trading partners.

between the relative price of the domestic country and its trading partners, and the exchange rates of the domestic currency vis-á-vis the trading partners is zero, and purchasing power parity holds, then the domestic currency would be pegged to any currency amongst those of its trading partners which inflates at the same rate as the domestic economy. Instability in REER can then be minimized. Moreover, if the variance of the exchange rates is greater than the covariance between the exchange rates and relative prices, then whenever the latter change, although the covariance will add to the instability of the REER, it is argued that, if the variance of the exchange rates offsets changes in the value of REER due to relative price changes, a greater weight should be assigned to currencies for which the variance in the exchange rates is greater than the covariance between these rates and relative prices. If, however, there is be a single currency that is characterized by this feature, then a single currency peg to that currency is optimal.

Building upon this theoretical model, Lipschitz and Sundararajan (1982) examined the objective function proposed by Branson and Kasteli-Papaefstratiou: stabilization of terms of trade, or trade balance, and arrived at a different weighting scheme. The model concludes that, there is no prior justification for the weights derived for REER when relative prices were held constant being the same as those attained whenever the model allows for fluctuations in relative prices.

Thus, for policymakers, any relationship between exchange rates and relative prices is of importance and must be incorporated into the determination of the optimal basket weights. Assuming the existence of a certain systematic relationship, the task of the authorities would be to choose the set of weights from the expression of either objective function, so as to minimize its variations. The expression defined as:

$$OB = \acute{w}(\hat{r}p + \hat{s}) - (rp_h + \acute{\beta}\hat{s})$$

where

OB = either objective variables, terms of trade or trade balance

$\acute{w}$ = the transpose of the vector of elasticity weights

$\hat{r}p$ = a matrix of the log of the ratios of the trading partners' prices to that of a numeraire

$\hat{s}$ = a matrix of the log of the exchange rates defined as numeraire per other trading partners

rp_h = a matrix of the log of the ratios of domestic price level to that of the numeraire

s_h = a matrix of the log of the exchange rate defined as domestic per that of the numeraire.

Then, the minimization with respect to $\acute{\beta}$ was shown by Lipschitz and Sundararajan to depend on the variance-covariance matrix of exchange rates, and on the covariance matrix of relative prices and exchange rates. Thus, the choice of weights depends on the weights defined in the REER with fixed relative prices (elasticity weights in this example), and moreover, on the variance and covariance terms of exchange rates and relative prices.

To sum up, it is argued in the last two models that, once a choice of an optimal single currency or a basket of currencies is considered, there exists a compelling rational to incorporate variances and covariances of relative prices and exchange rates in the decision.

Another contribution to the literature on the optimal currency peg was presented by Bhandari (1985-a). The basic motivation of the analysis is based on the observation that not all peggers fix the weights of the currencies rigidly in the basket. Nonetheless, some peggers allow for changes in the exchange rates of their currencies with respect to the currencies to which the are pegged. Calling the latter practice a flexible basket or a wide margin policy, as opposed to the fixed exchange rates in the basket, called a rigid basket or a narrow margin policy, the analysis proceeds to examine two important issues: Firstly, what is the optimal margin size and secondly, what is the optimal composition of the basket ?

A multicountry model is constructed in which commodity as well as money market relationships are defined. Accordingly, a basket peg is defined as (all variables are in log form):

$$E^{*} = \lambda E_{AB} + (1 - \lambda)E_{AC}$$

where

E^{*} = the domestic currency value of the basket

$\lambda, (1 - \lambda)$ = target shares of currency B and C, respectively

E_{AB}, E_{AC} = the exchange rates of foreign currencies, B and C, in terms of the domestic currency, A.

Although this basket defines the rule at which the domestic country aims, there is, however, no guarantee that it will be satisfied. To see this, let the targeted exchange rates be defined as:

$$E_{AB} = E^{*} - (1 - \lambda)E_{BC}$$

$$E_{AC} = E^{*} + \lambda E_{BC}.$$

These relationships reflect the effect which E_{BC} may have on the value of the exchange basket chosen by the domestic country. With a rigid basket, fluctuations in E_{BC} are offset by matching changes in E_{AB} and E_{AC}. However, adopting a flexible basket peg will allow for intervention in the exchange rate market. The intervention parameter (defined as the margin size) is defined as the difference between the targeted exchange rates and the actual rates. Nevertheless, a currency share in a basket and the intervention parameter would depend on the objective of the peg.

The authorities in the domestic country are assumed to be interested in an objective function which includes external and internal components. Accordingly, Bhandari defined the following loss function which is to be minimized:

$$L = \theta var(REER) + (1 - \theta)var(Y_a)$$

where

$\theta, (1 - \theta)$ = measures of the importance attached by the authorities to external target and internal target, respectively

$var(i)$ = the variance of the i argument

$REER$ = real effective exchange rate

Y_A = domestic income

$(0 \leq \theta \leq 1)$.

The weights of currencies of the trading partners are embodied in the REER term, whereas the intervention parameter is derived in the manner explained above (for instance, $E^*_{Ai} - E_{Ai}$, where i may be the currency of either of the trading partners, and E^*_{Ai} is the targeted exchange rate). It is found that the weights of the currencies and the size of the intervention parameter depend on: firstly, domestic bilateral trade patterns; secondly, the relative weights assigned to the external and internal components; thirdly, the relative sizes of the trading partners; fourthly, the relative variability in monetary and real policies in the countries of the trading partners.

Empirical estimation of the model was conducted for hypothetical countries (no real data was used) and some important findings are reported below.

In summary, a rigid basket is optimal if trade is symmetric between the domestic country and its trading partners, without regard to the nature of disturbances. However, if trade is asymmetric, then a rigid basket is optimal if shocks are monetary in nature, although the weight of the currency of the closer trading partner would be increased. However, if shocks are real in origin and originate in both trading partners, then for a flexible basket, the share of the country with whom the domestic country trades more increases in excess of unity, but by less than unity for a rigid basket.

Furthermore, if disturbances are mostly monetary in origin, then a rigid basket is optimal without regard to the relative size of the trading partners. Contrary to this, if all shocks occur in one country, then a rigid basket is not optimal even with symmetric trade patterns. However, adopting a flexible basket in this case, would reduce the weight of the currency of the country which experiences the shock.

Bhandari investigated the significance of the degree of variability in monetary and real variables in the trading partners on the domestic economy and concluded that, if trade is symmetric, an optimal intervention parameter is zero, i.e. a rigid basket is optimal with an equal weighting scheme within that basket. On the other hand, if trade is not symmetric, then a more flexible weight will be assigned to the currency of the trading partner whose monetary policies are less stable. It may be argued that this would allow the authorities to distant the behavior of the domestic currency from that of the less stable currency. Finally, real disturbances were found to affect the composition of the basket regardless of trade patterns, and also altered the size of the intervention parameter.

In a subsequent contribution, Bhandari (1985-b) expanded the above model in terms of its welfare function. Accordingly, he defined the following loss function which the authorities attempt to minimize:

$$L = a_1(C_1) + a_2(C_2) + a_3(C_3) + a_4(C_4)$$

where
a_i = weight assigned to each criterion
C_1 = variance of domestic output around its expected value
C_2 = variance of domestic output around its full-information level
C_3 = variance of domestic money supply
C_4 = variance of real effective exchange rate
$\sum a_i = 1$.

Contrary to the generally cited argument of assigning a greater weight to the currency of the most significant trading partner, call it country B, Bhandari found this to be subject to several qualifications, and to depend upon both the optimality criterion chosen by the domestic country, as well as, upon the nature of shocks in the system.

Simulation of the model indicates that, if disturbances are monetary in nature, then the weight of currency B is reduced under criteria C_1, C_2 and C_3, and the flexibility of the exchange rate between the domestic currency and currency B would be increased. However, the weight of currency B would have risen under the fourth criterion, and the flexibility increases. This latter conclusion is due to the fact that a non-internal solution was achieved[15]. Bhandari argued that, this result is contrary to the argument that is arrived at whenever a basket with a simple weighting scheme (based on trade patterns) was adopted, where flexibility of the exchange rate between the currency of the domestic country and that of its most significant trading partner, would be more rigid[16].

Alternatively, had shocks been real in nature, then the weight assigned to currency B would have been reduced under the C_1 criterion, whilst it would have been increased under the other criteria. With respect to the degree of flexibility of the basket, the simulation results favored increasing flexibility with respect to currency B if C_1 was the objective. However, the weight would have been increased and the flexibility reduced under C_2, C_3 and C_4, although the flexibility of the exchange rate would have increased in the latter case due to the non- internal solution. It is worth mentioning that, although a simple trade-weighted basket only takes trade patterns into consideration in assigning currency weights and ignores the nature of shocks in the world, it was found that under criteria C_2 and C_3, the simple trade-weighted basket and the optimally derived basket generated in the present model enhanced the optimality of increasing the flexibility of exchange rate if shocks were real in nature. However, if the disturbances were monetary in origin, conflicting conclusions were reached.

Furthermore, the exclusive consideration given to trade patterns in the simple trade-weighted basket has contributed to its insensitivity to changes in the relative size of the trading partner. In contrast, the basket derived in Bhandari's model favored increasing the weight assigned to larger countries, when all criteria were considered, thus leading to a less flexible exchange rate between the domestic

[15]A non-internal solution is defined whenever the absolute value of λ is negative or greater than unity.

[16]Looking at the extreme case when trade with country B amounts for all trade conducted by the domestic country, reveals the fact that the domestic currency should be pegged to currency B.

currency and currency B. This holds whether disturbances were real or monetary in nature.

Examination of the relative role of monetary and real policies concludes that lower weights must be assigned to the currency of the country which exhibits a less stable policy and consequently, the flexibility of the bilateral exchange rate in the basket would be increased. This holds under all criteria. However, this conclusion would not hold for criteria C_4 had the real economic behavior in that country been less stable. Nevertheless, the simple trade-weighted basket can not be compared in this case, because it is insensitive to monetary or real policies.

The conclusions arrived at in this model as well as in all other earlier models, rely on the assumptions stated, the objective functions and the data used. In comparing the models discussed above, several general similarities and differences may be obtained. Many models have singled out the REER as an important variable in the choice of the optimal currency peg. This importance is derived from the role the index may play in affecting the competitiveness of the domestic economy. Explicitly, Black argued that the measure of an effective exchange rate should be weighted according to trade in goods and services. Stabilization of the real effective exchange rate is rather a general argument, which was defined by Lipschitz and Sundararajan (1980) as:

> . . . is one that minimizes the variance of the real exchange rate about its equilibrium, while maintaining the average value of the real exchange rate close to its equilibrium level over the reference period[17].

It may be argued that Black favored adjusting the effective weights of exchange rates to account for inflation differentials. However, the process of adjustment was advocated explicitly by Lipschitz, Lipschitz and Sundararajan, and Bhandari.

With regard to the determination of the appropriate set of weights in the basket, Flanders and Helpman advocated elasticity weights, Branson and Kasteli-

[17]Lesile Lipschitz, and V. Sundararajan, " The Optimal Basket in a World of Generalized Floating," *IMF Staff Papers*, vol. 27, no. 1 (1980), p. 95.

Papaeftratiou favored a weighting scheme which is related to market power, and Connolly, and Connolly and Yousef argued for trade weights, although they placed greater emphasis on historical links and the implicit confidence in the currency to which the domestic currency may be pegged. Lipschitz and Sundararajan argued that in the weighting policy proposed by Flanders and Helpman, elasticity weights are not, in general, optimal. Moreover, Turnovsky, by allowing for expectations and capital mobility in the model, has shown that trade shares can be of little importance to the choice of the optimal basket arrangement, although price elasticities of demand gained ground as a determinant of optimal weights in certain cases.

On the issue of flexibility of weights in the chosen basket, Bhandari has demonstrated that not all peggers adopt a rigid basket peg; some countries have allowed for flexibility in their pegs. The two models presented by Bhandari cited certain situations when rigid baskets would be more optimal relative to flexible baskets, and examined the conditions according to which the degree of flexibility of a particular exchange rate should be increased or decreased.

On the generality of the models, although Connolly, and Connolly and Yousef relied on partial equilibrium, monetary settings, Turnovsky, and Bhandari considered general macroeconomic models. Furthermore, Turnovsky's model aimed at relaxing several constraints embodied in other models.

The optimality of a single currency peg or a basket of currencies peg has centered on several properties. Black argued that single currency peg is unlikely to minimize the impact of shocks originating abroad, and thus favored a basket peg. Crockett and Nsouli (1977) noted that a single currency peg would require holding of reserves, since the fixed exchange rate parity between the domestic currency and that of an industrial country, is not likely to be the equilibrium exchange rate. Furthermore, movements in this parity will reflect movements in the balance of payments of the industrial country and since the factors affecting the equilibrium exchange rates of the industrial country's currency vis-á-vis the rest of the world, tend to differ from those affecting the domestic currency exchange rates with respect to the same currencies, the need for reserves may be greater under a single currency peg. A general disadvantage which is frequently cited is that a single currency peg, assuming trade with more than a country, will result in higher import prices. It may be argued that investment returns will either be biased toward the country to whom currency the domestic currency is pegged, risking political consequences, or diversified, thus risking changes in the expected value of returns in terms of the domestic currency.

A peg to a single stable currency is advantageous when seen as promoting the stability of the domestic currency. This result is related to the argument of confidence in the domestic currency, discussed earlier, which is important to many developing countries. As it will appear in Chapters V and VI, a peg to the currency in which a country receives most of its revenues will make it more convenient for its government to plan its budget.

In general, a basket peg is preferred on the grounds of minimization of imported shocks caused by exchange rate fluctuations. A major difficulty frequently associated with the basket is embodied in its configurations, i.e. the currencies included and their weights. However, some authors have argued against a customized basket peg because trade and investments will be discouraged as countries adopt different baskets.

Table (2) summarizes the models reviewed in this chapter, with particular emphasis assigned to the objective function(s) proposed and the recommended peg.

This concludes the review of the literature on the optimal currency peg for developing countries. However, this would provide only part of the analysis of the existing work which is relevant to the major concern of the present thesis. In addition to pegging the domestic currencies of the Gulf Cooperation Council, the member states invoice most of their trade (imports and exports) in foreign currencies. This scheme is likely to introduce an exchange rate risk which is added to other potential types of risk involved in international trade. Although, customarily oil has been invoiced in dollars and the imports of the GCC member states have been invoiced in the currency of exporters or of a third country, familiarization with the literature of the currency invoicing of contracts would illustrate how revenues from oil exports can be affected by risk involved in trade. Furthermore, it will show that small economies tend to be more vulnerable to invoice contracts in the currency(s) of their partners. The next chapter will, in addition, show that the issue of determining how a commodity, oil in the present case, is invoiced, is important from the point of view of the parties involved in trade. Nonetheless, this concern is justified because of the potential impact on payments and revenues from contracts the various contractors pay and receive.

Thus the next chapter will review the literature on the currency invoicing of contracts at the international level, where risks of various types can have consequences on the value of these contracts. Moreover, it will shed light on how the currencies of contracts are determined, and possible methods of minimizing the risks impinging on either party of a contract. After that, the analytical framework is presented, and then estimated.

Author	Objective function	Recommended peg
Black	Stabilizing REER by minimizing variations in relative prices	A basket in which weights are based on trade in goods and services
Crockett and Nsouli	Stabilize EER so as to stabilize balance of payments	Import-weighted basket, the SDR may be a good proxy
Flanders and Helpman	Stabilize EER so as to minimize variations in real income and balance of payments	With respect to balance of payments, peg to a basket with more weight given to the currency of a country with which the domestic country trades less, but competes more
Branson and Katseli.	Stabilize the terms of trade	Peg to a basket in which market power of the domestic economy is reflected
Connolly (1982) Connolly (1983) Connolly and Yousef	Minimize the level of variations in imported inflation	Peg to a single currency of an important trading partner or a basket reflecting trade patterns
Turnovsky	Stabilize domestic real income	Depending on the source and the type of disturbances, single or a basket peg may be optimal
Lipschitz	Minimize allocative effects of exchange rate changes via minimizing REER	Trade-weighted basket

..., continue

Author	Objective function	Recommended peg
Lipschitz and Sunda. (1980)	Stabilizing REER	Single currency peg to a currency which inflates at the same rate as the domestic currency. Or a basket with weights reflecting those in the NEER
Lipschitz and Sunda. (1982)	Stabilize terms of trade and trade balance	Same as above with respect to a single currency or a basket
Bhandari (1985-a)	Stabilization of REER	Adopting a flexible or rigid basket, subject to many qualifications
Bhandari (1985-b)	Minimization of variance of domestic output, money supply and REER	Optimally derived basket which depends on sources and nature of changes in trading partners' countries

Table 2: Summary of objective functions and recommended pegs

Appendix III.A

The Mechanics of Single Currency and Basket of Currencies Pegs

This appendix describes how a single currency peg and a basket of currencies peg operate. The examples given are hypothetical ones, so the data are not intended to reflect actual relationships. However, the objective of explaining the mechanics of each currency peg will not be affected by the fact that real data are not used.

III.A.1. Single Currency Peg

By definition, a peg to a single currency implies fixing the value of the domestic currency in terms of a specific number of units of a foreign currency. In what follows, currency h refers to the domestic currency, while other currencies are referred to by 1, 2, and 3.

Assume that at time t, the authorities in the domestic country decided to peg the domestic currency to a single currency, for whatever reason[18]. Explicitly, let the value of the domestic currency in terms of currency 1 equal 0.25, thus

$$E^t_{h/1} = 4.00$$

Given the exchange rate between currency 1 and any other currency in the world, the exchange rate between h and the other currency can be found. For example, assume that

$$E^t_{1/2} = 2.00$$

then

$$E^t_{h/2} = E^t_{1/2}/E^t_{1/h} = 2.00/0.25 = 8.00.$$

If a rigid single currency peg is adopted, then there will be no change in $E_{h/1}$; consequently h fluctuates against currencies 2 and 3, at the same rate as currency

[18]There is extensive literature on this and Williamson (1982) presents a survey article; Chapter III of this thesis also presents a review of the literature on this topic.

1 does. For example, assume that at time t+1, currency 1 appreciates against currency 2 by 50 percent, then currency h must appreciate by 50 percent vis-á-vis currency 2. Accordingly, in our example, we get a new exchange rate between h and 2, but not between h and 1. That is

$$E^{t+1}_{h/2} = E^{t+1}_{1/2} / E^{t+1}_{1/h} = 1.00/0.25 = 4.00$$

where
$E^{t+1}_{1/h} = E^{t}_{1/h}$.

It may be the case that the authorities would like to keep the exchange rate between h and 2 fixed. Can they pursue this policy under the present peg ? The answer is simply no. This is because keeping the exchange rate between h and 2 fixed implies, by definition, that h is pegged to 2. In the face of changes in $E_{1/2}$, the initial peg to currency 1 would be abandoned.

Alternatively, the authorities may think the appreciation of currency 1 against 2 undesirable and decide to appreciate against 2 by less than the implied appreciation by the change in $E_{1/2}$. In this case, any change in $E_{h/2}$ which is not equivalent to the change in $E_{1/2}$ would result in a partial peg of the domestic currency to currency 1. For example, if the domestic currency is desired to appreciate against currency 2 by only 25 percent (not 50 percent as implied by the change in $E_{1/2}$), then we get

$$E^{t+1}_{h/1} = E^{t+1}_{2/1} / E^{t+1}_{2/h}.$$

But, we know that $E^{t+1}_{2/1} = 1.00$, and we have $E^{t}_{h/2}$. However, since the desired $E^{t+1}_{h/2}$ equals the previous value less 25 percent, we have

$$E^{t+1}_{h/2} = 8.00 - [0.25(8.00)] = 6.00.$$

Thus, the percentage change in $E_{h/2}$ is

$$e_{h/2} = [(6.00 - 8.00)/8.00]100.0 = -0.25.$$

Therefore, the domestic currency has appreciated by only 25 percent against currency 2. Adopting this policy would, however, change the exchange rate between the domestic currency and currency 1. Simply, a new rate emerges from

$$E_{h/1}^{t+1} = E_{2/1}^{t+1}/E_{2/h}^{t+1} = 1.00/0.1667 = 5.99.$$

If the domestic currency appreciates against currency 2 less than does currency 1, it is implied then the domestic currency would have to depreciate against currency 1. In fact,

$$e_{h/1} = [(5.99 - 4.00)/4.00]100.0 = 0.4975$$

where

$e_{h/1}$ = percentage change in $E_{h/1}$.

Thus, h has depreciated against currency 1 by more than 49 percent.

What constitutes an optimal policy for pegging the domestic currency as the exchange rates amongst the other currencies in the world change depends on the criteria by which a peg is assessed. However, it is argued that, with trade diversification, a peg to a basket of currencies can best help achieve the targets set out in the economy. The mechanism of a potential basket peg is discussed next, with the aim of displying changes in the values of the other currencies in terms of the domestic currency, as the exchange rates amongst them change.

III.A.2. Basket of Currencies Peg

Viewed from the prospective of the policymakers, a single currency peg may be seen to yield a non-optimal solution, given a particular welfare function. Consequently, a peg to a basket which is composed of a fixed number of units of more than one currency may qualify as an alternative. Formally, a basket peg may be defined as a policy of determining the value of the domestic currency in terms of a number of foreign currencies, each weighted according to a certain method. A familiar weighting scheme is the one in which trade shares, imports, exports or total shares are used to determine the initial weight of each currency in the basket. However, as we will see later, as the exchange rates between the domestic currency and individual currencies change, the weights would have to change, since the number of units of each currency is held fixed. If the authorities adjust the weights, then the basket is said to be flexible. Alternatively, keeping the weights fixed, even though the exchange rates have been altered, yields a rigid basket.

Assume that at time t, the domestic currency is pegged to a basket which consists of three currencies. The initial number of units of each currency included in the basket, the initial weights, and the initial exchange rates between all currencies in this world are given in Tables (1) and (2). Note that i refers to currencies 1,

Currency	$E_{1/i}$	$E_{2/i}$	$E_{3/i}$	$E_{h/i}$
1	1.0000	0.8846	0.7055	0.4975
2	1.1305	1.0000	0.7975	0.5624
3	1.4175	1.2539	1.0000	0.7052

Table 1: The exchange rates at time t

2, and 3, and the exchange rate $E_{1/i}$ is defined as units of currency 1 per unit of currency i.

At this stage it may prove necessary to define some relationships between the domestic currency and the other currencies included in the basket, as well as between the three currencies of the trading partners, i.e. countries 1, 2 and 3.

Currency	N_i	$E_{h/i}$	N_i^h	W_i
1	0.360	0.4975	0.1791	0.1791
2	0.400	0.5624	0.2250	0.2250
3	0.845	0.7052	0.5959	0.5959

Table 2: Number of units and weights in the initial basket

1)

$$W_i = N_i E_{h/i} / V_h$$

2)

$$W_i = N_i^h / V_h$$

3)

$$V_i = V_j E_{h/j}$$

4)

$$V_h = V_i E_{h/i}$$

where

N_i= number of units of currency i included in the basket

$E_{h/i}$= the exchange rate between currency h and currency i, defined as units of h per unit of i

N_i^h = value of the number of units of currency i in terms of currency h

W_i= weight of currency i in the basket.

Furthermore, by definition we find the cross exchange rates between any three currencies, if the exchange rates are known between any two currencies in terms of a third currency. That is, by definition

5)

$$E_{h/1} = E_{2/1} / E_{2/h}.$$

In general

$$E_{k/j} = E_{i/j} / E_{i/k} = E_{i/j} E_{k/i}.$$

If the domestic currency, h, is pegged in terms of a weighted basket of currencies 1, 2 and 3, the initial value of the basket in terms of the domestic currency may be defined as

$$V_h = N_1 E^t_{h/1} + N_2 E^t_{h/2} + N_3 E^t_{h/3}. \tag{1}$$

Thus, in our example,

$$V_h = 0.360(0.4975) + 0.400(0.5624) + 0.845(0.7052) = 1.000$$

Assume that at time t+1 currency 1 has appreciated vis-á-vis currency 2 by 20 percent and vis-á-vis currency 3 by 40 percent. Thus, new exchange rates amongst the currencies of the trading partners emerge. The new exchange rates for $E_{1/2}$ and $E_{1/3}$ are simple to find; they are only 20 percent and 40 percent less than the old rates between currencies 1 and 2, and between currencies 1 and 3, respectively. Thus, the new rates are

$$E^{t+1}_{1/2} = 0.9044$$

$$E^{t+1}_{1/3} = 0.8502.$$

The task to perform now is to find the new value of the basket in terms of the domestic currency and to check whether this value has changed. Moreover, what are the required changes so that the new value will coincide with the initial value of the basket ?

As we have seen in calculating the value of the basket at time t, the exchange rates between the domestic currency and the currencies of the trading partners, are essential. However, if $E^{t+1}_{h/1}$ can be found, then by definition (4), V^{t+1}_h will be determined. Explicitly,

$$V^{t+1}_h = V^{t+1}_1 E^{t+1}_{h/1}.$$

The new value of the basket in terms of currency 1 may be found accordingly:

$$V^{t+1}_1 = N_1 E^{t+1}_{1/1} + N_2 E^{t+1}_{1/2} + N_3 E^{t+1}_{1/3}.$$

Thus

$$V^{t+1}_1 = 0.360(1.0000) + 0.400(0.9044) + 0.845(0.8502) = 1.4402.$$

Let us call this value $E^{t+1}_{1/basket}$. Then using the cross exchange rate property, we can derive $E^{t+1}_{h/1}$. That is

$$E^{t+1}_{h/1} = E^{t+1}_{basket/1}/E^{t+1}_{basket/h}.$$

Nonetheless, a basket peg implies that the value of that basket in terms of the domestic currency is fixed over time and defined at the initial time. In our example, this is given by V^t_h =1.0000, which may be defined as $E_{basket/h}$ =1.0000. This can be used to derive the new exchange rate between the domestic currency and currency 1, using the above cross rates condition between currencies h, 1, and the basket (if one can call it so). Substitution implies

$$E^{t+1}_{h/1} = E^{t+1}_{basket/1}/E^{t+1}_{basket/h} = 0.6943/1.0000 = 0.6943.$$

From a comparison of this rate with the rate at time t, we can conclude that the domestic currency has depreciated against currency 1 by about 33.33 percent. However, since the domestic currency is pegged partially to currency 1, as well as to the other currencies, the actual change in $E_{h/1}$ must be weighted, as we will explain later. For the time being, the new value of the basket in terms of the domestic currency may be determined as

$$V^{t+1}_h = V^{t+1}_1 E^{t+1}_{h/1} = 1.4402(0.6943) = 1.0000$$

Thus, the value of the domestic currency in terms of the basket has not changed (the opposite is true as well).

In terms of weighted changes of exchange rates between the domestic currency and these of its trading partners, a basket peg implies that the following condition must hold:

$$W_1 e_{h/1} + W_2 e_{h/2} + W_3 e_{h/3} = 0 \tag{2}$$

where

$e_{h/i}$ = percentage change in the domestic currency price of currency i.

In order to check this condition, we need to find $E^{t+1}_{h/2}$, and $E^{t+1}_{h/3}$. Again, using the cross rates between currency 1 and each of 2, 3 and h, we get

$$E^{t+1}_{h/2} = E^{t+1}_{1/2}/E^{t+1}_{1/h} = 0.9044/1.4403 = 0.6279$$

$$E_{h/3}^{t+1} = E_{1/3}^{t+1}/E_{1/h}^{t+1} = 0.8502/1.4403 = 0.5903.$$

Since the value of the domestic currency with respect to each of the three currencies changes as the cross rates change, there is an inter-relationship between, say, changes in $E_{2/1}$, and variations in $E_{h/1}$ and $E_{h/2}$. For our present example, the appreciation of currency 1 against 2 by 20 percent, will not imply that the domestic currency will appreciate against currency 2 by the same percentage. This is expected since the domestic currency is only partially pegged to currency 1. As a matter of fact, the percentage change in the domestic currency price of each of the other currencies is given by the following:

$$e_{h/1} = W_2 e_{1/2} + W_3 e_{1/3}$$

$$e_{h/2} = W_1 e_{2/1} + W_3 e_{2/3}$$

$$e_{h/3} = W_1 e_{3/1} + W_2 e_{3/2}.$$

Substituting these into equation (2) yields

$$W_1[W_2 e_{1/2} + W_3 e_{1/3}] + W_2[W_1 e_{2/1} + W_3 e_{2/3}] + W_3[W_1 e_{3/1} + W_2 e_{3/2}] = 0$$

where we can define

$$W_1[W_2 e_{1/2} + W_3 e_{1/3}]$$

as the implied change in the domestic currency (since it is pegged to each of the three currencies) against currencies 2 and 3, as a result of the change in the exchange rates between currency 1 and each of currencies 2 and 3. Similarly we can talk about the implied changes in the domestic currency price of currencies 1 and 3, in the second part, and 1 and 2, in the last part of the equation.

However, more information is needed to be able to calculate these changes. Namely, $e_{j/i}$, for i=1, 2, 3 ($j \neq i$) need to be defined. Using the change in the natural log as an approximation for the percentage change[19], we get

$$e_{1/2} = \ln(0.9044/1.1305) = -0.2231$$

[19] $\ln(x_t/x_{t-1})$ = relative change in x. However, a percentage change will be obtained by multiplying the result by 100.

$$e_{1/3} = \ln(0.8502/1.4175) = -0.5112$$

$$e_{2/1} = 0.2231$$

$$e_{3/1} = 0.5112$$

$$e_{2/3} = \ln(0.9401/1.2539) = -0.2880$$

$$e_{3/2} = 0.2880.$$

These values can be substituted into the above equation yielding

$$\begin{aligned} 0 &= 0.1791[0.2250(-0.2231) + 0.5959(-0.5112)] + 0.2250[0.1791(0.2231) \\ &\quad +0.5959(-0.2880)] + 0.5959[0.1791(0.5112) + 0.2250(0.2880)]. \end{aligned}$$

Thus, the condition of a basket peg in terms of weighted changes in the exchange rates is maintained.

As we have defined earlier, the weight assigned to a foreign currency in the basket is a function of the exchange rate between the domestic currency and that currency, as well as of the value of the basket in terms of the domestic currency. Although the latter does not change as a result of changes in the exchange rates, the former does; however, it is not frequently changed. The rationale for the policy of not changing the weights is embodied in the relationship between trade shares and these weights. Applying definition (2), new weights can be found, which are: 24.99, 25.12 and 49.88 for currencies 1, 2 and 3, respectively (use the new exchange rates to calculate these weights). If the trade patterns of the domestic country have not varied over the periods of time when the exchange rates changed, then altering the weights may trigger domestic inflation, caused by aforementioned changes.

It can be assumed that the original weights reflect import shares, that is the weight of each currency in the basket was equated to the percentage of goods that the domestic currency imports from each country. Furthermore it can also be assumed that the domestic country imports 20 percent from country 1 and it has pegged 20 percent of its currency to currency 1, i.e. $W_1 = 0.20$. Then, with the same import share prevailing in the next period, where currency 1 has appreciated against, say, currencies 2 and 3, by 10 percent, the cost of 20 percent of the domestic country's imports will not change, while the cost of 80 percent of the imported goods will rise in terms of the domestic currency. If the weight of currency 1 is changed in time t+1, while the import share remains at 20 percent, then the domestic economy will suffer. On the one hand, had the weight of currency 1 been increased to, say, 30 percent, then the cost of imports from country 1 will not change and, moreover, there will be a further decline in the cost of imports from countries 2 and 3, in terms of the domestic currency. However, the rise in the domestic currency value in terms of currencies 2 and 3 would have two potential effects. Firstly, there would be a deterrent effect on domestic exports to these two countries; secondly, imports from these countries may be stimulated due to the decline in the cost of imports from these countries in terms of the domestic currency. On the other hand, had the weight of currency 1 been less than the import share, the appreciation of currency 1 against 2 and 3, would raise the cost of imports from country 1, although there would be a partial decline in the imports from countries 2 and 3, due to the implied appreciation of the domestic currency against 2 and 3.

As a result, stabilization of the cost of domestic imports from all trading partners would be met on average if the domestic currency is pegged to an import-weighted basket. Furthermore, these weights may have to be kept constant, although changes amongst the exchange rates of the trading partners imply otherwise.

IV. A Review of Literature on Contract Invoicing and International Trade

The demise of the international financial agreements that followed the gold standard brought concern about the future of international trade and the financial settlements involved. Traders feared the uncertainty surrounding their transactions, which rose from fluctuations in the exchange rates of their currencies with respect to those of their trading partners.

The collapse of the Bretton Woods agreement in early 1971 and the subsequent short-lived Smithsonian agreement which ended in 1973 were seen as deterrents to international trade since traders were no longer certain about the real value of their sales or purchases. Under these standards, member states were not allowed to vary the par value of their currencies unless such variations were permitted by the IMF. Nevertheless, the IMF allowed the country to adjust its exchange rate in terms of the common denominator, the United States dollar, without prior consent of the IMF, within a narrow band of one percent up or down. But the collapse ended such assurances for traders who worried particularly most about market-originated forces, depreciation and appreciation as well as official acts by governments which were designed to devalue or revalue their currencies.

Although trading partners would face no exchange risk in dealing in any currency under a rigidly fixed par value arrangement (no bands around the exchange rates), and may face less risk under the above mentioned agreements, their transactions would be exposed to various kinds of risk if the currencies involved in the transactions experience changes in terms of their relative values. This could happen under the flexible or floating exchange rate regimes as well as under an adjustable peg regime. Consider two individuals living in two different countries, each of which has its own national currency. Furthermore, assume there is a floating exchange rate regime through which the values of these currencies are simultaneously determined. Individual A, living in country A, imports a particular type of goods from individual B, who lives in country B. At time t a contract was signed by the two individuals, in which A will pay at time t+1 a total of 100,000 units of a currency for certain units of goods imported from B. Would both individuals consider this contract to be an assurance against exchange rate fluctuations ? The outcome depends largely on the currency involved in the transaction. If we assume currency B was used as a means of payment, then, say, a depreciation of this currency in terms of currency A would result in an unexpected gain by individual A, since it takes fewer units of his currency to purchase the required units of currency B. By contrast, had currency A been the contracted currency, individual B would receive the contracted amount, but currency A is worth more in terms of his domestic currency; thus individual B would have gained from this scheme of invoicing.

This simple example illustrates the complexity of contract invoicing (the act of specifying the currency of payments) and the uncertainty which could unfold when a contract matures.

The subsequent summary of the literature on " Contract Invoicing and International Trade ", will discuss the theoretical as well as the empirical issues involved. The remaining parts of the review will start by discussing the importance of the issue in hand. Then, in the second section, the role which risk may play in trade is covered. The third section describes the alternative regimes of invoicing. Empirical analysis of invoicing practices is presented in the fourth section. The factors which contribute to the choice of the currency of a contract, are described in the fifth section. The sixth section discusses the forward market and how it can be used to cover for risk in conducting trade. Another form of avoiding risk in trade, leads and lags, is described in the seventh section, followed by some concluding remarks.

IV.1. The Importance of Invoicing Practices

The practice of invoicing contracts in certain currency(s), from a microeconomic perspective, has consequences on the individual's economic behavior. The behavior of a utility-maximizing consumer is affected by wealth as well as prices, among other factors. Assuming a well-behaved utility function, the consumer is expected to be worse off as a result of an increase in the relative price level, where this price affects the consumption bundle of the various (normal) goods consumed. Furthermore, the individual's wealth would decline in real terms as the price level rises disproportionately. Similarly, the real value of assets held by firms and the expected real value of their stream of income would decline.

On the general level the choice of invoicing tends to have effects at the macroeconomic level, such as its effect on the trade balance which is thoroughly discussed in the literature associated with the J-effect (Magee, 1973). In short, Magee (1973) explored the effects on the trade balance after a devaluation in the domestic currency, during two distinct periods of time: the currency contract period and the pass-through period. Throughout the first period, contracts are in force and the currency of denomination is taken as given. However, the second period is characterized by flexibility of prices and the likelihood of newly negotiated contracts that take into consideration the consequences of the devaluation.

IV.2. Risk in International Finance

The possibility of loss of profitability and real wealth of a firm arising from changes in the exchange rate of one currency in terms of the other represents the broadly defined concept of risk in international finance.

The importance of analyzing risk in international trade rests on its welfare implications and its effect on the efficiency of stabilization policies. Risk which emerges from exchange rate changes can increase the costs of financing trade, whenever traders consider the transaction of goods and assets as risky. In addition, there would be a welfare loss if the real rates of return from two identical investments differ as a result of the risk involved in holding foreign currencies (Wihlborg, 1978).

The risks involved in trading internationally may be categorized by four kinds of exposure a firm is likely to face: translation exposure, transaction exposure, economic exposure and political exposure. Translation exposure is associated with uncertainty in exchange rates which may affect the liabilities and assets of a firm once they are converted into domestic currency for accounting purposes. The transaction exposure is actually the realization of the effects of exchange rate changes on the liabilities and assets which are being transacted (Levi, 1983). The first two types of exposure may give rise to exchange risk, which is defined as the possibility of loss which may arise when the related exchange rate varies. A firm that faces exchange risk could eliminate it by invoicing the contract in its own currency; however, the other individual who is involved in the transaction will have to assume the risk.

While exchange risk affects the expected revenue of the firm, price risk, which may be classified as an economic risk, affects the firm since it is subject to international as well as domestic market conditions. Moreover, exchange rate changes can introduce price risk, as they alter the new worth of the firm (Aliber, 1976). An example of this price risk could be manifested in the risk which inventory holding may cause to a firm. Prindl (1976) argued that if stocks are bought in a different currency to the one they are sold in, an appreciation of the foreign currency would change the costs to the importer if the domestic price cannot be altered to accommodate the foreign currency price change. Moreover, Aliber (1976) emphasized that as long as the contract calls for future date payment, the firm would have to accept a particular price defined at the present time which must be honored in the future. As a consequence of fluctuations in the exchange rate, the actual price of the contract may change and then the net worth of the firm's assets would be affected.

In addition to the uncertainty in the exchange rate market, there exists the probability of confiscation, liquidation, capital control, exchange rate control or destruction which may result from a political rather than an economic event. A good example of this political risk is confiscation or nationalization of foreign investments after a revolution. It is expected, however, that the seller will continue to encounter price and political risks although it may be successful in eliminating exchange risk.

Consequently, it is of great importance to an exporter as well as an importer to realize the extent to which any of these forms of risks apply to their international trade, since conducting trade internationally involves at least one of the participants making use of the foreign exchange market. Furthermore, a firm must analyze the options available to it to avoid being exposed to risk whenever it can do so. However, the ability of a firm to minimize risk is not always subordinate to its control; rather, it depends on many factors. Among these are the currency of invoice, the degree of risk aversion of both traders, the hedging ability of either traders and leads and lags, which will be discussed in subsequent parts of this chapter.

IV.3. Types of Invoicing Practices

Contracts that involve transaction for goods and financial assets between one country and another can be invoiced in two types of currencies: vehicle and nonvehicle currencies. Nonvehicle currency invoicing is defined as occurring whenever the currency of either the exporter or the importer is used; vehicle currency invoicing, on the other hand, occurs when a third currency is used in invoicing the contracts (Magee and Rao, 1980-b). The nonvehicle currency contracts may not be strictly invoiced in either currency, rather they may consist of a mix of both at various weights. For example, it may be the case that the currencies of the exporter and the importer are used in equal proportions in the invoicing of a specific contract. Similarly, a vehicle currency invoicing may not be a single currency; composite units may be used, such as the SDR and the ECU. For example, Asheim and Park (1976) have referred to the privately issued unit of contract in which trade may be invoiced. By early 1974, such a unit was developed by Barclays Bank of London, called the B-Unit and was defined in terms of five major industrial countries as different units of their currencies.

IV.4. Currency of Denomination of a Trade Contract

The era of fixed exchange rates did not provide an incentive for analyzing the issue of currency invoicing in the international flow of goods. The literature on this matter developed mainly in response to the empirical findings revealed by Grassman (1973-a), which emerged after the abandonment of the Bretton Woods international monetary system. However, some earlier theoretical analysis was presented by Einzig (1962, 1968). Grassman analyzed the Swedish pattern of trade invoicing and observed certain practices. As reported in Table (3), the findings reveal that about 66 percent of Sweden's exports and 26 percent of its imports were invoiced in the Swedish domestic currency.

Moreover, the currency invoicing of Swedish trade depended on the trading partner. Trade with the U.S. and the U.K., for instance, was heavily invoiced in the U.S. dollar and the U.K. pound sterling. In fact the U.S. dollar was the choice whenever the need for a third currency invoicing was adopted as an alternative. This observation by Grassman has become known as Grassman's Law. Thus, this law states that most of a small developed country's trade will be invoiced in the exporter's currency, a smaller proportion will be invoiced in the importer's currency, while the remainder will be invoiced in a third currency (Grassman, 1976).

The choice of currency of settlement for Danish foreign trade confirms the pattern found for Sweden. Grassman (1973-a) reported the seller's currency to be the dominant currency of invoice, with 41 percent of Denmark's exports invoiced in the Danish krone. Imports were mainly invoiced in the importer's currency, with only 19 percent invoiced in the Danish currency and the U.S. dollar and the British pound playing a minor role.

Further empirical testing of Grassman's law was conducted for a number of countries with various assumptions and constraints. Magee (1974) analyzed the U.S. trade pattern with explicit focus on its imports from Japan and West Ger-

Currency	Exports		Imports	
	1973	1968	1973	1968
Swedish kronor	67.4	66.1	25.7	25.8
U.S. dollars	14.1	12.3	20.0	22.0
Deutsche marks	4.80	3.80	19.7	17.4
Pound sterling	4.60	11.2	10.3	17.3
Danish kroner	0.90	1.80	4.50	3.90
Norwegian k.	1.00	0.70	3.60	2.20
Dutch guilders	0.05	n.a.	2.80	n.a.
Swiss francs	1.60	0.05	2.40	2.40
French francs	0.07	0.80	2.10	2.50
Italian lira	0.10	0.03	1.90	1.80
Other	4.30	2.50	7.00	4.70
Total	100	100	100	100
Total (a)	51.200	24.600	45.800	26.200

Source: Grassman (1973-a), p. 217
a: Millions of Swedish kronor.
n.a.: Not available.

Table 3: The currency denomination of Sweden's trade payments (percentage)

many. Keeping in mind the period over which the survey was conducted, 1971 to 1973, and defining it as a transitional period from the Bretton Woods system to the flexible exchange system, the findings reveal the following conclusions. The total proportions of Japanese and German exports invoiced in the exporter's currency were 37 percent and 79 percent respectively. Most of Japan's exports to the U.S. were invoiced in dollars, 63 percent; Germany tended to invoice only 17 percent of its export contracts to the U.S. in dollars. These findings conform, in part, with those presented by Grassman; the Japanese invoicing practice, however, constituted a deviation.

Another estimation was reported for the Netherlands, where Van Nieuwkerk (1979) supported Grassman's findings. The Netherlands' currency, guilder, was used to invoice 50 percent and 25 percent of the country's exports and imports, respectively.

In addition to the exporters' preference for invoicing their exports in terms of their own currencies, Grassman observed that Sweden's imports from developing countries tend to be predominantly invoiced in the Swedish kronor, and from Latin American countries, the dollar and the Swedish currency unit were the dominant means of invoicing. Page (1977) found substantial evidence in support of the importance of characteristics of the trading partners in determining the invoicing of contracts. In general, large percentages of nine industrial countries' exports were invoiced in their currencies. The only exception was Finland, for which the dollar was the dominant currency of invoicing. The dollar was the currency of contracts for exports from France and Sweden to the U.S., and about 50 percent of the U.K. exports to the U.S. was denominated in dollars, with the rest was in sterling. Furthermore, the exporter's currency was mainly the currency of denomination of exports to the third world, except Latin America for whom the dollar proved again to be the major currency. However, the role of the dollar declined substantially when trade flows between the member states in the European Economic Community, EEC, were considered.

Further evidence was presented by Carse et al. (1980), who analyzed U.K. foreign trade from the invoicing perspective. Considering the number of transactions, the results reveal that about 86 percent of the total number of the sampled British export contracts were invoiced in the British currency; only 11.5 percent were invoiced in the buyer's currency. The data on export by trading partner show that the pound sterling preserved its role in invoicing exports to all countries in the survey including the U.S; however the dollar was the currency most commonly used to invoice British exports after the pound sterling. In contrast to British exports, about 64 percent of the total imports by the U.K. were invoiced in the seller's currency, while the pound was used to invoice about 29 percent of the total transactions sampled in the survey. About 59 percent of imports from Latin America and 95 percent of those from the U.S. were priced in dollars. The role of the pound was predominant in U.K. imports from Eastern Europe, where only 20 percent of total imports from this block were priced in other currencies.

In general, we find these studies to be supportive of the early evidence presented by Grassman. With minor deviations, it was found that most of a developed country's exports were invoiced in the domestic currency. In the second place was the currency of the buyer , and lastly there was the presence of a vehicle currency, usually U.S. dollar.

Since the choice of currency for invoicing is of considerable importance to a given firm, this economic agent is likely to seek out the various methods available to invoice in the most stable currency, so as to minimize the potential negative effects of the choice on its earnings as well as on the value of its assets. In the next part we shall consider the various factors which have been mentioned in the literature as contributing factors to the strategy of selecting the currency of invoicing.

IV.5. Determinants of the Choice of a Contract Currency

In surveying the theoretical and empirical models of contract-currency invoicing, several factors to which the choice of the invoicing currency is attributed have been mentioned. Among these are: i) tradition and habit; ii) type of goods; iii) market power; iv) inflation differentials and the stability of inflation rates; v) degree of risk aversion.

Although not every factor has been referred to by each of the models considered in this review, a discussion of each factor in turn should reflect the importance and the contribution of these factors to the process of selecting the currency of denominating contracts.

i. Tradition and Habit

The pioneer work of Grassman (1973-a, 1973-b), revealed that certain invoicing practices for selected commodities reflect mere tradition and habit. This practice is evident in raw materials such as oil, where the dollar has been the currency of denomination. For Sweden, Grassman noted that the pound tends to be the currency denominating the exports of forestry products. A similar conclusion was arrived at by Magee (1974), who surveyed the invoicing practices of American importers. According to the data presented by Magee, imported steel plates and sheets from Japan and Germany were invoiced in the U.S. dollar.

ii. Type of Goods

In addition, currency invoicing choice may be affected by the type of goods being traded. McKinnon (1979) distinguished between two groups of goods, tradables I and tradables II. According to this classification, tradables I tend to have distinct characteristics, i.e. heterogeneous products, with which a producer can be associated. This group includes manufactured and trade-mark products. Another economic characteristic of these commodities is that their prices tend to be fixed for a relatively long time, although their producers could have a direct influence on them. On the other hand, tradables II include commodities which are homogeneous and produced on a large scale. Producers tend to be incapable, in general, of controlling their fluctuating prices. Goods such as primary products would qualify for this class.

The evidence on the currency invoicing of these groups of goods has disclosed some uniform practices. McKinnon (1979) found contracts for goods produced as tradables I to be invoiced in the home currency of the exporter. However, primary products have been found to be priced in dollars (oil would be an example). Similar evidence was presented by Page (1977). As reported in Table (4), she found invoicing of machinery and transport equipment in Sweden and the U.K. to be invoiced in the exporter's currency. Moreover, Page found oil to be invoiced in dollars for all of the countries considered in the estimation.

Although these invoicing schemes seem to be confirmed by the data, Magee (1974) found some surprising results. Commodity comparison of German and Japanese exports to the U.S. shows that while Germany invoiced most of its exports in the Deutsche mark, Japanese export contracts have been priced in dollars. These products included non-primary goods; almost all manufactured goods exported to the U.S. followed this practice. The only commodity Magee found to comply with McKinnon's classification for tradables I is organic chemicals, where both countries priced them in the exporter's currency. Magee argued that the Japanese have built in a tradition of invoicing in dollars, and this practice has been somehow maintained by manufactures even at a time of a decline in the purchasing power of the dollar. For example, when the dollar was devalued in 1971 relative to other currencies, including the yen, Japanese exports continued to be contracted in dollars; the denomination of such contracts actually increased from 61 percent in 1971 to 72 percent in 1973.

In addition, Japan has a long official financial preference for the dollar. Magee (1974) reported that two factors could be identified as constructive in promoting the role of the dollar in denominating Japanese exports. Firstly, some Japanese banks find it easier to finance foreign trade contracts in dollars due to financial regulations in Japan. The Japanese monetary agencies since the postwar period have encouraged and actually subsidized activities that would increase dollar earnings. Secondly, banks prefer dollar-denominated contracts since they find greater financial gain in finance charges as a result of financing in dollars. Bilson (1983) added that, because most of Japan's inputs in the production process of manufactured goods are invoiced in dollars, Japanese exports would be expected to be invoiced in dollars. Furthermore, Bilson argued that the management of a firm may eliminate the uncertainty in revenue by invoicing Japanese exports in dollars.

In an attempt to explain the Japanese practice further, Page (1977) argued that, although the Japanese practice is an exception rather than a rule, this can be attributed in part to the relatively recent rise in Japanese share of the export market, and the restrictive use of the yen as a medium for settling international payments due to government's policy.

Further evidence on the issue of invoicing according to commodities was presented by Carse et al. They examined the U.K. trade invoicing pattern according to the classification presented by McKinnon (1979). The presence of the dollar was clearly observed in the U.K. imports of both tradables (Table 5). However, the dollar played a smaller role in invoicing U.K. exports, whether tradables I or tradables II. An analysis of the British total trade invoiced in vehicle currencies, according to the value of transactions, showed about 77 percent of tradables I and tradables II to be invoiced in vehicle currencies (dollars or pounds).

iii. Market Power

Theoretically market power which a firm might have, tends to enable a utility-maximizing consumer or a profit-maximizing producer to influence the outcome in a market setting to its own benefit. This market characteristic has a substantial impact on the currency denomination of contracts, since the trader who gets contracts invoiced in his currency will avoid exchange risk.

Commodity	Sweden	U.K.
Food	49.0	67.0
Fuels	30.0	65.0 a
Chemicals	62.0	65.0
Textiles	73.0	66.0
Metals	64.0	59.0
Electrical machinery	72.0	76.0
Other machinery	83.0	88.0
Transport	77.0	90.0
Other	65.0	72.0
Total	66.0	73.0

Source: Page (1977), p. 79
a: And basic materials.

Table 4: Share of exporter's currency in invoicing by commodity (percentage)

	Value of transactions.		
	dollar	pound	vehicle
Exports:			
Tradables I	7.0	75.7	82.7
Tradables II	9.2	77.3	86.5
Imports:			
Tradables I	37.5	28.7	66.2
Tradables II	43.2	31.5	74.7
Total			
Tradables I	16.4	61.2	77.6
Tradables II	34.8	42.8	77.6

Source: Carse et al. (1980), p. 71.

Table 5: U.K. trade invoiced in vehicle and other currencies (percentage)

Although none of the models surveyed has given an explicit definition of market power, there is a general argument that exporters are in a better position to specify their preferences during the negotiations of the various aspects of a contract. Magee (1973, 1974) concluded that since sellers are more specialized in the production of goods and sell to a number of heterogeneous consumers, sellers are expected to acquire greater market power than buyers. Moreover, their demand to denominate contracts in their own currency reflects their profit maximizing behavior of minimizing exchange risk as well as the cost which may arise if they have to approach the forward market to hedge.

Levi (1983) and Grassman (1973-a) argued that exporters are more likely to invoice in their own currency since there is, in general, an exchange risk involved. However, their success in achieving such a target will depend crucially on their negotiation power.

Although the former authors may have successfully presented the importance of market power in affecting the conditions of a contract invoicing process as well as its outcome, the empirical evidence on the invoicing practice adopted by Japanese firms is contradictory. As we have emphasized earlier, Magee observed Japanese firms invoicing most of their exports to the U.S. in dollars not in yen, as would be expected, it is assumed that sellers tend to insist on contracts being in their currency.

Bilson (1983) found a considerable interdependence between the firm's degree of risk aversion and market power on the one hand, and the practice of invoicing in the exporter's currency, on the other. If the exporter is risk neutral, he would make the importer choose any arrangement of the foreign and domestic currencies, since the exporter is only interested in the total revenue from the transaction. However if in addition to this degree of riskiness, the exporter 's market power increases, then the proportion of the contract denominated in his currency will rise relative to that invoiced in the importer's currency. Thus the equilibrium point, in the microeconomic utility-maximization framework presented by Bilson (1983), will be affected by the market strength of the two trading partners. However, it is not necessary for an exporter who possesses market power to be able to invoice contracts in his currency; rather, the outcome will depend on the risk aversion of the importer. If an importer who is risk averse is considered, then a rise in the exporter's market power will not lead to the exporter demanding invoicing in its own currency, instead it is more likely that the elaboration of this power will be reflected in higher export prices. Consequently, Bilson argued, the rise in prices would increase the profit margin of the exporter, and this would put him in a better position to negotiate invoicing a higher proportion of the contract in his own currency. However, Bilson, who defined market power as being dependent on the availability of alternative suppliers, the market structure and factors like regulation and tariffs, argued that exporters are expected to devote their market power to increasing the proportion of contracts denominated in their currency, rather than charging importers higher prices.

The exporter's ability to shift exchange risk to the importer, once contracts have been invoiced in the former's currency, is supplemented by the importer's ability to adjust selling prices if an unexpected devaluation occurs. Importers are believed to be more capable of adjusting their selling prices in response to exchange rate fluctuations. On the contrary, exporters tend to face resistance to adjusting their wage bill as well as interest payments in response to a decline in earnings whenever the currency of invoicing experiences a reduction in its purchasing power. The premium paid to the importers, to compensate them for bearing the risk, may come, for example, in the form of extended time of credit or discounted prices (McKinnon, 1979).

The models presented by Baron (1976), Hooper and Kohlhagen (1978), and Bilson (1983), are based on microeconomic foundations. They derived the strategy of an importer and an exporter who maximize their utility over both expected profit, from which they gain utility, and also over the expected variance in profit, from which they receive disutility. Accordingly, whether the exporter likes to invoice in his currency is seen to depend on the expected utility as a function of profit under the two alternative schemes of invoicing, i.e. the domestic or the foreign currency, not just the market power possessed by traders.

iv. Inflation Differentials and the Stability of Inflation Rates

The real value of a currency depends on the general price level in a given country. A rise in the inflation rate is expected to reduce the purchasing power of an asset or revenue which a firm holds or expects to earn at a future date. Consequently, both exporters as well as importers would prefer to minimize the negative impact of a rise in the inflation rate on the value of a contract[20]. Models such as those presented by Baron (1976), Hooper and Kohlhagen (1978) and Bilson (1983) defined the utility functions of an importer as well as an exporter to include the variance of expected profit, which measures the risk involved, where the variance is determined in part by the actual price a firm expects to receive at the time of payment (note that this price is a function of the exchange rate). Bilson argued

[20]Stiglitz (1972), and Sandmo (1971), have demonstrated separately the impact of price stabilization on the behavior of the consumer and the firm. This was discussed in Chapter III.

that, although the currency of the exporter is more likely to be the currency of a contract, a high inflation rate in the exporter's country or greater variations in that rate would lead the exporter (and the importer) to invoice contracts in the currency which is considered to be relatively stable and experiencing a lower rate of inflation.

Furthermore, Bilson argued that there is a negative covariance between the revenue of an importer and his costs, which constitutes a strong incentive to invoice in currencies with low inflation whenever the domestic price level is more variable. To see this, assume a domestic importer who is selling in the domestic market an imported product from a foreign country. Furthermore, assume the contracts are invoiced in the foreign currency. Then an unexpected decline in the domestic inflation rate will reduce domestic revenue, thus making the importer worse off. However, the price of the foreign currency in terms of the domestic currency is lowered, i.e. the importer's cost has declined. In contrast, had contracts been invoiced in the domestic currency, domestic revenue would have declined, but the domestic value of the contract, taking into consideration the appreciation of the domestic currency, would have risen. Thus contracting in the stable currency is preferable from the standpoint of a utility-maximizing importer.

The preference of the exporter does not differ from that of the importer. Consider an unexpected depreciation in the exporter's currency. This will raise the exporters production costs and lower the price of its currency in terms of the currency of the importer. Consequently, there is a rise in costs and a decline in revenue, in terms of the relative value of earnings. Therefore, exporters should avoid invoicing in the more variable currencies. The survey reported by Page (1977) seems to support these arguments. She found a negative correlation between the inflation rate in the exporter's country and the use of the exporter's currency in denominating international transactions.

Dunn (1971) examined the question of whether firms respond constantly to deviations from Purchasing Power Parity (PPP) due to exchange rate changes by adjusting the prices of their contracts or output. Dunn stressed that firms, or exporters in this case, do not respond to transitory deviations from PPP by adjusting the prices of their output. The reason for this is embodied in the firms' practices which take into account expected deviations of this sort. For a firm that invoices its exports in a certain currency, not to worry about transitory deviations from PPP, requires certain conditions to hold. Firstly, the profit margin must be set so as to absorb variations in its real return. Secondly, variations in the exchange rate should remain within a range which would enable the firm to observe such variations without the need to respond by changing prices. Lastly, the foreign market must be viewed as important by the exporter, so that the firm views varying prices to be counter-productive and likely to reduce its competitiveness in the foreign market. Empirical evidence presented by Dunn supports his argument, and data for Canada yielded no significant values when the relationship between changes in the price level and the exchange rate was tested statistically.

Aliber (1976) estimated price risk as short-run deviations from PPP induced by changes in exchange rates. Empirical estimation of the price risk for eight industrialized countries revealed that there is a positive relationship between the price risk and the variance of the exchange rate. Although no measure of the significance of this impact was presented, Aliber concluded that price risk tends to increase uncertainty in trade which may have negative effects on the volume of goods traded in the international market.

Magee and Rao (1980-a) argued that both the exchange rate and the inflation rate are random variables at the time of the contract and can affect the relative value of a contract. Consider an importer and an exporter in a market setting. If the contract is invoiced in the importer's currency, then the relative value of the contract is seen to be:

$$R_v = P_{cm}/P_t$$

where

R_v = relative value of a contract

P_{cm} = price of the contract fixed in the importer's currency

P_t = the general price level in the importer's country.

However, the role of the exchange rate is evident if the contract is written in the exporter's currency. Then, the relative value of the contract is:

$$R_v = P_{cx}E_{mx}/P_t$$

where

P_{cx} = price of the contract fixed in the exporter's currency

E_{mx} = the importer's currency price of the exporter's currency.

If the contract is invoiced in the importer's currency, then P_{cm} is fixed and the relative value of the contract is affected by the inflation rate in the importer's country, i.e. by P_t. Consequently, a rise in this rate of inflation will reduce the relative value of the contract. On the other hand, had the contract been written in the exporter's currency, two factors may affect the relative value of the contract: the exchange rate and the inflation rate in the importer's country. For example, a rise in that rate of inflation would lower the relative value of the contract, unless matched by an equal depreciation of the importer's currency vis-á-vis the currency of the exporter.

The distinction between the effect of general price level and the effect of relative price level on the choice of currency of denomination of contracts in international trade has been explored further by Cornell (1980), who argued that rational economic agents would incorporate expected inflationary differentials in their negotiated contracts. Consequently, they would prefer to invoice in the currency which was viewed as being stable when expectations were formed, in the sense it has lower expected variations in the inflation rate relative to other competing currencies.

If on the other hand relative price changes are considered, Cornell showed that such variations will produce real changes in the exchange rate, even though the general price levels in the two countries are constant. Since the effect of relative price changes depends on the assumption of different preferences in the two countries (consumers in each country assign different weights to the various goods in a given bundle), then, in order to bear the exchange risk involved, one trader must be paid to accept invoicing to be conducted in the foreign currency, since each party would like to write the contract in its own currency. However, since future prices are not known with certainty, i.e. both the general price level and the relative price level are randomly distributed over time, in general, price risk can not be eliminated. Nevertheless, general guidance may be given. If the inflation rates are highly variable in both countries, contracts would experience the minimum distortion in their real values if they are invoiced in a third currency. In the more obvious case, if the inflation rate is more variable in one country relative to the other, invoicing would have to be conducted in the more stable currency. Lastly, if the levels of variations in both countries follow approximately similar behavior, the importer and the exporter are most likely to be indifferent as to what currency the contract should be invoiced in.

In an attempt to explain the effect of inflation differentials on the practice of contract invoicing in developing countries, the Bilson-Magee hypothesis, was developed. This hypothesis states that all traders in countries with the risk of high inflation will prefer to price in the stronger (low-inflation or appreciating) currency of the trading partner. Consequently, bilateral trade between developing and developed countries is invoiced in the latter countries' currencies. Another reason for this type of denomination is the behavior of economic variables in developing countries. The hypothesis argues that economic variables in these countries are not consistent with expectations, which inflicts real costs on the value of international trade contracts (Rao and Magee, 1980-b). This could justify, according to the hypothesis, the current behavior of avoiding contracts being denominated in a developing country's currency.

To conclude, there is overwhelming agreement on the method of invoicing if there is a differential of the inflation rates of the trading partners. Both the importer and the exporter tend to prefer a more stable currency (in terms of variations), since the choice of a stable currency is positively associated with the real value of the contract.

vi. Degree of Risk Aversion

Earlier in the survey we have defined several types of risk which are likely to be encountered by a trader in the international market. However, there is no reason to believe that individuals faced with the same kind of risk would behave identically. Rather, their willingness to bear risk depends to a large extent on their degree of risk aversion. While a risk-averse person needs to be paid to take risk, a risk lover would bear the uncertainty involved in a given transaction without such a requirement; rather, he would pay a premium for the privilege of bearing risk. On the other hand, individuals who would take risk even if they are not compensated, are called risk-neutral agents[21].

The analysis of the U.S. import invoicing practice conducted by Magee (1974) examined some of the determinants of the selected invoicing schemes and argued that one of the factors that may explain the differences in the practice of invoicing Japanese and German exports to the U.S. is the nature of the risk degree involved. Magee viewed Japanese exporters as being less risk averse than U.S. importers, and hence accepted the denomination of contracts in the importer's currency. German exporters are more risk averse than their U.S. customers, and consequently insisted on contracts being written in the Deutsche mark.

Thus, if traders are risk averse, it is expected that they would react negatively to an increase in risk in trade. Nonetheless, if the decline in the volume of trade, as exchange rate risk rises, results in a reduction in welfare, then increasing the volume of trade would constitute a legitimate macroeconomic objective. During the period after the Bretton Woods agreement, instability in the exchange rates has been blamed for the decline in the volume of trade (Akhtar-Hilton (1984), Cushman (1983)), and the transmission of inflation which is caused by and passed through the exchange rates (pass-through effect). Moreover, if contractors are

[21]In the present context, risk aversion refers to the degree of avoiding changes in the expected value of a trade contract, which may result from an exchange risk or other types of risk.

risk averse, then fluctuations in exchange rates can affect the decision of producers and consumers in many ways. Competitiveness is an essential feature of production and trade; however, this is affected by exchange rate changes since these changes influence the prices producers pay and charge (their relative prices). Profit margins are thus affected.

Several studies have analyzed the effect of exchange rate risk on both the equilibrium price and quantity. Hooper and Kohlhagen (1978) tested this hypothesis empirically and reported several observations. Firstly, exchange risk was found to have a positive impact on the price charged by exporters when they bear the exchange risk, and a negative impact when importers bear the risk[22]. If exporters expect exchange rate uncertainty, they would adjust their prices to include the risk factor. However, importers would reduce their demand for imports when they bear the exchange risk, thus prices would decline[23]. Secondly, the effects of exchange rate uncertainty in sixteen cases of multilateral and bilateral trade flows analyzed for the U.S. and Germany were found to have no significant impact on the volume of trade. Furthermore, Hooper and Kohlhagen confirmed the results obtained by Magee (1974) and Grassman (1973-a, 1973-b, 1976): trade is invoiced predominantly in the exporter's currency and so exchange risk is endured largely by importers. For U.S. imports, which are predominantly in dollars, the impact of exchange risk on price was found to be negative. Thus, exchange risk is borne largely by exporters as a result of this denomination scheme of contracts.

Another study conducted by Akhtar and Hilton (1984) concluded that there is evidence to imply that exchange rate risk does have impacts on the volume of trade, as well as the price of traded goods. Exchange rate risk (uncertainty) is defined to include both an observable component, which is the ex post variability in the nominal effective exchange rate index, and an unobservable component which is formed on an ex ante basis by economic agents. Simply, using the variability in the

[22]Hooper and Kohlhagen defined exchange risk as the difference between the current spot exchange rate and the forward rate 90 days earlier.

[23]Exchange rate risk may arise in the present setting if at least part of the contract is invoiced in the exporter's currency.

exchange rate after variability has occurred undermines the fact that before this variability became known, agents could have formed different expectations about that variability. However, there is no feasible mean of modeling this component. Fitting the model to the U.S. and Germany data revealed that exchange rate variability has a negative impact on the volume of trade in manufactured goods.

Gotur (1985) extended Akhtar-Hilton's model by including a larger sample of countries, and tested the robustness of the model over different sampled observations. She found no significant and consistent statistical evidence to conclude that exchange risk had an impact on volume of trade. In an explanation of the findings of Akhtar and Hilton, Gotur argued that they had used a less acceptable method of correcting for serial correlation in the data, and they should have used a broader index of effective exchange rate (Gotur used the MERM index)[24].

Although Akhtar and Hilton discounted the use of variability in the real exchange rate as a proxy for exchange rate uncertainty[25]. Cushman (1983) used this variability as a measure of exchange risk, and argued that some studies which did not find a significant impact of exchange risk on the volume of trade failed to allow for lags of sufficient length to work through the system. Thus, testing this model, Cushman found variability in the exchange rate to have negative effects on trade volume, when he fitted the data for six major industrial countries. However, potential reasons given as decisive in yielding this conclusion are not simple to identify. In this respect, Cushman wrote:

> The factors making a difference in this current attempt could be either the specifications of the equations in real terms, or the specification of the risk variable (standard deviation with quarterly observation over a year's time rather than a shorter time period), or the longer lags we were willing to try[26].

[24]This is derived from the IMF's Multilateral Exchange Rate Model (MERM). It includes 18 countries, whereas the index used by Akhtar and Hilton includes 10 countries.

[25]M. Akhtar, and S. Hilton, " Effects of Exchange Rate Uncertainty on German and U.S. Trade, " *Federal Reserve Bank of New York Quarterly Review*, vol. 9 (Spring 1984), p. 10.

[26]D. Cushman, " The Effects of Real Exchange Rate Risk on International Trade, " *Journal of International Economics*, vol. 15 (1983), p. 59.

A survey of the potential effects of exchange rate variability on international trade was conducted by the International Monetary Fund (1984). In general, this study reviewed the evidence presented by other authors and analyzed their assumptions as well as conclusions. Although the survey found a rise in exchange rate instability since the move toward a more flexible exchange rate regime by the industrial countries, little evidence was revealed about the negative effects of this instability on the volume of international trade. However, this does not undermine the importance of exchange rate variability in analyzing international trade. The survey concludes:

> The failure to establish a statistical link between exchange rate variability and trade does not, of course, prove that a causal link does not exist. It may be that the measures of variability are inadequate measures of uncertainty; that other factors overwhelm the impact of variability in the estimating equations; or that the presence of statistical problems ... interferes with the effectiveness of statistical tests[27].

Clearly, this magnifies the difficulty associated with measuring exchange rate variability, and how, in a dynamic world, to separate its causal effect on trade from the effects of other factors, where the effects of exchange rate risk may facilitate themselves through other variables, such as prices of traded goods.

The potential impacts of exchange risk on exporters and importers were discussed further by Baron (1976), who argued that most studies of the effect of risk on the denomination choice of contracts, implicitly have risk embodied in their models by allowing for a lag from the time of contracting until the date of payment. Baron (1976) argued that theoretically, the seller will still face risk even if contracts call for immediate payment. The elimination of payment lag will eliminate part of the exchange risk, but not transaction risk (which is part of the exchange risk), if

[27]Exchange Rate Volatility and World Trade. *IMF Occasional Paper*, no. 28 (Washington: International Monetary Fund, July 1984), p. 36.

contracts are invoiced in the importer's currency, because the exporter will bear the exchange cost of converting the foreign currency into its own currency. On the other hand, if contracts are invoiced in the currency of the exporter, the quantity demanded will be variable since the exporter does not know prior to the contract what the importer's price will be at the time when the importer approaches the goods market. Such uncertainties could be eliminated if the exporter can adjust the price he is charging for every movement in the exchange rate. For example, if the exporter is able to adjust his price, then his revenues from sales will not change as a result of changes in the exchange rate, since the selling price can be changed so as to offset the effects of fluctuations in the exchange rate on revenues.

Baron (1976) integrated the theoretical model to account for the effect of exchange rate regimes on the choice of invoicing practices. Under the floating exchange rate system, Baron argued, the price charged by risk-averse exporters will, in general, be higher than the price demanded by the same exporter had the world been on the fixed exchange system if the contract is invoiced in the importer's currency. In contrast, if contracts are invoiced in the currency of the exporter, a transaction carried out under a system of floating exchange rate will induce the exporter to charge lower prices in order to induce the importer to buy the goods, since the importer will be bearing the exchange risk involved in transacting.

Aliber (1976) compared the performance of foreign exchange markets during the periods of floating exchange rate with that during pegged exchange periods for several industrial countries' cross exchange rates. The study showed that exchange risk increased sharply under the floating system (1973-1974), relative to the pegged periods (1962-1967). Moreover, price risk, measured as percentage deviations from purchasing power parity with the U.S., was found to be significantly larger in the period of floating rates compared to the pegged rate period. However, the causality is not clearly defined, since other economic variables changed after the flexible exchange-rate regime was adopted. For example, monetary and fiscal policies were modified so as to help achieve the economic targets in a given economy after adopting the new regime.

Wihlborg (1978) argued that a particular level of risk need not be a result of adopting a certain exchange rate regime, rather, it may be the consequence of official policies implemented by governments. For example, if the domestic government aims to control the domestic real rate of return, it may achieve that by discouraging the outflow of capital from the country. Then it may increase currency risk.

Faced with these uncertainties, firms tend to seek the possible ways of minimizing and thus avoiding risks. Various methods have been developed to provide such protection, although their contributions are not equally effective. The forward market by far is the most popular, relative to other methods, despite its limitations.

IV.6. The Forward Market and Covering Risk

Transactions across national borders involve the possibility of being exposed to the various types of risk. Although political risk can not be quantified easily and is thus difficult to cover in the financial market, the practice of covering for risks which may arise in the financial sense, such as exchange risk, has been adopted by the financial community.

The literature has identified several methods which traders can use to cover risk. Firstly, it may be feasible for the traders to include an exchange rate clause in the contract, specifying that any change in the exchange rate will be borne by either party. Secondly, traders may seek to transfer their risk to a financial or commercial institution, such as a bank, that will implement the payment or the collection. Thirdly, traders can hedge the risk by obtaining the required foreign currency at the time, and holding it until the maturity date of the contract or fourthly, they could acquire the foreign currency at an earlier date and pay at the time of entering into the contract or any later date. Fifthly, a multi-currency basket of foreign exchange may be held in anticipation of conducting foreign trade, and consequently, payments. Finally, a forward transaction may be entered into

(Van Nieuwkerk ,1979).

The literature has devoted considerable time to the option of covering forward and hedging forward so as to reduce risk in international trade, compared to the time allocated to analyze the other methods. Van Nieuwkerk (1979) argued that there is evidence to support this practice as other methods have not been as widely used in international financing practices as has the forward covering.

The use of covering or hedging forward may depend on the type of exposure a firm is likely to experience. McRae and Walker (1980) clarified this by defining covering as the act of:

> Protecting the value of the future proceeds of an international trade transaction, usually by buying or selling the proceeds in the forward market[28].

Hedging refers to a similar action but under different exposure. Hedging may be defined as:

> The protection of the accounting value of foreign currency assets and liabilities against unrealized foreign exchange (translation) losses, by, for example, forward sales or purchases[29].

Although there is some distinction in the definitions of covering and hedging, the distinction is very minor and we will, as is often done in the literature, use these two acts of reducing risk interchangeably. Hedging by using the forward market may be illustrated by considering a Japanese exporter who is to receive payments for his exports invoiced in pounds in 90 days. He can eliminate the exchange risk which may affect the real value of the contract by selling the expected pounds in the forward market, i.e. to deliver the pounds at a future date. Alternatively, the exporter can approach the British financial market and borrow pounds, convert

[28] T. W. McRae and D. P. Walker, *Foreign Exchange Management* (N.Y.: Prentice-Hall International, Inc., 1980), p. 273.

[29] McRae and Walker, p. 276.

them into yen and invest the amount in Japan for a period equal to that of the contract. In addition, the exporter would have to purchase in the forward market an amount equal to that expected to be paid on the borrowed principal. Then, when the exporter receives the pounds agreed upon in the contract, he would use that to pay his liability in pounds in the British market, and use the interest received from his investment to pay for the forward contract, which covers the interest on the principal.

Grassman estimated the use of forward contracts in covering exchange risk in Sweden in 1968 and in 1973. In 1973 about 11 percent of foreign trade transactions were covered by forward contracts, compared to only about 5 percent in 1968. Furthermore, the data for 1973 show that large transactions are normally covered by the forward market. Grassman argued that there is no clear evidence on correlation between the use of cover and the currencies used to denominate contracts per se. However, covering is found to be associated with particular types of goods, i.e. transactions of certain goods were covered, whereas those involving other types of goods were not.

Carse et al. (1980) analyzed the behavior of British firms and estimated the percentage of forward covering according to the value of transactions and the number of transactions sampled. As reported in Table (6), forward covering is very small for exports, where only 4 percent of contracts classified according to the value of transactions were covered by the forward market and 2 percent classified according to numbers of transactions. However, the percentage of imported transactions covered by forward contracts was substantially greater, using either classification.

In spite of the use of the forward market in the U.K., the survey conducted by the authors revealed that market participants have sought invoicing in pounds as the best possible protection against risk. As it can be inferred from Table (6), in many cases importers and exporters invoiced their contracts in pounds, or preferred to uncover their transactions rather than use forward contracting.

	Exports		Imports	
	value of transactions	number of transactions	value of transactions	number of transactions
Sterling invoicing	75.9	85.5	30.3	28.2
Covered forward	3.7	1.9	25.3	15.4
Other methods	7.9	1.7	5.2	3.80
Exposed to risk	12.5	10.9	39.2	52.6

Source: Carse et al. (1980), p. 67.

Table 6: Methods of reducing foreign exchange risk in the U.K. (percentage)

Testing McKinnon's classification with respect to covering, they found no consistent pattern. According to the types of goods traded, if the number of transactions in exports and imports is used, about 1 percent of exports of tradables I and 7 percent of tradables II were covered by forward contracts. However, the figures for imports are higher, where about 24 percent of tradables I and 18 percent of tradables II were covered by the same method.

Since forward cover is a method of covering for expected risk, we may expect covering international transactions to increase during periods of instability in the exchange market. Van Nieuwkerk (1979) tested this hypothesis for the Netherlands and found a rise in the use of the forward market during the period from 1968 to 1973, which was a period of relative instability in the international monetary system, and a period of unrest for some vehicle currencies such as the dollar and the pound (Table 7).

Limited use seems to be made of the forward market relative to what might be expected in view of the risk involved in contracting across countries and time. As the evidence from the data analyzed for Sweden, U.K. and the Netherlands shows, firms have minimized the covering of their transactions and preferred to have an open position for the duration of contracts. In spite of the availability of the

	1968	1973	1976
Imports.			
Guilders	23.5	26.2	31.4
Forward market	14.3	32.4	31.6
External compensation	7.10	7.60	13.0
Total covered imports	44.9	66.2	76.0
Uncovered imports	55.1	33.8	24.0
Exports.			
Guilders	42.3	45.3	50.2
Forward market	18.4	22.5	22.7
External compensation	1.0	2.0	4.4
Total covered exports	61.7	69.8	77.3
Uncovered Exports	38.3	30.2	22.7

Source: Van Nieuwkerk (1979), p. 90.

Table 7: Various methods of covering exchange risk in the Netherlands (percentage)

forward exchange markets in all the industrial countries, except Iceland, and the emergence of this market or similar alternatives (for example options, swaps and futures), there has been limited use of forward cover in international trade[30]. There are several possible factors which may affect the use of the forward exchange rate market. Among these are: firstly, borrowing and lending in the foreign exchange market involve transactions and administrative costs, and in covering forward, the costs may exceed the expected benefits. Secondly, Grassman (1973-b), indicated that the forward markets are technically complicated. Thirdly, the maturity date on a forward contract, under present arrangements, may not conform with that period over which contractors like to cover, or the time when a contract matures (Carse et al. (1980), Magee and Rao (1980-b) and McKinnon (1979)).

Empirically, there appears to be a general reluctance to use hedging forward across firms, commodities and countries. Another method of covering risk, however, adopted on a smaller scale, involves the timing of payments.

IV.7. Leads and Lags

In view of an anticipated devaluation of the contracted currency, firms may adopt the option of leading or lagging the payments involved. Leading, the act of accelerating the settlement of payments, and lagging, the practice of delaying payments, if allowed for by a clause in the contract and the political institutions, could play a major role in shifting exchange risk and political risk between the various parties in international trade. Nevertheless, this technique may be used for the purpose of speculation with respect to interest rates.

To clarify, consider two trading partners, a British importer and a U.S. exporter, who have agreed at a prior date to invoice the transaction in terms of the pound. Further, within the time that separates the contracting and the delivery dates,

[30] An IMF study shows that all industrial countries, except Iceland, have forward exchange markets, with a few number of countries limiting the maturities on these. The reference is: Policies for Developing Forward Foreign Exchange Markets. *IMF Occasional Paper*, no. 60 (Washington: International Monetary Fund, June 1988).

expectations form in which the pound is expected to depreciate. Accordingly, the importer would have little incentive to alter the date of the contract's payments. However, the American exporter would be better off if it could accelerate the collection of the payments, so as to convert them into another currency and thus hope to avoid the lower purchasing power of the pound after the devaluation takes place. Had the contract been invoiced in terms of dollars, the importer would have wished to lead the payments, since the pound would be expected to loss some of its purchasing power in terms of the dollar. Meanwhile, the exporter would prefer to extend the credit to the importer, i.e. the exporter would lag the payments, so that the dollar would be worth more in terms of the pound. A similar argument would hold had there been expectation of the pound being revalued. Then, the importer would like to lag the payment, while the exporter would favor leading.

Since this risk-minimizing scheme implicates a conflict of interests if used between traders of different interests, there is very little discussion of it in the contemporary literature. The use of leads and lags is adopted more frequently between the various affiliates of a multinational corporation, since it could serve as a tool to shift liabilities, assets, risks, taxes and capital, and is often used to speculate on interests. Einzig (1967) referred to the situation involving sterling in 1957 as an example of leads and lags. In 1957, sterling was anticipated to depreciate, thus people who had expected to receive payments in sterling sold forward, to avoid holding sterling at a time when its relative value would be lower. On the other hand, those expecting to make payments left their position in the foreign exchange market uncovered, in anticipation of relatively cheaper sterling in the future.

In summary, invoicing contracts in international trade tends to be correlated with the perception of stability in the exchange rate by traders, although this risk is not the only one a firm may be exposed to.

Bilson (1983) has neatly summarized the main generalizations of the empirical studies conducted into the issue of contract invoicing in international trade. Firstly, according to Grassman's rule, as Bilson calls the formula labeled by others as Grassman's law, the exporter's currency is likely to be the dominant currency in invoicing trade in manufactured products between developed countries. Secondly, the use of the forward market as a hedging device has been very limited, although the introduction of the flexible exchange rate regime may have increased its appeal. Thirdly, trade in primary products and capital assets is typically denominated in a vehicle currency; the U.S. dollar remains the most popular currency. Fourthly, the currency of a developed country tends to dominate invoicing of trade between developed and less developed countries. Lastly, in international contracting currencies of countries with relatively more stable inflation rates than others tend to be favored over currencies which experience a greater degree of variation in their market values.

The empirical as well as the theoretical work conducted in the field of contract invoicing builds on the results reported by Grassman in the late 60's and the early 70's. From his analysis of the Swedish foreign trade invoicing practices, Grassman found about 66 percent of Sweden's export contracts to be invoiced in the Swedish domestic currency. When considered as an importer, its currency was used about 26 percent to invoice trade contracts, and a smaller percentage was denominated in a vehicle currency. Later, Grassman found a similar pattern of invoicing was adopted in Denmark.

The literature which followed that concentrated most of its efforts on explaining Grassman's findings and tried to determine the various factors involved in affecting the currency of denomination of trade contracts.

The empirical models described the problem facing a trader as one of minimizing the loss of profitability, and thus minimizing the possible risks involved in dealing in the foreign market. Exchange risk, price risk and political risks are considered to be the most important types of risk a firm must aim at reducing. The firm's success depends to a large extent on the choice of the currency of invoice , which itself is determined by a variety of factors. Among these are: i) tradition and habit; ii) type of goods; iii) market power; iv) inflation differentials and the stability of inflation rates; v) degree of risk aversion.

Grassman similar to most other authors, found tradition affects the choice of invoicing currency for oil. McKinnon, Page and Magee, have specifically concluded that certain goods tend to be invoiced in a particular currency, whereas others are very likely to be invoiced in another currency. Since producers tend to be smaller in numbers and face heterogeneous consumers, many authors believe that exporters have greater market power and use it to get contracts invoiced in their own currencies. The major deviation from this hypothesis was the Japanese invoicing practice, where Japanese firms denominate most of their exports in the U.S. dollar.

Since inflation erodes the purchasing power of a currency, inflation differentials and the level of variations in the inflation rates are seen to constitute a major determinant of the choice of invoicing contracts. Hooper and Kohlhagen, Bilson, Magee and Rao and Aliber, among others, have stressed the importance of this determinant. They concluded that a currency which could qualify as an invoicing currency for international contracts would have to have the least variations in its purchasing power relative to other competing currencies.

In addition, degree of risk aversion plays a prominent role in affecting the currency of denomination of trade contracts. Although the risk aversion factor is a leading determinant under the flexible exchange regime (or adjustable peg), its importance tends to decline if the world adopts a fixed exchange rate regime. Empirical evidence shows that exchange risk has a tendency to rise under a flexible exchange rate regime compared with a fixed exchange rate regime; however, these results must be treated with caution. The data analyzed in the models considered, covered in most cases the transitional period of the early 70's.

Faced with these uncertainties even in the behavior of the determinants of the choice of the invoicing currency, firms have a tendency to cover their transactions. Such cover has usually taken the form of writing contracts in the domestic currency of the firms, and to a smaller extent, the forward market has been approached.

A summary of what different models have defined as the major determinants of the choice of currency used to denominate international trade transactions is provided in Table (8).

It may be argued that the alternative issues raised in this survey are of importance to the discussion of the choice of the optimal currency for invoicing oil. In particular, for the Gulf Cooperation Council member states, any model which is designed to examine the impact of the choice of an optimal currency for invoicing oil must incorporate the behavior of their domestic currencies with respect to the currency in which oil is invoiced, and with respect to the currencies of their major trading partners. As we have demonstrated in the present review, the value of an expected level of income is a function of exchange rate fluctuations. Thus, for the GCC countries, invoicing oil in every currency of theirs, i.e. each country invoices oil in terms of its currency, does not eliminate the exchange rate risk which may emerge due to denominating their imports in terms of other currencies than the currency(s) in which oil is invoiced. Accordingly, the methodology constructed in the next chapter aims to integrate both issues, that is the invoicing currency for oil as well as the choice of exchange regime adopted by the GCC member states.

Author/(Model)	The determinants of the currency choice
Aliber (1976)	Costs risk, exchange risk, price risk, inflation differentials.
Grassman (1973,a,b,1976)	Tradition and habit, size of transaction, market power, types of goods, availability of forward market.
Page (1977)	Market power, types of goods, the trading partner's country, inflation differentials
Magee (1973,1974)	Tradition, types of goods, government regulations, degree of risk aversion, market power
McKinnon (1979)	Types of goods, the importer's ability to adjust its selling prices
Bilson (1983)	The currency of invoicing inputs, degree of risk aversion, market power, inflation differentials
Baron (1976)	Comparison of costs and benefits of various invoicing, degree of risk aversion, market power, inflation differentials
Magee and Rao (1980,a,b)	Inflation differentials, degree of risk aversion, deviations from PPP
Cornell (1980)	Inflation differentials, relative price changes
Hooper and Kohlhagen (1978)	Degree of risk aversion, inflation differentials
Carse et al.	Types of goods

Table 8: Comparison of the determinants of the choice of invoicing trade contracts

V. The Methodology

In a closed economy, policymakers have to concentrate on internal objectives, and do not need to worry about external objectives. However, once an economy trades across its borders, both of these objectives tend to be taken into consideration. Internal objectives (or internal balance), in general, refer to full employment or a rate of unemployment which is about the natural rate, i.e. corresponding to the level of employment such that labor demand equals labor supply at an equilibrium real wage [31] and a rate of inflation of no more than 2 to 3 percent per year.[32] External objectives (or external balance) refer to equilibrium in the balance of payments, or maintaining disequilibrium below a certain level.

The Gulf Cooperation Council member states may be classified as open economies, according to the criterion specified by Heller (1978). The figures for imports as a proportion of Gross Domestic Product for the GCC countries, are reported in Table (9). The rates recorded in 1988 vary from more than 73 percent for Bahrain, to as low as 17.48 percent for Qatar. This may be explained by the small contribution from the oil sector to the gross domestic product in Bahrain, with a value of about 17.3 percent in 1987, compared to 30.3 percent for Qatar[33]. However, Bahraini imports include oil imported from Saudi Arabia, which is mainly re-exported, thus raising the contribution of imports to the total gross domestic product. Qatar, however, lacked the re-export market that emerged for other GCC states such as the U.A.E.; thus formed a smaller proportion of the gross domestic product. Aside from these observations, the GCC member states have shown a similar degree of openness.

Moreover, the ratio of imports to aggregate consumption (private and public), remains high. This is shown in Table (10) for the member states of the Gulf

[31] Milton Friedman, " The Role of Monetary Policy, " *American Economic Review*, 58 (March 1968), p. 1-17.

[32] Dominick Salvatore, *International Economics*. 2nd ed. (New York: Macmillan, 1987), p. 459.

[33] *Gulf Economic and Financial Report*, vol. 4, no. 10 (Manama: Gulf International Bank, December 1989), p. 2-8.

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
1980	93.04	23.70	28.97	18.36	26.24	31.06
1981	96.47	28.87	31.72	17.50	22.58	29.39
1982	78.47	38.38	35.47	25.58	26.17	30.95
1983	63.00	32.56	33.06	22.45	27.64	29.54
1984	68.31	30.34	33.25	16.91	29.05	25.10
1985	65.59	28.69	33.62	18.51	23.64	24.19
1986	65.97	30.14	35.49	21.91	22.96	28.84
1987	78.92	22.50	25.54	21.53	24.85	29.33
1988	73.85	25.88	31.31	17.48	28.40	35.75

Source: Data from 1980-1982 are derived from: G.C.C. Main Economic Indicators (1989), vol. 4, Dhahran: King Fahd University of Petroleum and Minerals, 1989, p. 85, and p. 98. Data from 1983-1988, were derived from: Gulf Economic and Financial Report, vol. 4, no. 10 (Manama: Gulf International Bank, December 1989), p. 2-7.

Table 9: Shares of imports to total gross domestic product (1980-1988), %

	Bahrain	Kuwait	Oman	Saudi Arabia	U.A.E.
1980	101.2	81.59	72.30	n.a.	122.2
1981	98.75	73.50	66.80	80.00	87.93
1982	91.25	72.06	65.63	73.62	82.38
1983	87.18	74.80	57.27	67.90	78.92
1984	74.49	71.69	58.00	66.88	72.35
1985	69.82	71.01	56.23	60.93	69.25
1986	63.47	61.22	n.a.	55.66	64.56
1987	n.a.	57.04	n.a.	50.39	65.89

Source: International Financial Statistics Yearbook, 1989. Country page.
n.a.: Not available.
The ratio is defined as the sum of government and private consumption in the denominator, whilst imports are in the numerator. For Bahrain oil imports were excluded, because they were for re-export. Data for Qatar were not available.

Table 10: The ratio of imports to aggregate consumption (1980-1987), %

Cooperation Council. Countries with a more active re-export sector, such as the U.A.E., have recorded the highest ratios. The reductions in the ratios are observed to be related to oil revenues. One may observe that during periods when oil revenues rose, imports have also risen, but by more than consumption. During the years when oil revenues experienced a decline, the import sector was affected by this more than consumption. In addition, since the upsurge in oil revenues in the mid 1970's, domestic production of import substitutes has been stimulated both by government legislations as well as by the prospect of profit.

However, if the degree of openness is measured using the ratio of the sum of exports and imports to gross domestic product, a different picture can be drawn.

For example, in 1988 this measure indicated an openness degree of 137 percent for Bahrain, which reflects the large amount of trade conducted by Bahrain, for whom the dependence on oil revenues is the smallest. For the other GCC member states, the slowdown of economic activities after the decline in oil revenues in 1988, has reduced their degree of openness. For example, this measure had a value of 61.31 percent for Kuwait and 76.39 percent for Oman. For Qatar, which depended less on re-export activity than the other GCC states, the decline in exports has reduced its degree of openness in 1988 to about 47.83 percent, compared to about 91 percent in 1985. A similar conclusion may be drawn for Saudi Arabia. In 1985 the measure recorded 86 percent, compared to about 59 percent reported in 1988. An exception is the U.A.E., for which the degree of openness declined from 92 percent in 1985 to about 87 percent in 1988. This may be explained by the large re-export sector present in the U.A.E. Despite the efforts of the GCC member states to diversify their economies, the domestic production base is relatively narrow and there is a distinct dependence on oil exports as the major item from which most of these countries' income is derived (see Table 11). Therefore, development plans tend to be closely related to the level of revenues received from oil exports[34].

Moreover, government budgets depend on the expected value of oil revenues, and private investment and spending rely on these budgets. Governments in the region employ almost all the national labor force, as well as providing the vast majority of services to the public. Furthermore, as the dominant employer and purchaser of services and goods, the government can affect investment plans and consumption patterns. Investment is affected both directly, through direct government demand, and indirectly as a result of the government influencing the salary scale, allowances, cash transfer, and availability of loans to the public. There is also the demand for housing units from the public, which affects the demand of the latter group for goods and services from the private investors. Thus, for a member state of the GCC, the value of oil revenues at any given time is important. As a matter of fact, the contribution from these revenues to the total government

[34] Further discussion of this point is presented in Chapter VI.

Year	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
1976	77.2	92.5	98.7	96.7	99.7	96.7
1977	78.4	91.6	97.6	98.3	99.6	95.7
1978	79.9	91.8	94.5	96.6	99.2	95.4
1979	81.4	94.0	94.7	95.1	99.1	94.3
1980	93.2	92.3	96.1	94.5	99.2	93.9
1981	93.0	87.2	94.1	94.0	99.3	97.9
1982	85.0	82.7	92.3	93.5	98.8	97.6
1983	82.9	87.1	91.7	90.8	97.8	87.2
1984	87.7	89.7	91.7	93.3	96.9	88.9
1985	86.6	90.3	93.0	93.9	94.4	88.1
1986	84.1	88.1	89.1	91.7	91.0	92.1
1987	83.9	90.0	89.8	90.3	90.9	72.8

Source: GCC Main Economic Indicators (1989), vol. 4, Dhahran: King Fahd University of Petroleum and Minerals, 1989, p. 50.

Table 11: Share of oil in total exports of the GCC countries (1976-1987), %

Country	1986[1]	1987[2]	1988[3]
Bahrain	61.00	45.00	52.30
Kuwait	88.00	88.40	87.10
Oman	75.40	81.60	73.80
Qatar	75.00	88.00	88.00
Saudi Arabia	66.60	69.40	59.30
United Arab Emirates	84.00	82.00	72.40

(1) Source: Gulf Economic and Financial Report, vol. 2, no. 10 (Manama: Gulf International Bank, 1987).
(2) Same source, vol. 3, no. 10, 1988.
(3) Same source, vol. 3, no. 10, 1989.

Table 12: Oil revenues as percentage of total government revenues in the GCC (1986-1988)

revenues in the region have remained large. Table (12) shows oil revenues as a percentage of total government revenues for the GCC countries, where it is evident that oil provided the bulk of their governments' sources of income. In latter years, these shares begin to decline slightly, which is due mainly to the adoption of financing deficits through government borrowing. Nonetheless, the shares remain relatively high, and are considered to provide the bulk of funds for government budgets in the GCC countries.

The dependence of the GCC economies on oil revenues as the primary source of income exposes them to fluctuations in the price of oil as well as to exchange rate risk, if oil is invoiced in a currency which fluctuates vis-á-vis the domestic currencies. At present, with oil invoiced in terms of the U.S. dollar, this exchange risk has been totally avoided by four of the GCC member states, who practically peg their currencies to the dollar, and partially avoided by Kuwait which pegs to a basket of currencies in which the dollar retains a large weight. The interviews conducted by the researcher in the period from the 10th of February to the 10th of March 1990, which sampled bankers, foreign exchange advisors (both at the central banks as well as commercial banks in the region), officials at central banks, such as the governor of the Central Bank of the United Arab Emirates, the governor of the Qatar Monetary Agency, the deputy governor of the Bahrain Monetary Agency, and the directors of the Economic and Research departments at the Central Bank of Oman and the Saudi Arabia Monetary Agency, were designed to explore the official point of view of the exchange rate arrangements adopted by the GCC member states. Through these interviews, it was concluded that a relationship between the exchange rate regime adopted and the currency invoicing of oil is both essential and influential.

Thus the argument put forward by the authorities at the central banks and the monetary agencies in the GCC countries that pegging to the same currency in which oil is invoiced minimizes the uncertainty in government budget processes, since the value of oil revenues in terms of the domestic currencies is known (aside from possible fluctuations in output or price of oil, which are exogenous), is valid. Note that such certainty is important in economies which are government-dependent, such as those of the GCC countries[35]. However, pegging to the currency in which these countries receive their income does not imply that this is the optimal policy in terms of the purchasing power of oil revenues, because this ignores the potential effects of price fluctuations caused by exchange rate changes amongst the trading partners, or between the domestic currencies of the GCC member states and the currencies of their trading partners. These revenues are used to finance imports, where imports are not totally invoiced in dollars.

In an attempt to analyze the import invoicing currency practices in the GCC member states, about 1000 questionnaires were mailed to importers, supplemented by 50 questionnaires dispatched to bankers. The purpose of both sets of questionnaires was similar; however, the one mailed to importers was designed to provide

[35]This argument is based on the author's interviews with the Governors of the central banks or other officials in the GCC member states. Complete references to these interviews are listed in the bibliography.

	Dollar	Pound	Mark	Lira	Yen	Franc	Others
1984	59.24	4.36	7.65	2.05	10.09	1.72	14.89
1985	52.28	5.49	8.41	2.50	10.65	2.03	18.64
1986	51.63	5.18	8.30	3.28	9.66	2.20	19.75
1987	57.44	4.88	6.48	2.97	7.65	1.82	18.75
1988	59.65	3.88	6.66	3.02	6.69	1.57	18.53

Source: Quarterly Statistical Bulletin, vol. 16, no. 1 (Kuwait: Central Bank of Kuwait, January-March 1989), p. 19.

Table 13: Financing Kuwaiti imports according to currencies (1984-1988), %

more detailed information, than that posted to bankers. Although the rate of return from both sets was relatively low (only 37 of the 1000 were received back, and only 5 of the 50 questionnaires), they have provided some information about the invoicing practices and the use of risk covering. One may argue that, domination by expatriate entrepreneurs, the lack of taxation and the conservative nature of family-based businesses, have contributed negatively to the rate of response. The interviews reveal that not all imports are denominated in dollars. Bankers and importers have admitted that the dollar is used as a vehicle currency for invoicing imports from developing countries, but imports from industrial countries are invoiced in the exporter's currency.

The evidence provided by the authorities in Kuwait shows that in 1988 about 50 percent of imports were invoiced in dollars. Meanwhile, as indicated in Table (13), the other currencies of the major industrial countries played a less prominent role. Nonetheless, one may argue that because of the similarities in the structure of the financial and commodity markets of the GCC countries, a similar invoicing scheme may be expected to characterize the import patterns of all other GCC member states.

Furthermore, the results of data collected from questionnaires mailed to importers in the GCC member states reveal various kinds of currencies used to denominate their imports. However, the dollar remains as a major currency. It emerges that trade amongst the GCC countries is denominated in the exporter's currency and the currency of the exporter tends to dominate the contracts of imports from the industrial countries. About 49 percent of importers surveyed indicated the use of the exporter's currency, whilst 33.3 percent have had their contracts denominated in dollars. As mentioned above, the role of the dollar in denominating imports to the GCC is further strengthened by their imports from developing countries in Asia, where exporters are encouraged by their economic institutions to obtain " hard currencies ". Evidence from sampled importers indicates that the choice of the currency of invoicing in trade in the GCC countries, rests to a large extent on exporters, where 78.8 percent of sampled firms cited this behavior. Moreover, only 15.15 percent admitted their role in determining the choice of the currency invoicing of imports. Thus, the potential of an exchange risk is present, even if the domestic currencies of the GCC are pegged to the dollar[36].

Thus it may be argued that an optimal policy of invoicing must be chosen according to its ability to minimize fluctuations in the real value of oil revenues, which may originate from the exchange rate between the domestic currencies of the GCC member states and the currency in which oil is invoiced (assuming the output of oil and the price level are given), and from a weighted import price index used to determine the real value of oil revenues (the nature of this price index will be discussed in the next section). Consequently, discussing the optimal currency invoicing for oil, while ignoring the relationship between the domestic currencies of the GCC countries and those of the countries from whom the GCC countries import, would not yield optimal results, since we would be then talking about the nominal value of oil revenues, which can be misleading. Given that the GCC member states are concerned with the value of oil revenues, the model may specified accordingly.

[36]Bankers concluded that less than 5 percent of importers cover for risk, using any technique (see section B in the historical review in Chapter VI, for a possible justification for this).

Consider revenues from oil exports by a member state of the GCC, to be referred to as the domestic country. This may be specified as

$$NVOR_i = P_i Q \tag{1}$$

where

$NVOR_i$ =nominal value of oil revenues expressed in currency i

P_i= price of oil in currency i

Q=quantity of oil

i= currency(s) in which oil is invoiced, where i = 1, 2, 3, ..., n.

For the domestic country, oil revenues would have to be converted into the domestic currency, unless i represents the domestic currency where oil is invoiced in i. However, if oil is invoiced in currency i, and i is not the domestic currency, then the exchange rate factor must be used to determine the domestic currency value of oil revenues. Assume that subscript h is associated with variables expressed either in the domestic currency, or associated with the domestic country. Then, if oil is invoiced in currency i, and $i \neq h$, the nominal value of oil revenues in terms of the domestic currency would be

$$NVOR_h = NVOR_i E_{h/i} \tag{2}$$

where

$NVOR_h$ =nominal value of oil revenues in currency h

$E_{h/i}$= number of units of h per unit of i.

Thus, the nominal value of oil revenues in terms of the domestic currency is the product of the nominal value of oil revenues in currency i, where $i \neq h$, multiplied by the exchange rate between the domestic currency and currency i. Obviously, if the currency in which oil is invoiced is the domestic currency, then the domestic currency value of nominal oil revenues is not affected by the exchange rate factor. However, once h is excluded as the currency of oil denomination, it is crucial to consider the relationship between the domestic currency and the currency in which oil is invoiced.

Equation (2) defines oil revenues as a nominal value. However, it is the real rather than the nominal value of oil revenues which occupies the authorities. According to macroeconomic theory, it is argued that economic agents, given a particular level of income, would be concerned with the purchasing power of that income. This purchasing power is inversely related to the price level. Thus, for the present analysis it is the real value of oil revenues which is assumed to be the relevant variable that the authorities are concerned with, i.e. no money illusion.

Accordingly, assuming oil is invoiced in currency i where $i \neq h$, the real value of oil revenues may be defined as

$$RVOR_h = NVOR_i E_{h/i} / P_k$$

where

P_k = a relevant price index.

There are many candidates that may be used to represent the price deflator. A domestic, foreign, or import price index may be used; however, since oil revenues are used primarily to finance imports directly by the public sector, and indirectly by the private sectors, it may be reasonable to deflate the nominal value of oil revenues by a weighted import price index of the GCC member states. Considering this alternative, the real value of oil revenues in the domestic currency would be

$$RVOR_h = NVOR_i E_{h/i} / P_h$$

where

P_h = weighted import price index of the GCC member states.

Under a floating exchange rate regime, the domestic currency value of real oil revenues would change as a result of fluctuations in $NVOR_i$, $E_{h/i}$, and P_h. In this case, a member state of the GCC would receive $NVOR_i$, and convert them into the domestic currency using the market determined exchange rate, $E_{h/i}$. Then using the weighted import price index, which is a weighted average of the price of imports (using trade shares), and adjusted for the exchange rate, the real value of oil revenues in terms of the domestic currency may be derived. The weighted import price index would be

$$P_h = (P_1 E_{h/1})^{\alpha_1} + (P_2 E_{h/2})^{\alpha_2} + \cdots + (P_n E_{h/n})^{\alpha_n} \tag{3}$$

where

$\alpha_1, \alpha_2, \ldots, \alpha_n$ = import shares from trading partners, 1, 2, ..., n.

However, if the domestic currency is fixed in terms of a single currency of a trading partner, or alternatively, to a basket of the currencies of its trading partners, variability amongst the currencies of the trading partners, would be an essential factor affecting the domestic price level via trade. At present, the currencies of Bahrain, Oman, Qatar, Saudi Arabia, the U.A.E., and to a large extent, of Kuwait, have shown limited flexibility against the dollar. However, neither their imports nor their total trade is concentrated exclusively with the U.S., and neither is totally invoiced in dollars. Thus, pegging to the dollar (or any other single currency) would not insulate the domestic economy from those changes in the prices of traded goods, that are induced by exchange rate fluctuations, so long as not all currencies in the system are fixed in terms of the dollar (or the currency concerned). A mechanism designed to capture such a potential impact is provided by the Purchasing Power Parity relationship, as will be evident from next section.

V.1 Formulation of the Model

The following analysis is based on several assumptions. Firstly, the GCC member states trade with six major industrial countries: France, Germany, Italy, Japan, the U.K., the U.S. Secondly, the economies of the GCC are small, in the sense that they take world prices as given, and open, so that import prices and exchange rate fluctuations can be transmitted to the domestic economies via trade. Thirdly, the floating exchange rate alternative is excluded from the possibilities considered for the GCC. Consequently, the currencies of the GCC member states are either pegged to a single currency or to a basket of currencies. Fourthly, oil may be invoiced in a single currency or a basket of currencies.

The discussion of the methodology is divided into two major sections. The first section derives the equations for the real value of oil revenues in terms of the domestic currency, if oil is invoiced in a single currency. The second section models the issue under the assumption that oil is invoiced in a basket of currencies. However, within each section, the analysis allows for many alternatives to which the domestic currencies of the GCC member states may be pegged.

1.1. Single Currency Invoicing of Oil

Assume that oil is invoiced in currency j, where $j \neq h$. Then the nominal value of oil revenues in terms of the domestic currency would be

$$NVOR_h = NVOR_j E_{h/j} \tag{4}$$

and the real value of oil revenues in terms of the domestic currency is

$$RVOR_h = NVOR_h / P_h.$$

Expressing this value in terms of percentage change by using the logarithmic approximation, yields

$$rvor_h = nvor_j + e_{h/j} - p_h$$

$$rvor_h = nvor_h - p_h \tag{5}$$

and the variance is

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + \sigma^2_{e_{h/j}} + \sigma^2_{p_h}$$

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_h} + \sigma^2_{p_h} \tag{6}$$

where

$$p_h = \alpha_1(p_1 + e_{h/1}) + \alpha_2(p_2 + e_{h/2}) + \cdots + \alpha_n(p_n + e_{h/n}). \tag{7}$$

Note that throughout the presentation, the lower case letters represent percentage change in the relevant variable, except for the trade shares. For example,

$$rvor_h = 100[\ln(RVOR_h^t / RVOR_h^{t-1})]$$

where
$RVOR_h^t$ = real value of oil revenues in currency h at time t
$RVOR_h^{t-1}$ = real value of oil revenues in currency h at time t-1.

The percentage change in the domestic currency's real value of oil revenues is a function of the changes in the nominal value of these revenues, as well as the weighted import price index. Thus, it is important to consider the exchange rate factor, where the exchange rate between the domestic currency and that in which oil is invoiced directly affects the nominal value of oil revenues in terms of the domestic currency, and the exchange rates between the domestic currency and those of its trading partners affect the import price index, thus affecting the real value of oil revenues in terms of currency h.

Furthermore, if the domestic currency is pegged to any of the six currencies of the industrial countries, or to an alternative basket of these currencies, or to predetermined baskets such as the SDR or the ECU, then the behavior of the exchange rates between the currency(s) to which the domestic currency is pegged vis-á-vis the rest of the currencies in the system, would be vital. Therefore, there is a need to develop a mechanism via which these rates can be determined[37].

In this regard, the monetary model presents the principle of purchasing power parity, PPP, which is assumed to reflect movements in exchange rates between the trading partners. These movements are assumed to be a function of inflation rates in these countries, as well as a random variable which may reflect random shocks to the exchange rates due to some other changes which affect the exchange rates,

[37]Connolly (1982, 1983) and Connolly and Yousef (1982), have derived expressions for the imported component of the domestic inflation rate under both single currency and a basket of currencies pegs. Explicitly, the derivation of p_h makes use of their analysis.

and do not act through the inflation rates. PPP between currency i and currency j may be defined as

$$E_{i/j} = (P_i/P_j)exp^{\xi_{ji}} \tag{8}$$

where

$E_{i/j}$ = units of currency i per unit of currency j

P_i, P_j = inflation rates in country i and country j, respectively

ξ_{ji} = deviations from purchasing power parity due to random shocks to the PPP relationship.

The error term ξ_{ji} is assumed to be randomly distributed with zero mean and a variance which is given by $\sigma^2_{\xi_{ji}}$. Furthermore, adjacent observations of ξ_{ji} are assumed to be unrelated.

The domestic currency is related to currencies j and i through similar relationships. Therefore the relative purchasing power parity between the domestic currency and each of these currencies may be expressed as (using logarithmic transformation):[38]

$$\begin{aligned} e_{h/i} &= p_h - p_i + \xi_{hi} \\ e_{h/j} &= p_h - p_j + \xi_{hj}. \end{aligned} \tag{9}$$

Subtracting the second expression from the first gives[39]

$$\begin{aligned} e_{h/i} - e_{h/j} &= p_h - p_i - p_h + p_j + \xi_{hi} - \xi_{hj} \\ e_{h/i} - e_{h/j} &= p_j - p_i + [\xi_{hi} - \xi_{hj}]. \end{aligned} \tag{10}$$

Note that if either ξ_{hi} or ξ_{hj} is positive, then the domestic currency, h, has depreciated vis-á-vis i in the first case, or j in the second. However, if $\xi_{hi} > \xi_{hj}$, then h has depreciated against i more than against j. Thus, relative to h, it may be

[38]Note that since the expected value of the error term is zero, taking the log of equation (8) yields: $\ln E_{i/j} = \ln P_i - \ln p_j + \xi_{ji} \ln exp$.

[39]Note that, in terms of percentage change, $e_{h/i} - e_{h/j} = e_{j/i}$, since $E_{j/i} = E_{h/i}/E_{h/j}$. However, $e_{h/i} = p_h - p_i$, and $e_{h/j} = p_h - p_j$. Substituting for $e_{h/i}$ and $e_{h/j}$ in $e_{j/i}$, and substituting the new disturbance term, yields equation (11).

said that i has appreciated in terms of j, which is represented by $[\xi_{hi} - \xi_{hj}] = \xi_{ij}$. Substituting this equality in equation (10) yields

$$e_{h/i} - e_{h/j} = p_j - p_i + \xi_{ij}. \tag{11}$$

Accordingly, deviations of the exchange rate between any two currencies from their corresponding price ratio, i.e. deviations from the PPP condition, can be negative or positive, depending on the value of ξ_{ij}. If ξ_{ij} is positive, currency i appreciates relative to currency j more than suggested by the PPP condition. On the other hand, a negative value for ξ_{ij} implies that currency i depreciates against currency j.

In general, the PPP condition may be generalized as

$$\begin{aligned} e_{h/1} - e_{h/2} &= p_2 - p_1 + \xi_{12} \\ e_{h/1} - e_{h/3} &= p_3 - p_1 + \xi_{13} \\ &\vdots \\ e_{h/1} - e_{h/n} &= p_n - p_1 + \xi_{1n}. \end{aligned} \tag{12}$$

Although the exchange rates are assumed to be functions of the relative price ratios, these ratios are assumed to be determined by the relative money process. Thus, adopting the rational expectations framework, the monetary rule in the trading partners is assumed to be known. However, the actual money supply may differ from what is targeted by innovations, which are random. Thus, the actual inflation rates in the trading partners may be written as

$$\begin{aligned} p_1 &= \rho_1 + \upsilon_1 \\ p_2 &= \rho_2 + \upsilon_2 \\ &\vdots \\ p_n &= \rho_n + \upsilon_n. \end{aligned} \tag{13}$$

The expected component is represented by ρ_i, whereas the random component is captured by υ_i. The term ρ_i is assumed to be constant, while υ_i is assumed to be a normally distributed, serially uncorrelated independent random variable with zero mean and a variance equal to $\sigma^2_{v_t}$.

Although we are assuming that oil is invoiced in a single currency, the domestic currency may be pegged to a single currency or a basket of currencies. In this presentation, the currencies of the GCC member states may be pegged to a single currency of a trading partner, or to a weighted basket of the six currencies, the SDR, or the ECU. A chosen peg would affect the domestic price of imports, which may be used as a measure of the imported component of domestic inflation. Thus, if oil is invoiced in a single currency and the domestic currency is pegged to a single currency, there are a vast number of alternative currencies for pegging as well as invoicing. Furthermore, oil may still be invoiced in a single currency, whilst the domestic currency is pegged to a basket of currencies. In the next sections, oil is assumed to be invoiced in a single currency. However, the analysis can be extended to allow for the possibility of the domestic currency being pegged to a single currency or a basket of currencies.

1.1.A. Single Currency Peg

Pegging the domestic currency to a single currency implies floating with that currency vis-á-vis the other currencies in the system (assuming the other currencies are not pegged to the currency to which the domestic currency is pegged). Accordingly, there will be no deviations in the exchange rate between the domestic currency and that currency, if the peg is to be maintained. Thus, if the domestic currency is pegged to currency 1, then by definition

$$e_{h/1} = 0. \tag{14}$$

Then, the percentage change in the domestic price level would be related to the price level in country 1, so that the purchasing power parity relationships between the domestic currency and the other currencies may be expressed as

$$e_{h/2} = p_1 - p_2 - \xi_{12}$$

$$e_{h/3} = p_1 - p_3 - \xi_{13}$$
$$\vdots \tag{15}$$
$$e_{h/n} = p_1 - p_n - \xi_{1n}.$$

This information may be used to derive the percentage change in the domestic country's weighted import price index p_h, as defined earlier, which is required for the definition of the domestic currency real value of oil revenues, as indicated by equation (5). Substituting for $e_{h/1}, e_{h/2}, \ldots, e_{h/n}$, in the imported component of the domestic inflation rate, p_h, defined by equation (7), yields

$$\begin{aligned} p_h &= \alpha_1 p_1 + \alpha_2(p_1 + p_2 - p_2 - \xi_{12}) + \alpha_3(p_1 + p_3 - p_3 - \xi_{13}) \\ &\quad + \cdots + \alpha_n(p_1 + p_n - p_n - \xi_{1n}). \end{aligned}$$

Canceling terms and multiplying out gives

$$\begin{aligned} p_h &= \alpha_1 p_1 + \alpha_2 p_1 - \alpha_2 \xi_{12} + \alpha_3 p_1 - \alpha_3 \xi_{13} \\ &\quad + \cdots + \alpha_n p_1 - \alpha_n \xi_{1n} \end{aligned}$$

which allows for grouping terms with p_1 together, giving

$$\begin{aligned} p_h &= p_1(\alpha_1 + \alpha_2 + \cdots + \alpha_n) - (\alpha_2 \xi_{12} + \alpha_3 \xi_{13} \\ &\quad + \cdots + \alpha_n \xi_{1n}). \end{aligned}$$

Utilizing the fact that the sum of trade shares α_i is unity and using the summation operator yields a more compact expression for p_h:

$$p_h = p_1 - \sum_{i=2}^{n} \alpha_i \xi_{1i}. \tag{16}$$

If the domestic currency is pegged to a single currency, then this price formula reflects the relationship with the domestic price level, as well as how the domestic price is affected by changes in the domestic currency vis-á-vis the currencies of the other trading partners (via trade), to whose currencies h is not pegged. Note that although we have started by assuming α_i to represent import shares, there is no reason for them not to be defined as export or total trade shares. One may argue that once the domestic currency is pegged to a single currency, then the relevant α_i would be those of total trade. That is because deviations from PPP between the exchange rates of the currency to which h is pegged, and the other trading partners, would affect both the export and import sectors of the domestic economy. The relevance of the distinction is more important for a basket peg, as will be evident in later sections. Then, if the domestic currency is pegged to the currencies of the countries to which it exports, α_i will be set to correspond to export shares. Moreover, prices of exports (revenues from exports) will not be affected by changes in exchange rates amongst the currencies included. However, import prices may vary. Alternatively, if α_i are set to equal import shares, then import prices would not vary, although export prices may fluctuate. An average outcome may be achieved if the domestic currency is pegged to total trade shares. Note that the choice of alternatives is concerned with minimizing imported variation in prices due to exchange rate changes, not prices changes per se.

The choice of either set of weights as well as the currency(s) to which the domestic currency, h, is to be pegged depends on the objective the authorities wish to attain from the policy of pegging the domestic currency. Thus, it is essential to determine the optimal currency peg for the domestic currency, which requires developing a criterion upon which a peg may be preferred over another. As discussed in Chapter III, the literature has provided many criteria upon which a peg to a particular currency may be adopted. Since in the present analysis we aim at minimizing the variance of the real value of oil revenues expressed in terms of the domestic currency, minimization of p_h for member states of the GCC would contribute to the aim of choosing the currency for invoicing oil, because $rvor_h$ is a function of p_h. Furthermore, minimization of the variance may be justified according to the assumption of risk aversion. If the analysis assumes that the authorities in the GCC member states are risk averse, where the variance is used as a measure of risk, then it is perfectly logical to assume that they would attempt to minimize variations in the real value of oil revenues.

As mentioned in Chapter III, Stiglitz (1972) and Sandmo (1971) have argued that economic agents tend to favor small variations in prices over large variations. Beyond the political effects of inflation, rapid inflation can distort many economic variables. Inflation, defined as a general increase in the price level, will lead to a distributive effect as well as generate events which tend to contract the economy. It reduces real income for a given level of nominal income, or for a rise in nominal income that is less than the change in the price level. Furthermore, since the purchasing power of money declines as the price level rises, economic agents whose wealth is defined in terms of financial assets will lose relatively in terms of wealth as inflation rises. Consequently, their real income diminishes as the rate of inflation accelerates. In addition, for a given nominal interest rate, or a rate which grows by less than the rate of inflation, saving will be reduced as inflation erodes its purchasing power. The rises in demand for cash balances would be reduced if the nominal interest rate is raised sufficiently, making it difficult for investors to plan future investments. There would also be increases in the uncertainty about outstanding investments.

Moreover, the studies by Thirwall and Barton (1964) and Jung and Marshall (1986) provided evidence to support the monetarist belief that inflation tends to cause a lower rate of economic growth. The effects of inflation upon an open economy are more serious, because as the prices of domestic exports rise, the economy will face lower real net exports (postulating that not all competitors inflate at the same rate). Since open economies tend to depend on international trade, inflation originating in the rest of the world may be transmitted to these economies via many means. Among them are the exchange rates between the domestic currency and those of its trading partners, and changes in the prices of imported goods and inputs used in the domestic economy and imported from the rest of the world. These changes may be caused by real changes in the production cost of these goods and inputs. The rises in the prices of imported goods will inflict similar consequences on domestic consumption and on the prices of goods produced domestically using imported inputs. It may be argued, therefore, that minimizing variations in imported inflation is desirable, and constitutes a target upon which a peg may be evaluated. Empirically, Connolly (1982, 1983) and Connolly and Yousef (1982) have used the measure of stability in p_h to determine the optimal currency peg for developing countries.

Economically, agents should be concerned about inflation although they may not concede that this is so. The shortage of accurate data on the prices of imports of the Gulf Cooperation Council member states may hide such a concern. However, examination of available data on exchange rates may reveal some facts about the concern of the GCC member states about imported inflation. During times of increasing oil revenues, the domestic governments had no rigid constraint on spending and, consequently on balancing government budgets. Therefore, these governments were able to revalue their currencies vis-á-vis the dollar, although that action led to a reduction in oil revenues in terms of the domestic currencies. It may be argued that this policy was aimed at diminishing the effect of imported inflation. Indeed, some of the GCC member states undertook such a step: Bahrain, Qatar, Oman and the U.A.E. officially revalued their currencies. On the other hand, once oil revenues began to decline, a constraint on government budgets started to develop, thus inducing, as would be expected, the authorities to devalue their currencies vis-á-vis the dollar. Examination of most recent data on exchange rates reveal this trend. For example, Oman devalued its currency by more than 10 percent in 1986. Furthermore, the Saudi riyal was also devalued vis-á-vis the dollar in 1986. The other governments have been more reluctant to adopt that strategy, although several officials have admitted that there were plans to move into that direction, but that these were postponed as oil prices started to recover recently[40]. Devaluation would imply that imported inflation is of less importance than the state of government budgets; however, this does not imply that imported inflation is not an absolute concern to officials. Moreover, the move toward devaluation was supported by the fact that inflation originating in major developing countries has, on average, declined in recent times.

[40]This argument was brought to the attention of the researcher by Usama Almaliki, who is the economic advisor at the U.A.E. Central Bank.

Adopting the same objective function of a peg, the variance of p_h, as defined by equation (16), may be expressed as

$$\sigma^2_{p_h} = \sigma^2_{p_1} + \sum_{i=2}^{n} \alpha_i^2 \sigma^2_{\xi_{1i}} \tag{17}$$

where

$\sigma^2_{p_1}$ =variance of the inflation rate in country 1

$\sigma^2_{\xi_{1i}}$ = variance of deviations from PPP.

This assumes that the domestic currency is pegged to currency 1, where $1 \neq i$. Moreover, the variance of the rate of inflation imported by a GCC member state is a function of the variance of the rate of inflation in country 1, the variance of deviations from PPP, and trade shares.

Recall that the purpose of the derivation of p_h and its variance, $\sigma^2_{p_h}$ is to use this information to substitute for p_h and $\sigma^2_{p_h}$ in the equations for the domestic currency real value of oil revenues, $rvor_h$ and its variance, $\sigma^2_{rvor_h}$. Accordingly, conducting such substitutions into equations (5) and (6) implies

$$rvor_h = nvor_j + e_{h/j} - p_h$$

$$rvor_h = nvor_j + e_{h/j} - [p_j - \sum_{i=1}^{5} \alpha_i \xi_{ji}]. \tag{18}$$

The variance of this would be[41]

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + \sigma^2_{e_{h/j}} + [\sigma^2_{p_h}]$$

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + \sigma^2_{e_{h/j}} + [\sigma^2_{p_j} + \sum_{m=1}^{5} \alpha_m^2 \sigma^2_{\xi_{jm}}] \tag{19}$$

[41] The covariance terms between the exchange rates, nominal value of oil revenues and inflation rates are assumed to be zero throughout the thesis. However, the implicit covariance between the numeraire's exchange rate with respect to any of the other trading partners, and oil revenues in terms of the numeraire currency, which is implicitly included in the conversion of oil revenues from the numeraire currency into another, will prove to be important in the estimation. This covariance was solved for using:

$$Var(nvor_j) = Var(nvor_i) + Var(e_{j/i}) + 2Cov(nvor_i, e_{j/i})$$

where i is the currency in which oil is initially denominated, i.e. the dollar in the present analysis, and j is the currency in which oil revenues are converted. Note that, $nvor_j = nvor_i + e_{j/i}$, since, $NVOR_j = NVOR_i E_{j/i}$.

where

m = currencies of trading partners excluding currency j

(assuming six trading partners).

If the domestic currency is pegged to the same currency in which oil is invoiced, then the percentage change in the exchange rate between the domestic currency and that currency will be zero. So, if oil is invoiced in currency j and the domestic currency is also pegged to j, then the variance of $e_{h/j}$ equals zero, and the variance of the real value of oil revenues in terms of the domestic currency would be

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + [\sigma^2_{p_j} + \sum_{m=1}^{5} \alpha^2_m \sigma^2_{\xi_{jm}}]. \tag{20}$$

However, a potential alternative may exist when the domestic currency is pegged to one currency, while oil is invoiced in another. Thus, assuming the domestic currency is pegged to currency j, whilst oil is invoiced in currency k, the real value of oil revenues in the domestic currency

$$rvor_h = nvor_k + e_{h/k} - p_h.$$

Substituting for p_h from equation (16), and assuming j instead of 1 yields

$$rvor_h = nvor_k + e_{j/k} - [p_j - \sum_{m=1}^{5} \alpha_m \xi_{jm}]. \tag{21}$$

Similarly, the variance may be expressed, after similar substitution from equation (17), as

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_k} + \sigma^2_{e_{j/k}} + [\sigma^2_{p_j} + \sum_{m=1}^{5} \alpha^2_m \sigma^2_{\xi_{jm}}]. \tag{22}$$

Note that here the variance of $rvor_h$ is affected by the exchange rate between the domestic currency or the currency to which the domestic currency is pegged, j in this case, and the currency in which oil is invoiced, i.e. k.

1.1.B. Trade-Weighted Basket of Currencies Peg

On the other hand, oil may still be invoiced in a single currency, whereas the domestic currency is pegged to a basket of currencies. If this were the case, then the exchange rates of the domestic currency vis-á-vis the currencies of the trading partners would have different effects on the imported component of the domestic rate of inflation. In order to show these effects, an alternative p_h must be derived[42].

A basket peg may be defined as fixing the value of the domestic currency in terms of a sum of a specific number of units of the foreign currencies, converted by the exchange rates of each of the foreign currencies in terms of the domestic currency. Consequently, the determination of the value of the domestic currency in terms of a basket implies that the value of the basket must remain constant in terms of the domestic currency. This requires appreciation and depreciation in the domestic currency value of the foreign currencies included in the basket, if any one of these currencies appreciates or depreciates against the others. However, as the example provided in Appendix III.A at the end of Chapter III shows, the domestic currency's appreciations and depreciations against the currencies included in the basket are weighted by the weight of each currency in the basket.

Hence, the following condition must hold if the basket peg is to remain unchanged:

$$\beta_1 e_{h/1} + \beta_2 e_{h/2} + \cdots + \beta_n e_{h/n} = 0 \tag{23}$$

where

β_i = weight of currency i in the basket, i = 1, 2, ..., n.

Summing over β_i and $e_{h/i}$, yields

$$\sum_{i=1}^{n} \beta_i e_{h/i} = 0. \tag{24}$$

Thus, it is the sum of weighted changes which must be zero, but not necessarily the weighted change in each of the exchange rates. We may use this condition and the solutions derived from the PPP conditions stated by equation (12) to solve for

[42]The derivation of p_h stems from the two-country model suggested by Connolly (1982). The generalization of the two-country derivation may be obtained through algebraic manipulations of that model, and making use of note (7) of that article (see Appendix V.A at the end of this chapter for a similar derivation in the two-country model).

p_h. These solutions yield

$$e_{h/2} = e_{h/1} + p_1 - p_2 - \xi_{12}$$
$$\vdots$$
$$e_{h/n} = e_{h/1} + p_1 - p_n - \xi_{1n}.$$

Substituting these expressions in the basket peg equation (23) implies

$$\beta_1 e_{h/1} + \beta_2(e_{h/1} + p_1 - p_2 - \xi_{12}) + \cdots + \beta_n(e_{h/1} + p_1 - p_n - \xi_{1n}) = 0.$$

Multiplying out and solving for $e_{h/1}$ gives

$$e_{h/1} = \beta_2 p_2 + \beta_2\xi_{12} - \beta_2 p_1 + \cdots + \beta_n p_n + \beta_n \xi_{1n} - \beta_n p_1$$

(note that we have utilized the condition that the sum of $\beta_i = 1$). Similar expressions can be obtained by substituting for $e_{h/1}$ in

$$e_{h/2} = e_{h/1} - p_2 + p_1 - \xi_{12}$$
$$\vdots$$
$$e_{h/n} = e_{h/1} - p_n + p_1 - \xi_{1n}.$$

In particular, $e_{h/2}$, and $e_{h/n}$ would be

$$e_{h/2} = \beta_2 p_2 + \beta_2\xi_{12} - \beta_2 p_1 + \cdots + \beta_n p_n + \beta_n\xi_{1n} + p_1 - p_2 - \xi_{12}$$
$$e_{h/n} = \beta_2 p_2 + \beta_2\xi_{12} - \beta_2 p_1 + \cdots + \beta_n p_n + \beta_n\xi_{1n} + p_1 - p_n - \xi_{1n}.$$

Substituting these expressions for the $e_{h/i}$ in the domestic inflation rate equation (7) gives

$$\begin{aligned} p_h \;=\; & \alpha_1[(\beta_2 p_2 + \beta_2\xi_{12} - \beta_2 p_1 + \cdots + \beta_n p_n \\ & + \beta_n\xi_{1n} - \beta_n p_1) + p_1] + \alpha_2[(\beta_2 p_2 + \beta_2\xi_{12} - \beta_2 p_1 + \cdots + \beta_n p_n + \\ & \beta_n\xi_{1n} - \beta_n p_1) + p_1 - p_2 - \xi_{12} + p_2] + \cdots + \alpha_n[(\beta_2 p_2 + \beta_2\xi_{12} \\ & -\beta_2 p_1 + \cdots + \beta_n p_n + \beta_n\xi_{1n} - \beta_n p_1) + p_1 - p_n - \xi_{1n} + p_n]. \end{aligned}$$

Multiplying out, note that some terms cancel:

$$\begin{aligned} p_h = {} & \alpha_1\beta_2 p_2 + \alpha_1\beta_2\xi_{12} - \alpha_1\beta_2 p_1 + \cdots + \alpha_1\beta n p_n + \alpha_1\beta_n\xi_{1n} - \alpha_1\beta_n p_1 + \\ & \alpha_1 p_1 + \alpha_2\beta_2 p_2 + \alpha_2\beta_2\xi_{12} - \alpha_2\beta_2 p_1 + \cdots + \alpha_2\beta_n p_n + \alpha_2\beta_n\xi_{1n} - \\ & \alpha_2\beta_2 p_1 + \alpha_2 p_1 - \alpha_2\xi_{12} + \cdots + \alpha_n\beta_2 p_2 + \alpha_n\beta_2\xi_{12} - \alpha_n\beta_2 p_1 + \cdots + \\ & \alpha_n\beta_n p_n + \alpha_n\beta_n\xi_{1n} - \alpha_n\beta_n p_1 + \alpha_n p_1 - \alpha_n\xi_{1n}. \end{aligned}$$

By grouping some terms together, this may be written as

$$\begin{aligned} p_h = {} & (\alpha_1 p_1 + \alpha_2 p_1 + \cdots + \alpha_n p_1) - (\alpha_1\beta_2 p_1 + \alpha_2\beta_2 p_1 + \cdots + \\ & \alpha_2\beta_n p_1) - \cdots - (\alpha_1\beta_n p_1 + +\alpha_2\beta_n p_1 + \cdots + \alpha_n\beta_n p_1) \\ & +(\alpha_1\beta_2 p_2 + \alpha_2\beta_2 p_2 + \cdots + \alpha_n\beta_2 p_2) + \cdots + (\alpha_1\beta_n p_n + \\ & \alpha_2\beta_n p_n + \cdots + \alpha_n\beta_n p_n) + (\alpha_1\beta_2\xi_{12} + \alpha_2\beta_2\xi_{12} + \cdots + \\ & \alpha_n\beta_2\xi_{12} - \alpha_2\xi_{12}) + \cdots + (\alpha_1\beta_n\xi_{1n} + \alpha_2\beta_n\xi_{1n} + \cdots + \alpha_n\beta_n\xi_{1n} \\ & -\alpha_n\xi_{1n}). \end{aligned}$$

By factoring out $p_1, p_2, \ldots, p_n, \xi_{12}, \ldots, \xi_{1n}$, we can re-express this as

$$\begin{aligned} p_h = {} & p_1(\alpha_1 + \alpha_2 + \cdots + \alpha_n) - p_1(\alpha_1\beta_2 + \alpha_2\beta_2 + \cdots + \alpha_n\beta_n) \\ & - \cdots - p_1(\alpha_1\beta_n + \alpha_2\beta_2 + \cdots + \alpha_n\beta_n) + p_2(\alpha_1\beta_2 + \alpha_2\beta_2 \\ & + \cdots + \alpha_n\beta_n) + \cdots + p_n(\alpha_1\beta_n + \alpha_2\beta_n + \cdots + \alpha_n\beta_n) + \\ & \xi_{12}(\alpha_1\beta_2 + \alpha_2\beta_2 + \cdots + \alpha_n\beta_2) - \alpha_2\xi_{12} + \cdots + \\ & \xi_{1n}(\alpha_1\beta_n + \alpha_2\beta_n + \cdots + \alpha_n\beta_n) - \alpha_n\xi_{1n}. \end{aligned}$$

Furthermore, merit may be seen in further factorization, thus

$$\begin{aligned} p_h = {} & p_1(\alpha_1 + \alpha_2 + \cdots + \alpha_n) - p_1\beta_2(\alpha_1 + \alpha_2 + \cdots + \alpha_n) \\ & - \cdots - p_1\beta_n(\alpha_1 + \alpha_2 + \cdots + \alpha_n) + p_2\beta_2(\alpha_1 + \alpha_2 + \cdots + \alpha_n) \\ & + \cdots + p_n\beta n(\alpha_1 + \alpha_2 + \cdots + \alpha_n) + \xi_{12}\beta_2(\alpha_1 + \alpha_2 + \cdots + \\ & \alpha_n) - \alpha_2\xi_{12} + \cdots + \xi_{1n}\beta_n(\alpha_1 + \alpha_2 + \cdots + \alpha_n) - \alpha_n\xi_{1n} \end{aligned}$$

making use of the fact that the sum of trade shares is unity, and the sum of basket weights is unity. That is:

$$\alpha_1 + \alpha_2 + \cdots + \alpha_n = 1$$

$$\beta_1 + \beta_2 + \cdots + \beta_n = 1.$$

So,

$$\beta_1 = 1 - (\beta_2 + \cdots + \beta_n).$$

The domestic inflation rate may be expressed as

$$p_h = p_1[1 - (\beta_2 + \cdots + \beta_n)] + p_2\beta_2 + \cdots + p_n\beta_n + (\beta_2 - \alpha_2)\xi_{12} + \cdots + (\beta_n - \alpha_n)\xi_{1n}.$$

Consequently

$$\begin{aligned} p_h &= \beta_1 p_1 + \beta_2 p_2 + \cdots + \beta_n p_n + \xi_{12}(\beta_2 - \alpha_2) + \\ &\quad \cdots + \xi_{1n}(\beta_n - \alpha_n) \end{aligned}$$

which may be represented alternatively using the summation sign as

$$p_h = \sum_{i=1}^{n} \beta_i p_i + \sum_{i=1}^{n} (\beta_i - \alpha_i)\xi_{ji}. \tag{25}$$

The expression for the variance under a basket of currencies peg is:

$$\sigma_{p_h}^2 = \sum_{i=1}^{n} \beta_i^2 \sigma_{p_i}^2 + \sum_{i=1}^{n} (\beta_i - \alpha_i)^2 \sigma_{\xi_{ji}}^2. \tag{26}$$

However, if the weights used in the basket are equal to trade shares, then $\beta_i = \alpha_i$ and p_h and $\sigma_{p_h}^2$ may be re-expressed as

$$p_h = \sum_{i=1}^{n} \beta_i p_i \tag{27}$$

and the variance is

$$\sigma_{p_i}^2 = \sum_{i=1}^{n} \beta_i^2 \sigma_{p_i}^2. \tag{28}$$

The equation for the imported component of the domestic rate of inflation p_h can be substituted into the equation for the domestic currency's real value of oil revenues, assuming that oil is invoiced in a single currency, if the domestic currency is pegged to a trade-weighted basket. Such a substitution in equation (18) yields

$$rvor_h = nvor_j + e_{b/j} - [\sum_{i=1}^{n} \beta_i p_i]. \tag{29}$$

Similarly, the variance in the domestic currency real value of oil revenues may be expressed as

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + \sigma^2_{e_{b/j}} + [\sum_{i=1}^{6} \beta_i^2 \sigma^2_{p_i}] \tag{30}$$

where

i = currencies of the trading partners

j = currency in which oil is invoiced

$\sigma^2_{e_{b/j}}$ = variance of the exchange rate between the basket, b, and currency j.

(Where a peg to a basket, call it b, implies that h changes vis-á-vis j in the same way as b does, so h is replaced by b.)

If oil is invoiced according to this scheme and the domestic currency is pegged to a trade-weighted basket (either total trade or import shares), then the real value of oil revenues in terms of the domestic currency of a GCC member state is a function of several variables. Firstly, if oil is invoiced in the numeraire, then the variance of the nominal value of oil revenues in terms of the numeraire may induce instability in the real value of oil revenues in the domestic currency. Implicitly, this induced variability is affected by two exogenous variables, namely the quantity and the price of oil. Secondly, it is affected by the variance of the exchange rate between the currency is which oil is invoiced and the basket to which the domestic currency is pegged, which is represented by $\sigma^2_{e_{b/j}}$. Thirdly, it is affected by imported weighted inflation rates, which would be used to determine the real value of oil revenues. However, this is affected by the choice of the peg scheme. Thus, in this case, the imported weighted inflation rates are those which the domestic country expects to import, if its currency is pegged to a trade-weighted basket. Moreover, if j does not refer to the numeraire currency, then an additional source of shock may inflict instability on the domestic currency's real value of oil revenues, namely, the variance-covariance factor which is implicit in the conversion of the nominal value of oil revenues from the numeraire currency, into any other currency in which oil may be used. This factor will prove to be important in shaping many results

	Percentage of weight	Number of currency units
Dollar	42	0.452
Mark	19	0.527
Yen	15	33.4
French franc	12	1.02
Pound sterling	12	0.0893

Source: The Role of the SDR in the International Monetary System, IMF Occasional Paper, no. 51 (Washington: IMF, March 1987), p. 54.

Table 14: The valuation of the SDR basket from January 1, 1986

in Chapter VI.

Rather than pegging the domestic currency to a trade-weighted basket, it may be pegged to baskets in which the weights are determined exogenously. This alternative includes the IMF-defined basket, the SDR and the EEC-created basket, the ECU. The real value of the oil revenues in terms of the domestic currency if oil is invoiced in a single currency, while the domestic currency is pegged to either the SDR or the ECU, will be examined next.

1.1.C. Special Drawing Rights Basket Peg

In 1970, the first Special Drawing Rights were issued by the International Monetary Fund, IMF, to be used as a reserve. Although the weighting scheme went through some changes, as of November 1989 there were five currencies included in the configuration of the SDR. These currencies are: U.S. dollar, Deutsche mark, Japanese yen, U.K. pound, and the French franc, with initial weights and number of units as shown in Table (14).

However, because of its weighted value in terms of the most transacted currencies in international trade, many believe that a peg to the SDR could minimize imported inflation, if a domestic country's trade shares from the countries included in the SDR approximate to the weights of the currencies of those countries in the basket. A peg to the SDR would insulate the domestic country from the imported component of inflation which may be caused by fluctuations in the exchange rates amongst the currencies included in the SDR.

The imported inflation component of the domestic rate of inflation with the SDR peg may be derived from equation (25). However, this equation would have to be modified to accommodate the fact that the SDR does not include the currencies of all trading partners of the domestic country, as assumed in this analysis. Extending equation (25) for the SDR and assuming the dollar is the numeraire implies that p_h can be expressed as

$$\begin{aligned} p_h \;=\; & \beta_{us}p_{us} + \beta_{uk}p_{uk} + \beta_{ff}p_{ff} + \beta_{dm}p_{dm} + \beta_{yy}p_{yy} \\ & +(\beta_{uk} - \alpha_{uk})\xi_{usuk} + (\beta_{ff} - \alpha_{ff})\xi_{usff} + (\beta_{dm} - \alpha_{dm})\xi_{usdm} \\ & +(\beta_{yy} - \alpha_{yy})\xi_{usyy} + (-\alpha_{ll})\xi_{usll}. \end{aligned} \tag{31}$$

Thus if the domestic currency is pegged to the SDR, then the imported component of the domestic inflation rate is a function of the weighted rates of inflation in France, Germany, Japan, the U.K. and the U.S.; as well as weighted deviations from the PPP of the dollar with respect to these currencies. However, these deviations are weighted by the differences between the SDR weights and the trade shares. It is only for the lira that deviations are weighted by the trade share, because the weight of the lira in the SDR is zero.

Essentially, deviations from purchasing power parity reflect the effects of changes in the exchange rates between the numeraire currency, the dollar, and the other currencies of the industrial countries. This can be seen from the purchasing power parity conditions defined earlier. Therefore, if we assume that the dollar appreciated against the pound by 10 percent, cetris paribus, then this would lead to an appreciation in the domestic currency against the pound by β_{us} times the appreciation rate. Nevertheless, the domestic currency would depreciate against the dollar by the weight assigned to the pound in the basket, i.e. β_{uk}, times the rate of depreciation of the pound against the dollar. The effect of these deviations from PPP on p_h depend on the difference between the pound's weight in the SDR and the domestic country's trade share with the U.K. For example, if β_{uk} corresponds to import share from the U.K, then a negative value for $(\beta_{uk} - \alpha_{uk})$, given appreciation of the dollar, i.e. $\xi_{usuk} > 0$, would reduce p_h.

A similar argument may be constructed for the lira. Assuming that $\xi_{usll} > 0$, given that the lira has zero weight in the SDR basket, the domestic currency will appreciate against the lira by the weight assigned to the dollar in the SDR. Thus as long as α_{ll} is positive, appreciation of the dollar would imply that $[-\alpha_{ll}(\xi_{usll})]$ is negative, i.e. it contributes to the reduction in the inflation rate imported by the domestic country.

Consequently, for a peg to the SDR, the inflation rate imported by a small developing country can be expressed as

$$p_h = \sum_{i=1}^{5} \beta_i p_i + \sum_{s=1}^{4} (\beta_s - \alpha_s)\xi_{ks} + (-\alpha_{ll})\xi_{kll} \tag{32}$$

where

i= currencies included in the SDR, including k

s= currencies included in the SDR less k

k = numeraire currency (dollar)

α_{ll} = trade share with Italy

ξ_{kll} = deviations from PPP using currency k as the numeraire, and ll represents the Italian lira,

and the variance is

$$\sigma^2_{p_i} = \sum_{i=1}^{5} \beta_i^2 \sigma^2_{p_i} + \sum_{s=1}^{4} (\beta_s - \alpha_s)^2 \sigma^2_{\xi_{ks}} + \alpha_{ll}^2 \sigma^2_{\xi_{kll}} \tag{33}$$

where the number of currencies included is five and the dollar is used as a numeraire to measure deviations from PPP. Note that, unlike the trade-weighted basket peg, where $\beta_s = \alpha_s$, deviations from PPP are not neutralized in the present basket. Furthermore, the Italian currency is not included in the composition of the SDR, whilst it is included as a trading partner. Thus, adjustments would have to be made for this fact, as has been done above.

A peg to the SDR while oil is invoiced in a single currency, j, allows us to express the real value of oil revenues in terms of the domestic currency and its variance accordingly as

$$rvor_h = nvor_j + e_{h/j} - [\sum_{i=1}^{5} \beta_i p_i + \sum_{s=1}^{4} (\beta_s - \alpha_s)\xi_{ks} + (-\alpha_{Il})\xi_{kIl}] \qquad (34)$$

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + \sigma^2_{e_{sdr/j}} + [\sum_{i=1}^{5} \beta_i^2 \sigma^2_{p_i} + \sum_{s=1}^{4} (\beta_s - \alpha_s)^2 \sigma^2_{\xi_{ks}} + \alpha_{Il}^2 \sigma^2_{\xi_{kIl}}] \qquad (35)$$

where

$\sigma^2_{e_{sdr/j}}$ = variance of the exchange rate between the SDR basket, sdr, and currency j

i = currencies included in the SDR

s = currencies included in the SDR, excluding k

j = currency in which oil is invoiced.

Although the factors affecting equation (30) may continue to exhibit similar roles, in the present setting the SDR replaces the trade-weighted basket assumed in equation (30). Moreover, since SDR weights do not correspond to trade shares, deviations from purchasing power parity may induce further instability in the domestic currency's real value of oil revenues. In addition, since the lira is not represented in the SDR weighting scheme, whilst the countries of the GCC are assumed to trade with Italy, deviations from PPP with respect to Italy are weighted by trade shares, not by the difference between SDR and trade shares, as is the case with respect to the other trading partners.

In addition to the SDR basket, the member states of the GCC may choose to peg their currencies to the European Currency Unit. Undoubtedly, the ECU may qualify as an optimal peg for countries which trade less with the countries whose currencies are not represented in the ECU, the U.S. and Japan in our example. This is helped by the fact that the member states whose currencies are included in the ECU have the objective of stabilizing the exchange rates amongst their currencies. Furthermore, if the domestic country trades more with these countries, the move toward reducing variations in the inflation rates among the countries represented in the ECU should contribute to the domestic rate of inflation. In contrast, the objective of stabilizing exchange rates amongst the SDR member currencies is not officially targeted by the countries whose currencies are represented in that basket.

1.1.D. European Currency Unit Basket Peg

In addition to the trade-weighted basket and and the SDR-weighted basket, the domestic currency may be pegged to the newly created accounting unit; the European Currency Unit (ECU). As of November 1989, the European Monetary System, EMS, included twelve member states, although the U.K., Greece, and Portugal do not participate in the Exchange Rate Mechanism[43]. The members of the EMS are: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and the U.K. However, as of November 1989, the currencies of Spain and Portugal were not included in the calculation of the ECU. The inception weights and the number of units of each national currency included in the ECU are shown in Table (15).

In a similar manner to the derivation conducted for the SDR, p_h may be found by extending equation (25), and making use of the fact that the dollar and the yen are not assigned weights in the ECU basket. Accordingly, p_h may be written as

$$\begin{aligned} p_h &= \beta_{uk}p_{uk} + \beta_{dm}p_{dm} + \beta_{ll}p_{ll} + \beta_{bf}p_{bf} + \beta_{lx}p_{lx} + \beta_{ff}p_{ff} + \beta_{gl}p_{gl} + \\ &\quad \beta_{dk}p_{dk} + \beta_{ir}p_{ir} + (\beta_{uk} - \alpha_{uk})\xi_{usuk} + (\beta_{dm} - \alpha_{dm})\xi_{usdm} + \\ &\quad (\beta_{ff} - \alpha_{ff})\xi_{usff} + (\beta_{ll} - \alpha_{ll})\xi_{usll} + (-\alpha_{yy})\xi_{usyy} \qquad (36) \end{aligned}$$

[43]This mechanism aims at limiting fluctuations in the exchange rates amongst the member currencies, using intervention in the exchange rate market, and/or realignments.

	Percentage weight	Number of currency units
Belgian franc	8.2	3.71
Danish krone	2.7	0.219
French franc	19.0	1.31
Deutsche mark	32.0	0.719
Irish pound	1.2	0.00871
Italian lira	10.2	140
Luxembourg franc	0.3	0.14
Netherlands guilder	10.1	0.256
Pound	15.0	0.0878
Greek drachma	1.3	1.15

Source: The Role of the SDR in the International Monetary System, IMF Occasional Paper, no. 51 (Washington: IMF, March 1987), p. 43.

Table 15: The valuation of the ECU basket at September 17, 1984

which may be conveniently expressed as

$$p_h = \sum_{i=1}^{9} \beta_i p_i + \sum_{c=1}^{4} (\beta_c - \alpha_c)\xi_{kc} + (-\alpha_{yy})\xi_{kyy} \tag{37}$$

where

i = currencies included in the ECU

c = currencies of the trading partners which are included in the ECU

ξ_{kc} = deviations from PPP between the dollar and each of the pound, mark, franc, and the lira

ξ_{kyy} = deviations from PPP between the dollar and the yen

α_{yy} = trade share with Japan.

The index on the first summation represents the number of currencies included in the ECU. However, since it has been assumed that the GCC member states trade with only six countries, α_m for the other member states of the ECU apart from Germany, Italy, France and the U.K. is zero. Moreover, since the ECU does not include the currencies of the U.S. and Japan, with whom the domestic country trades, we have added the trade share of Japan, while the U.S. share is excluded, since we are assuming the dollar is the numeraire currency.

Similarly, the variance in the imported inflation rate in the domestic country would be given as

$$\sigma_{p_h}^2 = \sum_{i=1}^{9} \beta_i^2 \sigma_{p_i}^2 + \sum_{c=1}^{4} (\beta_c - \alpha_c)^2 \sigma_{\xi_{kc}}^2 + \alpha_{yy}^2 \sigma_{\xi_{kyy}}^2. \tag{38}$$

Having obtained an equation for the imported component of the domestic inflation rate and its variance, the real value of oil revenues in terms of the domestic currency, when the domestic currency is pegged to the ECU and with oil invoiced in a single currency j, may be defined as

$$rvor_h = nvor_j + e_{h/j} - [\sum_{i=1}^{9} \beta_i p_i + \sum_{c=1}^{4} (\beta_c - \alpha_c)\xi_{kc} + (-\alpha_{yy})\xi_{kyy}] \tag{39}$$

and the variance is

$$\sigma_{rvor_h}^2 = \sigma_{nvor_j}^2 + \sigma_{e_{ecu/j}}^2 + [\sum_{i=1}^{9} \beta_i^2 \sigma_{p_i}^2 + \sum_{c=1}^{4} (\beta_c - \alpha_c)^2 \sigma_{\xi_{kc}}^2 + \alpha_{yy}^2 \sigma_{\xi_{kyy}}^2] \tag{40}$$

where

$\sigma^2_{e_{ecu/j}}$ = variance of the exchange rate between the ECU basket, ecu, and currency j

j = currency in which oil is invoiced.

An ECU peg with a single currency invoicing scheme for oil would introduce further factors that would affect the domestic currency's real value of oil revenues, as did the SDR peg combined with single currency invoicing. In addition to $\sigma^2_{nvor_j}$, and the variance of the exchange rate between currency j and the ECU basket, $\sigma^2_{e_{ecu/j}}$, the weighted inflation imported by a member state of the GCC is affected by the variance of inflation rates in countries which are members of the ECU scheme. Moreover, deviations from PPP are weighted by the differences between basket weights and trade shares for the French franc, German mark, Italian lira, and British pound; however, for Japan they are weighted by trade shares only, since the yen is not a member currency of the ECU.

The above derivations describe the potential effect on the real values of oil revenues expressed in terms of the currencies of the GCC member states, of invoicing oil in a single currency while the domestic currency is either pegged to a single currency or to a basket of currencies. Furthermore, it may be envisaged that there exists a relationship between the revenues from oil exports and their potential contribution to the ability of the GCC member states to import. Fluctuations in oil revenues would, therefore, tend to be reflected in the domestic economy, and if these fluctuations are undesirable, as assumed in the present analysis, a way to minimize them is worth seeking. It may be argued that invoicing the price of oil in terms of a basket of currencies may fulfill that objective.

1.2. Invoicing Oil in a Basket of Currencies

Evidence about the behavior of exchange rates amongst the currencies of the major industrial countries reveals continued large fluctuations even throughout the

1980's[44]. A potential impact of this behavior is reflected in uncertainty regarding expected prices of imports and exports. Although the narrow and less diversified domestic production of import substitutes has constrained the ability of these economies to insulate themselves from external shocks to exchange rates (as well as real price shocks), the stream of oil revenues may be diversified in terms of their component currencies so as to match those used for financing imports. That is to say, since imports are denominated in a multicurrency scheme, the same scheme may be used to denominate oil. Also if oil is invoiced in a basket of currencies in which the weights and currencies correspond to the basket of currencies used to finance imports, potential exchange risk involved in trade between the GCC member states and the rest of the world can be eliminated.

As there were alternatives available to the GCC member states in choosing the exchange rate regime they would adopt, oil may be invoiced in a basket of currencies. The aim of adopting a basket invoicing scheme may rest on the desire of the domestic authorities to diversify the potential exchange risk, which can affect the stream of income from oil exports. The weights of this basket may be identical to those assigned to the various currencies in the optimal currency peg, if a basket peg is adopted, or may be different. Thus, with the objective of minimizing variability in the real value of oil revenues expressed in terms of the domestic currency, the domestic country is assumed to import a weighted average of inflation rates from countries included in the currency basket, as well as weighted deviations from PPP. However, in the current analysis, the imported component of inflation will have effects on the real value of oil revenues, whether the domestic currency is pegged to a single currency, or to a basket of currencies. It is important to realize that invoicing oil in a basket of currencies does not preclude the essential role the choice of pegging the domestic currency may play in the analysis. Nevertheless, a choice of a basket for pricing oil may have different effects on the real value of oil revenues, since the receipts from oil exports would differ in terms of the basket of currencies that the domestic country receives. However, in terms of the domestic

[44]Managing Financial Risks in Indebted Developing Countries, *IMF Occasional Paper*, no. 65 (Washington: IMF, June 1989).

currency, the real value of oil revenues is affected by the exchange rate arrangement that is adopted by the domestic authorities.

Evidence regarding the behavior of exchange rates between the currencies of major industrial countries reveals large fluctuations that have not exhibited any stability even in the 1980's, a period that has witnessed the Louvre Accord. The standard deviation of both the nominal and real effective exchange rates has been large[45]. A potential impact of this behavior is reflected in the uncertainty associated with expected prices of imports and exports of the GCC member states. Thus, neither the nominal nor the real values of oil revenues would be stable, unless an exchange rate arrangement between the currency(s) in which oil revenues are invoiced and the domestic currencies of the GCC, and between the latter currencies and the currencies in which imports are denominated, is established. Indeed, the alternative of matching the currencies in which oil is invoiced to those used for denominating imports would to some extent minimize the impact of exchange risk on the GCC economies.

Although oil is assumed to be invoiced in a basket of currencies, there are three potential baskets considered in the present presentation: trade-weighted, SDR and ECU baskets. The relationship between the choice of any one basket, based on the optimality condition, i.e. minimizing the variance of the domestic currency's real value of oil revenues, and the exchange rate regime adopted by the domestic country, can be stated for three possible alternatives:

Case 1: Oil is invoiced in a basket of currencies, whereas the domestic currency is pegged to a single currency.

Case 2: Oil is invoiced in a basket of currencies, and the domestic currency is pegged to the same basket.

Case 3: Oil is invoiced in a basket of currencies, while the domestic currency is pegged to another basket.

[45] Managing Financial Risks in Indebted Developing Countries, *IMF Occasional Paper*, no. 65 (Washington: IMF, June 1989).

It is worth noting that, by " another basket " we do not imply that both baskets should be composed of different currencies; although this is a sufficient condition, it is not a necessary one. A sufficient and a necessary condition would be met if the weight of at least one currency which is present in both baskets, differs between them.

Due to the relative complexity of these alternatives, a derivation of the real value of oil revenues in terms of the domestic currency is pursued for each case.

1.2.A. Real Value of Oil Revenues in Case 1

If the weighted imported component of the domestic inflation rate is assumed to be given by p_h, then the nominal value of oil revenues would be expressed as

$$nvor_h^1 = \theta_1(nvor_1 + e_{h/1}) + \theta_2(nvor_2 + e_{h/2}) + \cdots + \theta_n(nvor_n + e_{h/n}) \tag{41}$$

which may be summed into

$$nvor_h^1 = \sum_{i=1}^{n} \theta_i(nvor_i + e_{h/i}) \tag{42}$$

where

$nvor_h^1$ = percentage change in the nominal value of oil revenues expressed in terms of the domestic currency in case 1

θ_i = share of oil revenues denominated in currency i, and $\sum_{i=1}^{n} \theta_i = 1$.

Accordingly, the percentage change in the real value of oil revenues in terms of the domestic currency in this case, assuming that oil is invoiced in a trade-weighted basket, and that currency h is pegged to currency j, is

$$rvor_h^1 = \sum_{i=1}^{6} \theta_i(nvor_i + e_{h/i}) - p_h. \tag{43}$$

Substituting for p_h, assuming a single currency peg, implies

$$rvor_h^1 = \sum_{i=1}^{6} \theta_i(nvor_i + e_{j/b}) - [p_j - \sum_{m=1}^{5} \alpha_m \xi_{jm}] \tag{44}$$

and the variance is

$$\sigma^2_{rvor^1_h} = \sum_{i=1}^{6} \theta_i^2 (\sigma^2_{nvor_i} + \sigma^2_{e_{j/b}}) + [\sigma^2_{p_j} + \sum_{m=1}^{5} \alpha^2_m \sigma^2_{\xi_{jm}}] \tag{45}$$

where

j = currency to which h is pegged

i = currencies of the trading partners

m = currencies of the trading partners less j

$\sigma^2_{e_{j/b}}$ = variance of the exchange rate between currency j and the basket in which oil is invoiced, b.

(Note that pegging h to j implies that $e_{h/b} = e_{j/b}$.)

Whenever oil is invoiced in a basket of currencies, the nominal return from oil exports must be converted into domestic currency units. Alternative multi-exchange rates would be used. However, since h is assumed to be pegged to a single currency, j in this case, oil revenues denominated in various currencies would exhibit the same degree of variability in terms of j as that in terms of h. Accordingly, stability of the domestic currency's real value of oil revenues is influenced by the variance of the exchange rates between the currency to which h is pegged and the currencies in which oil is invoiced, weighted by the share of oil exports denominated according to trade shares.

Alternatively, while h is pegged to j, oil may be invoiced in the SDR. Then the real value of oil revenues in terms of the domestic currency of any of the GCC member countries would be

$$rvor^1_h = \sum_{i=1}^{5} \theta_i (nvor_i + e_{j/sdr}) - [p_j - \sum_{m=1}^{5} \alpha_m \xi_{jm}] \tag{46}$$

and the variance would be

$$\sigma^2_{rvor^2_h} = \sum_{i=1}^{5} \theta_i^2 (\sigma^2_{nvor_i} + \sigma^2_{j/sdr}) + [\sigma^2_{p_j} + \sum_{m=1}^{5} \alpha^2_m \sigma^2_{\xi_{jm}}] \tag{47}$$

where

i = currencies included in the SDR

m = currencies of trading partners less j
j = currency to which h is pegged.

Stability of the real value of oil revenues expressed in terms of the domestic currency is influenced by the variance of the nominal value of oil revenues expressed in each currency included in the SDR and the variance of the exchange rate between j, the currency to which h is pegged, and those currencies included in the SDR. Moreover, the variance of p_h (which is represented by the right hand side bracket) would affect the optimality of this pegging and invoicing scheme.

A third possibility is feasible if oil is invoiced in the ECU basket, with h fixed in terms of currency j. Then

$$rvor_h^1 = \sum_{i=1}^{9} \theta_i(nvor_i + e_{j/ecu}) - [p_j - \sum_{i=1}^{5} \alpha_m \xi_{jm}] \tag{48}$$

and variability is given by

$$\sigma^2_{rvor_h^1} = \sum_{i=1}^{9} \theta_i^2(\sigma^2_{nvor_i} + \sigma^2_{e_{j/ecu}}) + [\sigma^2_{p_j} + \sum_{m=1}^{5} \alpha_m^2 \sigma^2_{\xi_{jm}}] \tag{49}$$

where
i = currencies included in the ECU
m = currencies of the trading partners which are included in the ECU
j = currency to which h is pegged.

In addition to the variance of p_h, in this case, the variances of the exchange rates between currency j and the currencies included in the ECU are of importance to the stability of the domestic currency's real value of oil revenues.

1.2.B. Real Value of Oil Revenues in Case 2

If the weights of the currencies included in both baskets correspond perfectly to each other, then the percentage change in the real value of oil revenues in terms of the domestic currency would be

$$rvor_h^2 = \sum_{i=1}^{6} \theta_i(nvor_i) - [\sum_{i=1}^{6} \beta_i p_i + \sum_{m=1}^{5} (\beta_m - \alpha_m)\xi_{km}]. \tag{50}$$

However, since the assumption of equal weights implies that $\theta_i = \beta_i$ for all i, as in the trade-weighted basket, then

$$rvor_h^2 = \sum_{i=1}^{6} \beta_i(nvor_i) - [\sum_{i=1}^{6} \beta_i] \tag{51}$$

and the variance is

$$\sigma^2_{rvor_h^2} = \sum_{i=1}^{6} \beta_i^2(\sigma^2_{nvor_i}) + [\sum_{i=1}^{6} \beta_i^2 \sigma^2_{p_i}] \tag{52}$$

where

i = currencies of the six trading partners

$rvor_{h^2}$ = percentage change in the real value of oil revenues in terms of currency h in case 2.

On the other hand, if the SDR basket is used for pegging the domestic currency as well as invoicing oil, then the percentage change in the real value of oil revenues in terms of the domestic currency is given by

$$rvor_h^2 = \sum_{i=1}^{5} \beta_i(nvor_i) - [\sum_{i=1}^{5} \beta_i p_i + \sum_{s=1}^{4} (\beta_s - \alpha_s)\xi_{ks} + (-\alpha_{ll})\xi_{kll}] \tag{53}$$

and the variance is

$$\sigma^2_{rvor_h^2} = \sum_{i=1}^{5} \beta_i^2(\sigma^2_{nvor_i}) + [\sum_{i=1}^{5} \beta_i^2 \sigma^2_{p_i} + \sum_{s=1}^{4} (\beta_s - \alpha_s)^2 \sigma^2_{\xi_{ks}} + \alpha_{ll}^2 \sigma^2_{\xi_{kll}}] \tag{54}$$

where

i = currencies included in the SDR

s = currencies included in the SDR less k (currency k is the numeraire).

Alternatively, under an ECU peg and invoicing basket, the percentage change in the real revenues equation becomes

$$rvor_h^2 = \sum_{i=1}^{9} \beta_i(nvor_i) - [\sum_{i=1}^{9} \beta_i p_i + \sum_{c=1}^{4} (\beta_c - \alpha_c)\xi_{kc} + (-\alpha_{yy})\xi_{kyy}] \tag{55}$$

and the variance would be

$$\sigma^2_{rvor_h^2} = \sum_{i=1}^{9} \beta_i^2(\sigma^2_{nvor_i}) + [\sum_{i=1}^{9} \beta_i^2 \sigma^2_{p_i} + \sum_{c=1}^{4} (\beta_c - \alpha_c)^2 \sigma^2_{\xi_{kc}} + \alpha_{yy}^2 \sigma^2_{\xi_{kyy}}] \tag{56}$$

where

i = currencies included in the ECU

c = currencies of the trading partners which are included in the ECU .

Note that as expected, there would be no variations in the exchange rate between the basket in which oil is invoiced, and that to which the domestic currency is pegged, since they are the same baskets. However, if oil is invoiced in one basket of currencies, whilst the domestic currencies of the GCC member states are pegged to another, then different expressions are obtained for $rvor_h$ and its variance.

1.2.C. Real Value of Oil Revenues in Case 3

In addition to the domestic authorities fixing the value of their currency in terms of a basket and invoicing oil in terms of the same basket, there exists the possibility of pegging the domestic currency to a basket which is different from the one in which oil is invoiced. In the present context, there are three potential combinations of these baskets summarized as follows:

I) Oil is invoiced in a trade-weighted basket, while the domestic currency is pegged to either the SDR or the ECU basket.

II) Oil is invoiced in an SDR basket, while the domestic currency is pegged to a trade-weighted or an ECU basket.

III) Oil is invoiced in an ECU basket, but the domestic currency is pegged to either a trade-weighted or an SDR basket.

Accordingly, the equations for the percentage change in the real value of oil revenues and their variances are summarized as follow (the components were derived earlier):

I.1) <u>Invoicing oil in a trade-weighted basket, pegging to SDR</u>

$$rvor_h^3 = \sum_{i=1}^{6} \theta_i(nvor_i + e_{sdr/b}) - [\sum_{j=1}^{5} \beta_j p_j + \sum_{s=1}^{4}(\beta_s - \alpha_s)\xi_{ks} + (-\alpha_{ll})\xi_{kll}] \qquad (57)$$

and the variance is

$$\sigma^2_{rvor^3_h} = \sum_{i=1}^{6} \theta_i^2(\sigma^2_{nvor_i} + \sigma^2_{e_{sdr/b}}) + [\sum_{j=1}^{5} \beta_j^2 \sigma^2_{p_j} + \sum_{s=1}^{4} (\beta_s - \alpha_s)^2 \sigma^2_{\xi_{ks}} + \alpha_{ll}^2 \sigma^2_{\xi_{kll}}] \quad (58)$$

where

i = currencies included in the trade-weighted basket

j = currencies included in the SDR

s = currencies included in the SDR less k

k = numeraire (dollar).

I.2) Invoicing oil in a trade-weighted basket, pegging to ECU,

$$rvor^3_h = \sum_{i=1}^{6} \theta_i(nvor_i + e_{ecu/b}) - [\sum_{j=1}^{9} \beta_j p_j + \sum_{c=1}^{4} (\beta_c - \alpha_c)\xi_{kc} + (-\alpha_{yy})\xi_{kyy}] \quad (59)$$

and the variance is

$$\sigma^2_{rvor^3_h} = \sum_{i=1}^{6} \theta_i^2(\sigma^2_{nvor_i} + \sigma^2_{e_{ecu/b}}) + [\sum_{j=1}^{9} \beta_j^2 \sigma^2_{p_j} + \sum_{c=1}^{4} (\beta_c - \alpha_c)^2 \sigma^2_{\xi_{kc}} + \alpha_{yy}^2 \sigma^2_{\xi_{kyy}}] \quad (60)$$

where

i = currencies included in the trade-weighted basket

j = currencies included in the ECU

c = currencies of the trading partners which are included in the ECU

k = numeraire.

II.1) Invoicing oil in SDR, pegging to a trade-weighted basket

$$rvor^3_h = \sum_{i=1}^{5} \theta_i(nvor_i + e_{b/sdr}) - [\sum_{j=1}^{6} \beta_j p_j] \quad (61)$$

and the variance is

$$\sigma^2_{rvor^3_h} = \sum_{i=1}^{5} \theta_i^2(\sigma^2_{nvor_i} + \sigma^2_{e_{b/sdr}}) + [\sum_{j=1}^{6} \beta_j^2 \sigma^2_{p_j}] \quad (62)$$

where

i = currencies included in the SDR

j = currencies included in the trade-weighted basket.

II.2) Invoicing oil in SDR, pegging to ECU

$$rvor_{h^3} = \sum_{i=1}^{5} \theta_i(nvor_i + e_{ecu/sdr}) - [\sum_{j=1}^{9} \beta_j p_j + \sum_{c=1}^{4}(\beta_c - \alpha_c)\xi_{kc} + (-\alpha_{yy})\xi_{kyy}] \quad (63)$$

and the variance is

$$\sigma^2_{rvor_h^3} = \sum_{i=1}^{5} \theta_i^2(\sigma^2_{nvor_i} + \sigma^2_{e_{ecu/sdr}}) + [\sum_{j=1}^{9} \beta_j^2 \sigma^2_{p_j} + \sum_{c=1}^{4}(\beta_c - \alpha_c)^2 \sigma^2_{\xi_{kc}} + \alpha^2_{yy}\sigma^2_{\xi_{kyy}}] \quad (64)$$

where

i = currencies included in the SDR

j = currencies included in the ECU

c = currencies of the trading partners which are included in the ECU.

III.1) Invoicing oil in ECU, pegging to a trade-weighted basket

$$rvor_h^3 = \sum_{i=1}^{9} \theta_i(nvor_i + e_{b/ecu}) - [\sum_{j=1}^{6} \beta_j p_j] \quad (65)$$

and the variance is

$$\sigma^2_{rvor_h^3} = \sum_{i=1}^{9} \theta_i^2(\sigma^2_{nvor_i} + \sigma^2_{e_{b/ecu}}) + [\sum_{j=1}^{6} \beta_j^2 \sigma^2_{p_j}] \quad (66)$$

where

i= currencies included in the ECU

j= currencies included in the trade-weighted basket.

III.2) Invoicing oil in ECU, pegging to SDR

$$rvor_h^3 = \sum_{i=1}^{9} \theta_i(nvor_i + e_{sdr/ecu}) - [\sum_{j=1}^{5} \beta_j p_j + \sum_{s=1}^{4}(\beta_s - \alpha_s)\xi_{ks} + (-\alpha_{ll})\xi_{kll}] \quad (67)$$

and the variance is

$$\sigma^2_{rvor_h^3} = \sum_{i=1}^{9} \theta_i^2(\sigma^2_{nvor_i} + \sigma^2_{e_{sdr/ecu}}) + [\sum_{j=1}^{5} \beta_j^2 \sigma^2_{p_j} + \sum_{s=1}^{4}(\beta_s - \alpha_s)^2 \sigma^2_{\xi_{ks}} + \alpha^2_{ll}\sigma^2_{\xi_{kll}}] \quad (68)$$

where

i = currencies included in the ECU

j = currencies included in the SDR

s = currencies included in the SDR less k.

Note that $rvor_{h^3}$ represents the percentage change in the real value of oil revenues in terms of the domestic currency, defined in case 3.

To sum up, the model is designed to account for the fact that the GCC member states peg their currencies and may invoice oil in currencies other than the dollar. Thus, the objective of the present chapter is to analyze the effects of the various currency pegs and the alternative currencies that could be used to invoice oil, using the standard deviation in the real value of oil revenues as a measure of potential risk involved.

This concludes the description of the model and presents some interesting equations to be estimated. There appear to be two major issues of significant concern to the authorities in the GCC countries. Firstly, what is the optimal currency(s) peg with a view to minimizing the imported component of inflation. Secondly, would that choice provide the least variability in the real value of oil revenues, or would another invoicing scheme be more optimal. These issues will be tested empirically in the next chapter, with additional results as well as data used in estimation, tabulated in Appendix 1.

Appendix V.A

Derivation of the Basket Peg in the Two-Country Case

For the basket currency peg, Connolly (1982) has indicated the steps which may be adopted in order to define the domestic imported rate of inflation, in the two-country model. Thus, in what follows a basket peg will be derived for this case, making use of Connolly's note (7). Assume we have two countries, 1 and 2, whose currencies are included in the basket. Then, the exchange rate of each of these currencies vis-á-vis the domestic currency, h, and the inflation rate in both countries can affect the domestic rate of inflation. This imported component of domestic inflation rate is given by:

$$p_h = \alpha_1(p_1 + e_{h/1}) + \alpha_2(p_2 + e_{h/2})$$

where

$\alpha_1 + \alpha_2 =$ trade shares with country 1 and country 2

$\alpha_1 + \alpha_2 = 1.$

However the currencies of the two trading partners are related to each other through the PPP relationship, which is given by:

$$e_{h/1} - e_{h/2} = p_2 - p_1 + \xi_{12}$$

and the basket peg is given by

$$\beta_1 e_{h/1} + \beta_2 e_{h/2} = 0$$

where

$\beta_1 + \beta_2 = 1.$

So we can define

$$e_{h/2} = e_{h/1} - p_2 + p_1 - \xi_{12}.$$

However, if we substitute this definition for $e_{h/2}$ in the basket peg, we get

$$\beta_1 e_{h/1} + \beta_2(e_{h/1} - p_2 + p_1 - \xi_{12}) = 0$$

solving for $e_{h/1}$, gives

$$e_{h/1}(\beta_1 + \beta_2) = \beta_2 p_2 - \beta_2 p_1 + \beta_2 \xi_{12}$$

making use of the fact that the sum of the basket weights is unity, we get:

$$e_{h/1} = \beta_2 p_2 - \beta_2 p_1 + \beta_2 \xi_{12}.$$

At this stage we need to get an expression for $e_{h/2}$ as well. This can be obtained simply by substituting the expression for $e_{h/1}$ in the PPP condition. Thus

$$e_{h/2} = p_1 - p_2 - \xi_{12} + e_{h/1}$$

$$e_{h/2} = p_1 - p_2 - \xi_{12} + \beta_2 p_2 - \beta_2 p_1 + \beta_2 \xi_{12}.$$

Now a substitution of $e_{h/1}$ and $e_{h/2}$ in the imported component of domestic inflation rate, is possible. Such a step would yield:

$$\begin{aligned} p_h &= \alpha_1(p_1 + \beta_2 p_2 - \beta_2 p_1 + \beta_2 \xi_{12}) + \alpha_2(p_2 + p_1 - \\ &\quad p_2 - \xi_{12} + \beta_2 p_2 - \beta_2 p_1 + \beta_2 \xi_{12}) \end{aligned}$$

multiplying out and making use of the definition of the sum of trade shares is unity, implies:

$$p_h = p_1(\alpha_1 - \alpha_1\beta_2 + \alpha_2 - \alpha_2\beta_2) + \xi_{12}(\alpha_1\beta_2 - \alpha_2 + \alpha_2\beta_2) + \alpha_2\beta_2 p_2 + \alpha_1\beta_2 p_2 \quad (1)$$

which can be factored out as:

$$p_h = p_1[\alpha_1(1 - \beta_2) + \alpha_2(1 - \beta_2)] + \beta_2 p_2 + \xi_{12}[(\alpha_1 + \alpha_2)\beta_2 - \alpha_2] \quad (2)$$

note that $(1 - \beta_2) = \beta_1$, and again using the sum of trade shares, hence

$$p_h = p_1(\alpha_1\beta_1 + \alpha_2\beta_1) + \beta_2 p_2 + \xi_{12}(\beta_2 - \alpha_2)$$

$$p_h = p_1[\beta_1(\alpha_1 + \alpha_2)] + \beta_2 p_2 + \xi_{12}(\beta_2 - \alpha_2)$$

which gives, if summation operator used:

$$p_h = \sum_{i=1}^{2} p_i \beta_i + (\beta_2 - \alpha_2)\xi_{12}$$

and the variance would be:

$$\sigma_{p_h}^2 = \sum_{i=1}^{2} \sigma_{p_i}^2 \beta_i^2 + (\beta_2 - \alpha_2)^2 \sigma_{\xi_{12}}^2.$$

VI. Empirical Estimation of the Model

Empirical analysis of the model using alternative schemes of currency invoicing of oil is presented in this chapter. It may be worth recapping the main purpose of the model. As defined in the previous chapter, the model aims to find the optimal combination of the choice of currency(s) for invoicing oil and the optimal currency(s) peg for the GCC member states sampled. The objective of the authorities is to find the combination of invoicing currency for oil and pegging scheme that will minimize the variance of the percentage change in the real value of oil revenues in terms of the domestic currency.

However, since this real value is a function of the variance of the weighted imported inflation rate, it may be more convenient to analyze this variance first, then use it to define, in conjunction with the variance of the nominal value of oil revenues expressed in foreign currency(s), the variance of the real value of oil revenues in terms of the domestic currency.

Thus, within each section of the chapter, the equation to be estimated is stated at the beginning. Then, the variance of the weighted imported inflation rate is determined. Finally, the various components of the equation for the variance of the real value of oil revenues in terms of the domestic currency are pooled together. A historical review of the behavior of exchange rates, prices, money supply and oil revenues is presented in the first section of the chapter. The objective of this is to be acquainted with the development of these variables over time and their variability, as well as to recognize possible relationships amongst them. In the second section, single currency invoicing of oil is examined, and the optimality condition is checked throughout. However, within that section, alternative currency peg schemes, single and basket, are examined. The third section analyzes the performance of baskets of currencies as alternatives to a single currency invoicing scheme, assuming single currency pegs. Pegging and invoicing in the same basket is the subject of the fourth section. Section five discusses the results of pegging the domestic currency to one basket, whilst invoicing oil in terms of another. This explores both single currency and basket pegs, and their contribution to the variance of the domestic currency's real value of oil revenues. Toward the end of the chapter, summary tables of the findings are presented.

VI.1. Historical Perspective

Since the end of the Bretton Woods agreement, some of the GCC member states have chosen to peg their currencies to the dollar, whilst others preferred a less restricted commitment. The exchange rate arrangements adopted by these countries are based on the nature of the currency invoicing of their oil revenues. Although this may have reduced uncertainty in the domestic currency's value of oil revenues, it failed to insulate domestic prices from changes in the exchange rates between the currency to which the domestic currency is pegged and the domestic country's trading partners. During the period from 1971 until 1987, the purchasing power of oil revenues has exhibited little stability, as the dollar's relative value changed and oil exports fell. In the next sections, a historical record of the exchange rates, price indices, rates of money growth and oil revenues will be discussed, before the results of the empirical estimation of the model are presented.

A. Behavior of Exchange Rates

Despite the move towards a floating exchange rate regime that has emerged since the collapse of the Bretton Woods arrangements, the U.S. dollar has preserved most of its appeal to traders. In addition, it has continued to be used as a reserve currency as well as a benchmark to which movements in other currencies are compared. For the GCC currencies, this may be inferred from Table (16), which examines the rate of variations of the exchange rates of the domestic currencies with respect to the currencies of the industrial countries considered in the model, as well as relative to the SDR and the ECU.

Overall, the variance of the percentage change in the rate of exchange of the currencies of the GCC member states relative to the dollar has been more stable than the exchange rate of the currencies of the GCC's relative to the currencies

	E(BD/i)	E(KD/i)	E(RO/i)	E(QR/i)	E(SR/i)	E(Dh/i)
Dollar	-0.96 (2.69)	-1.23 (3.95)	0.01 (3.88)	-1.16 (2.78)	-0.64 (7.10)	-1.11 (2.35)
Yen	4.88 (14.29)	4.611 (12.42)	5.85 (15.39)	4.68 (14.43)	5.20 (16.61)	4.73 (14.11)
Franc	-1.09 (14.24)	-1.37 (12.27)	-0.12 (15.46)	-1.30 (14.34)	-0.77 (15.52)	-1.24 (14.36)
Mark	3.57 (13.63)	3.30 (11.57)	4.54 (15.00)	3.37 (13.69)	3.89 (15.27)	3.42 (13.79)
Lira	-5.19 (16.34)	-5.46 (15.00)	-4.22 (17.52)	-5.39 (16.44)	-4.87 (17.99)	-5.34 (16.01)
Pound	-2.90 (14.81)	-3.17 (12.54)	-1.92 (15.48)	-3.10 (14.68)	-2.58 (15.71)	-3.05 (14.54)
SDR	0.70 (6.87)	0.43 (4.77)	1.68 (8.37)	0.50 (6.96)	1.02 (7.08)	0.55 (6.99)
ECU	-1.29 (18.11)	-1.41 (14.95)	0.07 (20.07)	-1.48 (18.22)	0.07 (18.15)	-1.26 (18.09)

ECU data covers only the periods from 1979 to 1987
E(BD/i) defined as units of BD per unit of i.

Table 16: Means and standard deviations of the exchange rates of the GCC's currencies vis-á-vis others (1971-1987)

of the other five western economies as well as the SDR and the ECU. This is not coincidental and may be attributed to the actual pegging of at least four of the member states' currencies to the dollar.

Data in Appendix 1 show that for Bahrain and Oman the dollar has remained the currency to which the domestic currencies have shown limited flexibility since the collapse of the Bretton Woods agreement. The Bahraini dinar, BD, has been fixed rigidly at \$ 2.6596 since 1980. Similarly, the riyal Omani, RO, was officially pegged to the dollar at an exchange rate of RO 0.3454 from 1973 until 1985. Recently, in 1986, this exchange rate was raised to RO 0.3845, which was seen as a move to counter the decline in oil revenues and its subsequent effects on the domestic economy, and also to encourage exports and restrain imports. In an interview with officials at the Central Bank of Oman, the view was expressed that although pegging the RO to the dollar is based on the fact that oil revenues are invoiced in dollars, the decline in these revenues, both in terms of nominal and real values, has induced the Omani authorities to devalue the domestic currency. Moreover, the devaluation is expected to increase the nominal value of oil revenues in terms of the domestic currency, thus easing pressures on government budgets. Furthermore, the devaluation would have a positive impact on the balance of payments via reducing real domestic income and imports, thus lowering the demand for foreign exchange. A devaluation would also affect the GCC economies through another channel, the labor market. These economies depend largely on foreign labor[46]; thus a devaluation would affect the remittances of foreign labor, by reducing the amount of foreign exchange transferred abroad[47].

Qatar and the United Arab Emirates, U.A.E., have both pegged their currencies to the dollar since 1980. The rates have been defined at \$ 0.27473 and \$ 0.2724, respectively. Kuwait and Saudi Arabia have had a more distant official relation-

[46] Percentage of expatriates in labor force estimated in 1988 to be: 55.00, 81.00, 53.70, 83.00, 72.00, and 91.20 percent, in Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the U.A.E., respectively. Source: *Gulf Economic and Financial Report*, vol. 4, no. 10 (Manama: Gulf International Bank, December 1989).

[47] Personal interview with M. Kalmoor, Director of the Research and Statistics Department, Central Bank of Oman, Ruwi, Sultanate of Oman, February 28, 1990.

ship to the dollar. Aside from Oman, which devalued its currency by more than ten percent in 1986, the Kuwaiti dinar, KD, and the Saudi riyal, SR, have exhibited greater fluctuations in their value relative to the dollar than any other GCC country. Nevertheless, KD has been pegged to an unknown customized basket of currencies, which is thought to be defined according to trade shares. However, the analysts hypothesize that the weight of the dollar is as much as 70 percent[48]. A part of the field work conducted by the researcher included an attempt to explore the nature of these weights. Officials at the Central Bank of Kuwait argue that, although the basket is weighted according to total trade shares, with considerations awarded to the currency diversification of investment abroad, the dollar retains a large weight due to the fact that oil revenues are denominated in dollars, and most domestic exports are invoiced in dollars. When asked about that weight, the officials declined to reveal it, arguing that the purpose of this policy is to minimize speculations about the moves of the central bank in the exchange rate market, which can have substantial impact on a currency for which the market is thin[49].

Judging from the standard deviations in Table (16), it may be argued that the SR has been floating more freely than the currencies of the other member states.

In contrast to variations of the currencies of the member states relative to the dollar, variations relative to the SDR have been much greater. However, as can be expected, the standard deviation of the percentage change of the exchange rate of KD relative to the SDR is lower than that of the other GCC member states. This may be attributed to the practice of the Kuwaiti government of pegging to a basket in which the five currencies that are included in the calculation of the SDR are represented.

With respect to the currencies of the other western economies and the ECU, the standard deviations of the exchange rates tabulated in Table (16) are greater than those for the dollar or the SDR. The standard deviation recorded its highest

[48] Henry Azzam, editor, *Gulf Financial Market* (Manama:Gulf International Bank, 1988), p. 257.

[49] Personal interview with A. Al-Gharably, and F. Shalaby, Director of the Economic Department, and Economic Advisor, respectively. Central Bank of Kuwait, Kuwait, February 15, 1990.

value for the exchange rate with respect to the ECU. Considered individually, the currencies of all GCC member states have depreciated against the mark, yen, and the SDR, with their greatest loss in value to the Japanese currency (this may be explained by the fact that the dollar has lost ground to the yen lately). However, as can be inferred from the mean values, the currencies of the GCC member states have appreciated against the British pound and the Italian lira, although the appreciation against the latter has been greater.

It is evident that the figures in Table (16) support the fact that the dollar has continued to be used as a reserve currency and a currency which is seen to promote confidence in the currencies of the GCC member states. Thus, four of the GCC countries, Bahrain, Oman, Qatar and the U.A.E. continue to peg their currencies to the dollar, and the SR is believed to be moving in that direction (the exchange rate, as can be seen from Appendix 1, has been fixed for the last two years). This move has been justified by officials at the Saudi Arabia Monetary Agency on the grounds that, due to the decline in oil revenues, and increasing pressures on both government budgets, and the SR to decline in terms of it relative value, a move to a dollar peg has been a policy of minimizing variability in the domestic currency's value of oil revenues[50]. The Kuwaiti dinar is the only currency of the GCC countries that is not fixed rigidly to the dollar as a single currency peg. However, even for Kuwait, which pegs to a trade-weighted basket, other alternative baskets have not appealed to the monetary authorities in the country. In general, several factors may be thought of as favoring a dollar peg compared to alternative pegs such as the SDR and the ECU. Firstly, although the GCC countries would like to have their exports invoiced in terms of their currencies, in order to avert the exchange risk involved if exports are denominated in terms of other currencies, oil revenues are dollar-denominated. A possible hedge for this exposure is seen in pegging the domestic currencies of these oil exporting countries to the currency in which oil is invoiced, i.e. the dollar. Thus, a peg to the dollar diminishes the uncertainty of the relative value of oil revenues which consequently provides planners with

[50] Personal interview with A. Al-Naim, Director of Economic and Research Department, Saudi Arabia Monetary Agency, Riyad, Saudi Arabia, February 17, 1990.

greater certainty about government budgets. Secondly, the dollar can easily be converted into any other currency to be used as a medium of exchange by both the public as well as the private sectors, and to settle payments. Thirdly, pegging to a single currency requires lower reserve holdings of various currencies; holding higher levels of reserves may prove to be a difficult task for these developing economies. Fourthly, the SDR and ECU baskets lack the prime role of money, i.e. a medium of exchange by the public.

Thus, the dollar continues to be viewed as a confidence-promoting peg relative to the ad hoc baskets such as the SDR, ECU and trade-weighted baskets.

B. Behavior of Price Indices

The feature of openness which has characterized the economies of the GCC member states, and their dependence on imports to meet the domestic demand for durable and nondurable goods, have exposed them to price shocks which can be transmitted via trade in the form of a higher prices of imports.

Limitations on the data on price indexes prevent the analysis from covering all GCC member states. Such data are not available for Oman and the U.A.E[51] and are very limited for Qatar; notably none are available for the mid 1970's when inflation was sweeping the globe. Thus for Qatar, average inflation of about 3.84 percent was recorded over the years extending from 1979 to 1986, with a standard deviation of 2.79 percent. However, inclusion of the early years of 1970's may have affected the average rate of inflation in Saudi Arabia, which approached 5.83 percent, with a standard deviation of about 10.81 percent.

Looking at annual inflation rates, it might be expected that price indices (whether consumer price or producer price indices) would reflect the pattern of fluctuations in the prices of imported goods. Moreover, with the increases in oil revenues recorded in the last decade, the occurrence of a higher inflation rate might been expected in view of increasing aggregate demand, accompanied by limited domestic supplies. However, there are some possible reasons for observing

[51]The authorities in Oman will start publishing data on Consumer Price Index from 1990.

lower inflation rates in the GCC countries than those prevailing in the countries of their trading partners, or their counterparts among other oil exporting countries.

The average rates of inflation in Kuwait and Bahrain were 5.71 and 7.43 percent, respectively. However, as can be deduced from Table (17), the standard deviation of the inflation rate in Bahrain was more than twice that of the Kuwait. Nevertheless, the degree of variability in the Saudi inflation rate was higher than its counterparts in the other GCC countries. In fact, the Saudi's standard deviation was double the mean of standard deviations of all rates of the GCC member states for which data was available.

It may be argued that the consumer price index in most developing countries, including the sampled GCC's, does not respond to a similar index in an industrialized country. Several arguments can be presented to justify this phenomenon. In general, in the GCC member states, consumer foodstuffs are highly subsidized and many of them are rationed at government-controlled prices; however, the index includes these items. Moreover, the public sector provides many services free of charge, which nevertheless are included in the consumer price index. These services include free education at all levels and free medical care (although some countries have begun to charge nominal prices for the provision of the latter). In addition, the decisive role of the government as the owner and price setter of many important goods produced domestically, such as steel bars, flour and wheat has shifted financial resources to these sectors in order to subsidize prices. This policy is aimed at supporting the infant industries and depressing imports. Furthermore, it may be argued that the weights of the consumer price index (CPI) in these countries have changed little although consumption patterns have. All CPI's and their weights were developed during periods when these economies were starting to develop, where necessities seemed more important and were thus awarded greater weights. However, as manufactured goods, for which prices have risen, become more important to consumers, their weights remain biased downward in the CPI's; consequently, inflation rates are also biased. For example, the base year for measuring inflation in Qatar has been the CPI weights set in 1979, and 1978

Year	Bahrain	Kuwait	Qatar	Saudi Arabia
1972	4.80	n.a.	n.a.	4.44
1973	13.42	8.06	n.a.	15.29
1974	21.80	12.09	n.a.	19.38
1975	15.09	9.08	n.a.	29.58
1976	20.30	5.05	n.a.	27.54
1977	16.38	9.51	n.a.	10.74
1978	14.60	8.34	n.a.	-1.57
1979	2.200	6.74	n.a.	1.77
1980	3.77	6.72	6.61	3.66
1981	10.70	7.13	8.15	2.66
1982	8.52	7.44	5.55	-0.58
1983	2.92	4.64	2.75	-0.58
1984	0.32	1.14	1.09	-1.18
1985	-2.67	1.45	1.82	-3.34
1986	-2.32	0.96	1.63	-3.03
1987	-1.77	0.63	n.a.	-0.96
Geometric mean	7.43	5.71	3.84	5.83
S.D.	8.18	3.47	2.79	10.81

Data are not available for Oman and the U.A.E.
n.a.: Not available
S.D.: Standard deviation.

Table 17: Inflation rates in the GCC countries (1972-1987), %

in Kuwait.

Prices of imported goods are expected to be affected by the degree of pass-through of exchange rate fluctuations to the domestic market. This conclusion is strengthened by the nature of the market in which importers sell. Thus, facing low price elasticity for imports, a monopolist is expected to be able to shift prices to consumers more than a competitive supplier can. Field work was conducted to investigate this aspect of the problem. Results obtained from importers sampled reveal that about 81.8 percent of importers pass-through exchange rate fluctuations to the domestic market, where some have argued that their ability to engage in this behavior depends on the level of competition exhibited in the domestic market. Unfortunately, the lack of a consistent measure of prices has hidden the impact of the monopolistic feature of the GCC domestic economies, which, one may argue, should have resulted in higher domestic prices of imports, although it did not. These economies are characterized by a family-based enterprises, which tend to be authorized distributors of distinctive imported goods, and control a vast sector of the market share. It would not be uncommon to find a single importer engaged in importation of goods of a similar (or different) nature to be the sole and only distributor of these goods by law. The author's findings reveal that in the GCC economies, monopoly is protected by government legislation and in some cases it was found that a large number of these monopolists are themselves the authorized distributors of hundreds of imported goods, which can be of the same nature (such as several brand names of medical drugs). If the impact of this feature could be tested, it would show how the pass-through effect worked in one direction, raising prices, while declines in prices of imported goods have a tendency not to be passed to the domestic consumer[52].

Nevertheless, these factors, which have possibly contributed to price stability in the GCC member states, have also been assisted by changes in the economic

[52]It may be argued that, because of this feature and their ability to pass increases to domestic consumers, there is a less demanding incentive for importers to use any type of risk covering, since the latter involves costs. When asked about covering for possible risk in imports, about 70 of the sampled importers have shown no tendency to do that, whereas 21 percent have.

conditions at home. The domestic economies of the GCC member states have entered a stage of recession as a result of declining oil prices and revenues. This has greatly depressed housing rents and salaries, and reduced the price of land. Furthermore, as consumer spending declines, sellers have preferred to reduce their profit margins to accommodate increases in the prices of imports, rather than shifting the rises to consumers[53].

However, the potential price instability in the GCC should not be exaggerated. Instead, their imported rates of inflation should be related to those of countries from which they import most of their consumed goods. Inflation in the GCC countries may deviate from that of their trading partners only during the periods of oil booms, such as the period from 1975 to 1980.

C. Behavior of Money Supply

The rise in oil revenues from 1973 to 1980 has resulted in sharp increases in national income in the GCC member states. However, as sole owners of the oil resource, the domestic governments had the option of allocating the earned foreign exchange amongst the alternative domestic and foreign channels. A deviation from the theoretical implication that a rise in international reserves leads to an increase in domestic money supply was clearly recognized in these economies. It may be argued that the domestic governments did not have to issue any additional stock of the domestic currency in order to acquire the reserves. Reserves were simply earned from oil sales. Moreover, large quantities of the foreign exchange received were recycled abroad in the form of investment in the industrial countries, because the local financial sector was not capable of absorbing those sums of foreign exchange. Nevertheless, it can be said that holding of foreign reserves, instead of channeling them in the domestic market was essential to these countries in order to stabilize their currencies. (This is vital for countries which peg their currencies.)

Needless to say, the holding of international reserves by the GCC member

[53] *Gulf Economic and Financial Report*, vol. 3, no. 1 (Manama: Gulf International Bank. January 1988), p. 6.

Year	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
1972	18.35	n.a.	n.a.	36.09	33.92	n.a.
1973	12.55	8.29	3.93	15.70	30.09	n.a.
1974	38.08	24.41	60.34	29.99	36.19	98.37
1975	23.36	26.36	32.56	51.12	59.77	37.92
1976	50.03	31.42	33.28	43.62	51.00	64.16
1977	15.70	25.13	22.72	27.65	43.09	-7.52
1978	12.37	21.77	10.99	14.30	24.19	12.31
1979	2.33	12.85	6.54	9.18	12.83	3.60
1980	24.08	23.34	27.76	15.67	16.01	25.55
1981	33.21	30.22	32.69	34.82	28.51	21.23
1982	6.57	7.87	22.17	13.63	18.39	14.53
1983	7.75	4.33	17.81	-0.92	10.19	7.70
1984	-1.83	2.44	14.08	19.87	5.85	25.44
1985	8.73	-0.90	14.45	8.79	1.14	6.23
1986	-2.02	2.48	-7.59	10.59	8.84	4.29
1987	8.99	4.62	6.19	8.25	4.73	5.35
Geometric mean	14.26	13.49	17.28	18.53	20.65	18.48
S.D.	14.56	11.02	16.33	14.51	17.39	28.12

S.D.: Standard deviation.

Table 18: Money growth rates in the GCC countries (1972-1987), %

states did not mean that development plans were renounced. As oil revenue rose, government spending followed suit. Expenditure on housing, factories and services, as well as cash transfers were increased substantially. It is through this path that a proportion of international reserves led to rising growth rates of money.

Annual data on money supply, as measured by M2 (M1 plus quasi money, i.e. savings, time and all foreign currency deposits), are given in Appendix 1, while the annual growth rate of M2 is tabulated in Table (18). It is evident from the table that Bahrain and Kuwait have had the lowest average and the minimum standard deviation in money growth. For Kuwait, this stability may have contributed to the stability of the rate of inflation in the country, as tabulated in the previous section. However, if this argument is accepted, then it may be said that the instability incurred in Bahrain's inflation rate was not totally explained by the behavior of money supply in the country.

The rate of growth of money supply reached it's climax around the mid 1970's for all GCC member states. This was a direct result of increasing government spending as a way of raising personal income, and because of government commitments to establish the missing infrastructure. However, the highest mean rate of money growth and standard deviation of money were detected for the U.A.E, which may be attributed to the substantial rise in government spending in the earlier years of the boom in oil revenues.

Clearly, changes in money supply have been very sensitive to oil revenues and, consequently, to government spending. Hence it may be argued that money supply is affected to some extent by an exogenous variable, i.e. the earnings of foreign currencies from oil sales.

D. Behavior of Oil Revenues

The GCC economies depend on oil revenues as the major source of income; thus development plans tend to be influenced by changes in revenue. Although production is assumed to be constrained by agreements (such as those agreed upon by members of the Oil Producing and Exporting Countries, OPEC), or world demand, prices have demonstrated their ability to have a great impact on oil revenues.

Figures (4) to (9) reflect an upsurge in the dollar value of oil revenues during times when oil prices rose. This is evident in 1974, which reflects a high percentage change for all GCC member states; the highest value 172 percent was recorded for Saudi Arabia. Nevertheless, as international markets began to absorb the impact of the rise in prices and the 1973-1974 oil embargo, alternative sources of energy were sought and the ultimate emergence of producers outside OPEC released some of the pressures both on quantity produced and prices. Since then, the GCC's oil revenues have been fluctuating, although less than the rates recorded previously.

A partial recovery in revenues was reported in 1980, when the price of oil rose and reached more than \$ 30.00. This resulted mainly from the Iraq-Iran war. However, this rise was short lived, and when prices collapsed in 1986, a barrel of oil was sold for less than \$ 10.00. Undoubtedly, oil revenues have declined sharply since 1980, and are not expected to revive, at least not in the foreseeable future.

As Table (12), cited in Chapter V has shown, government budgets rely on oil revenues as a major source of income. However, in recent years, this source has not lived up to the expectations of the authorities in the GCC member states, forcing them to run deficits in their annual budgets, just when they were thought to be suppliers of funds. Even with these governments efforts to curb spending and to allocate funds more efficiently, deficits have persisted. A relationship between oil revenues, government spending and the situation of the budget, is depicted for each country in Tables (19) to (23).

Consider Bahrain, which is represented in Table (19). As oil revenues decreased in 1975, a deficit emerged in 1976. It seems that when there is a reduction in oil revenues in a particular year, its likely impact on government expenditure and the budget situation is experienced at a later date. This may be observed by examining the reductions which occurred in 1982 and 1983. Subsequent government

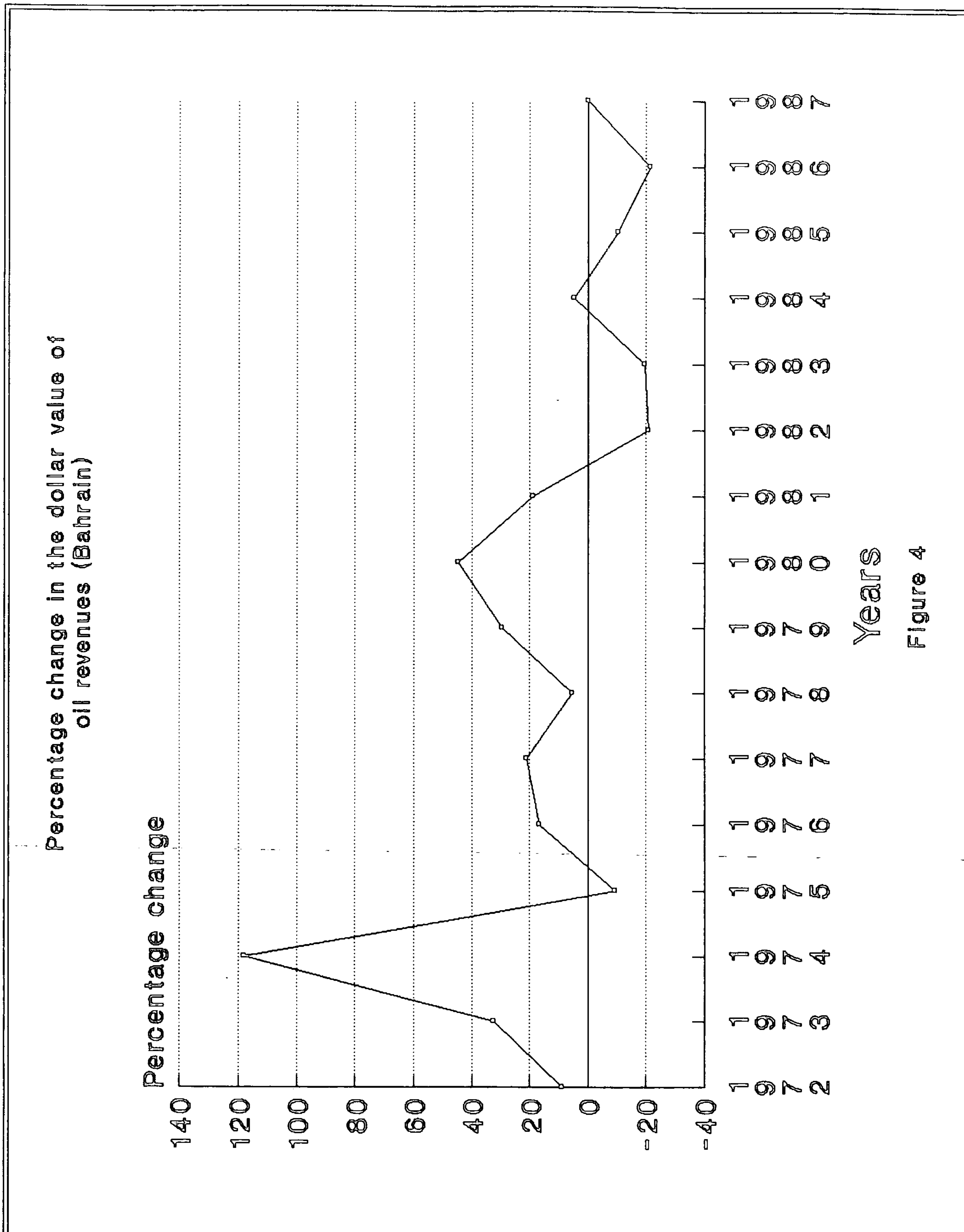

Percentage change in the dollar value of
oil revenues (Bahrain)
Percentage change
140
120
100
80
60
40
20
0
-20
-40
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
Years

Figure 4

Percentage change in the dollar value of oil revenues (Kuwait)

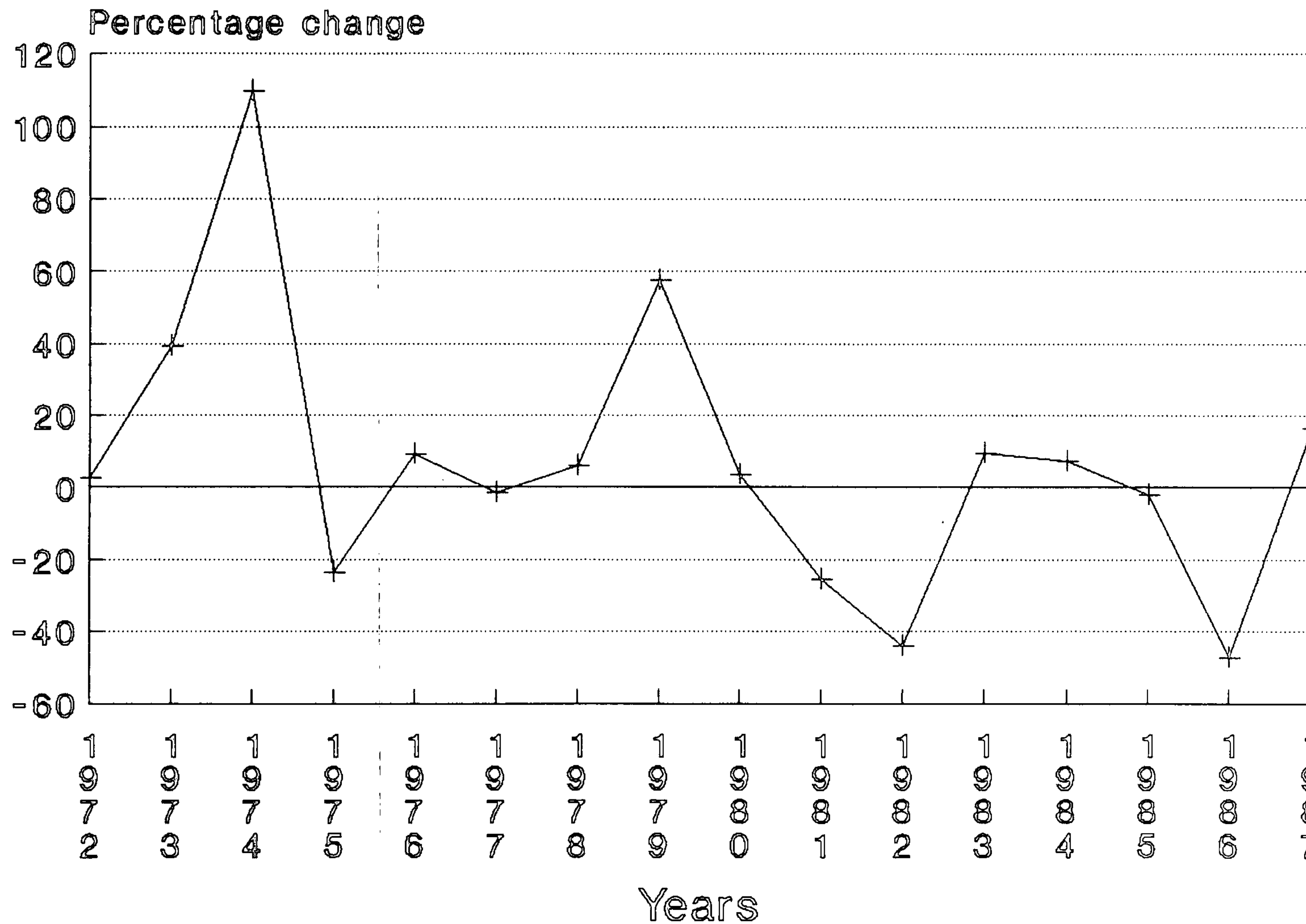


Figure 5

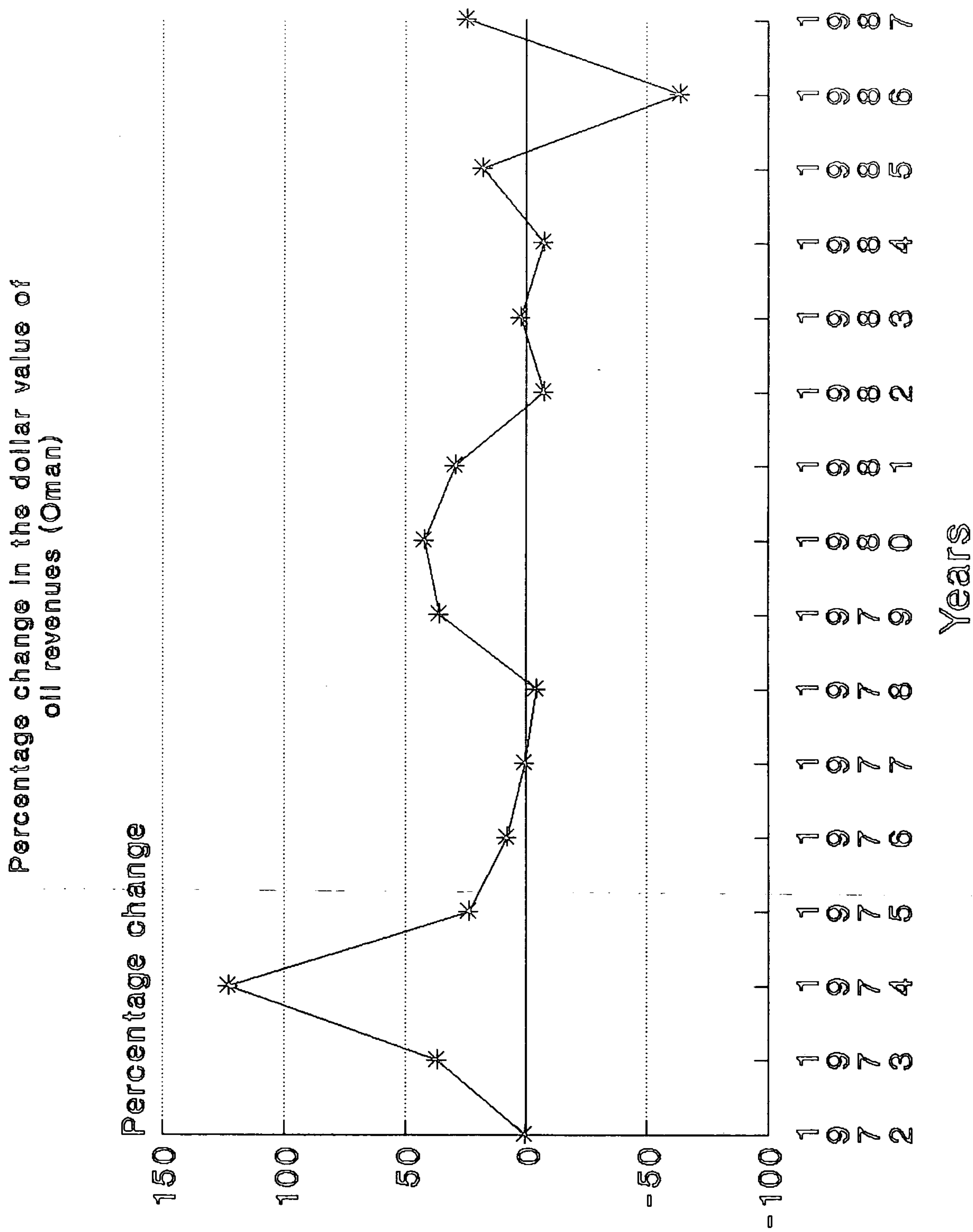
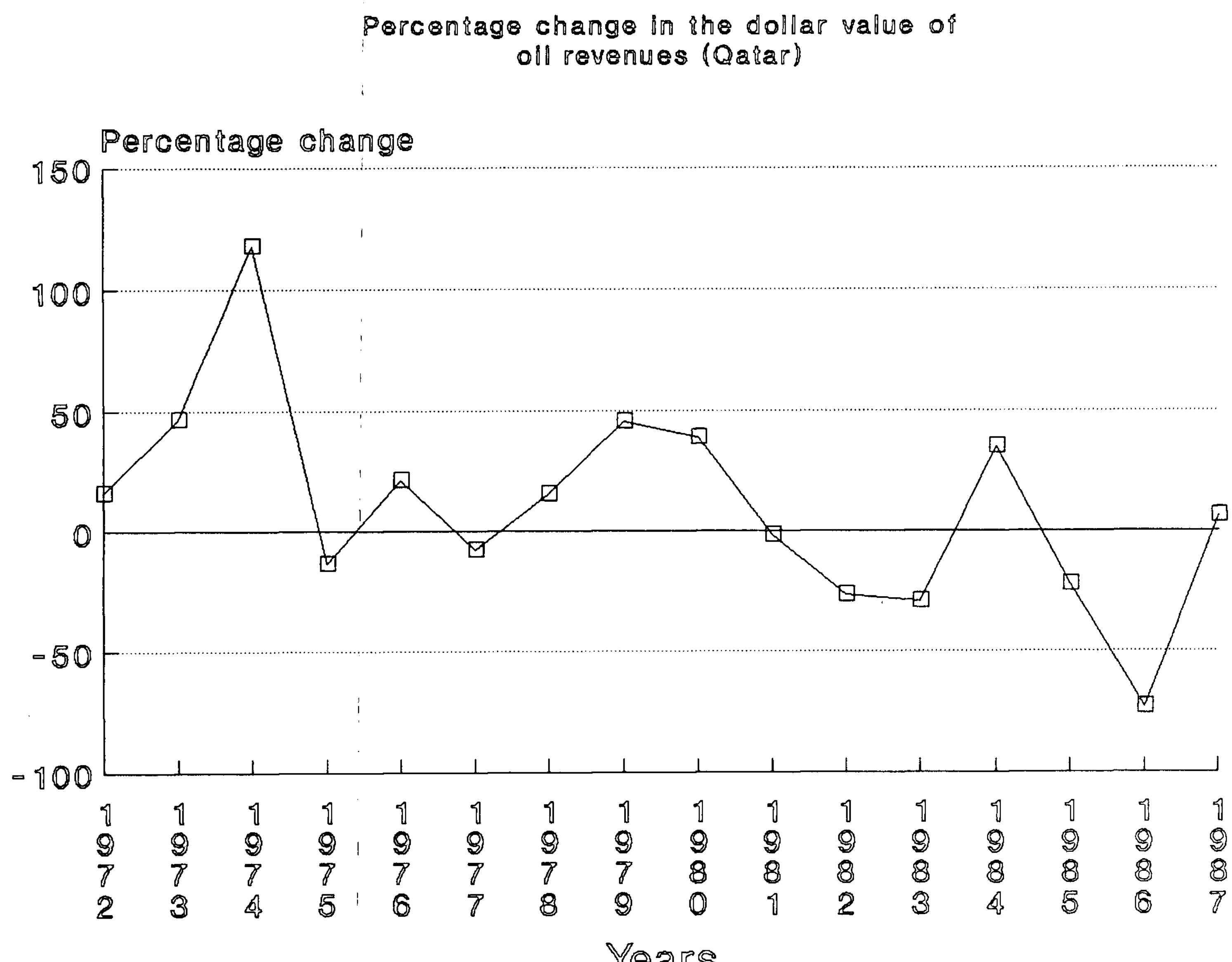
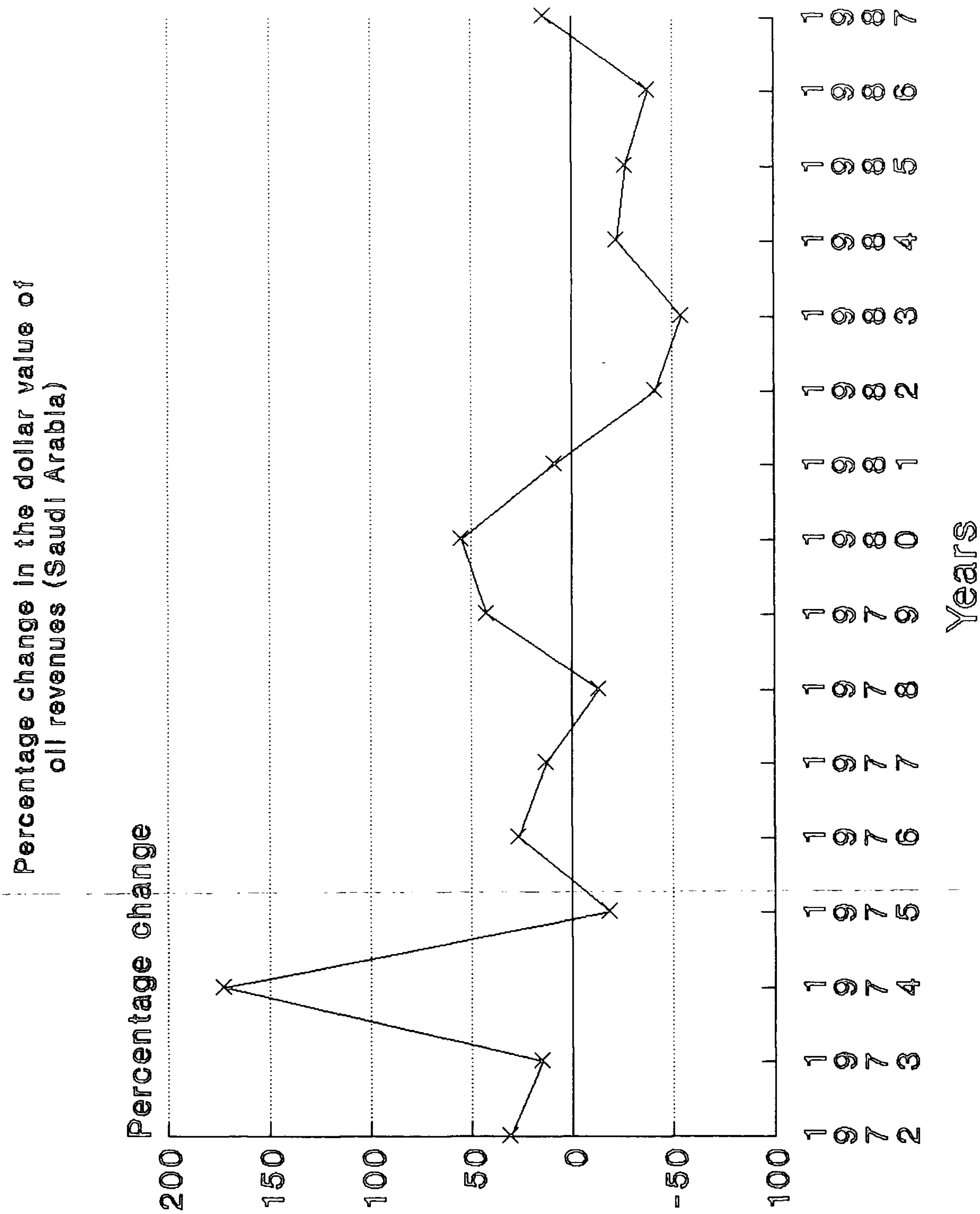

Percentage change in the dollar value of
oil revenues (Oman)
Percentage change
150
100
50
0
-50
-100
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
Years

Figure 6



Percentage change in the dollar value of
oil revenues (Qatar)
Percentage change
150
100
50
0
-50
-100
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
Years

Figure 7



Percentage change in the dollar value of
oil revenues (Saudi Arabia)
Percentage change
200
150
100
50
0
-50
-100
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
Years

Figure 8

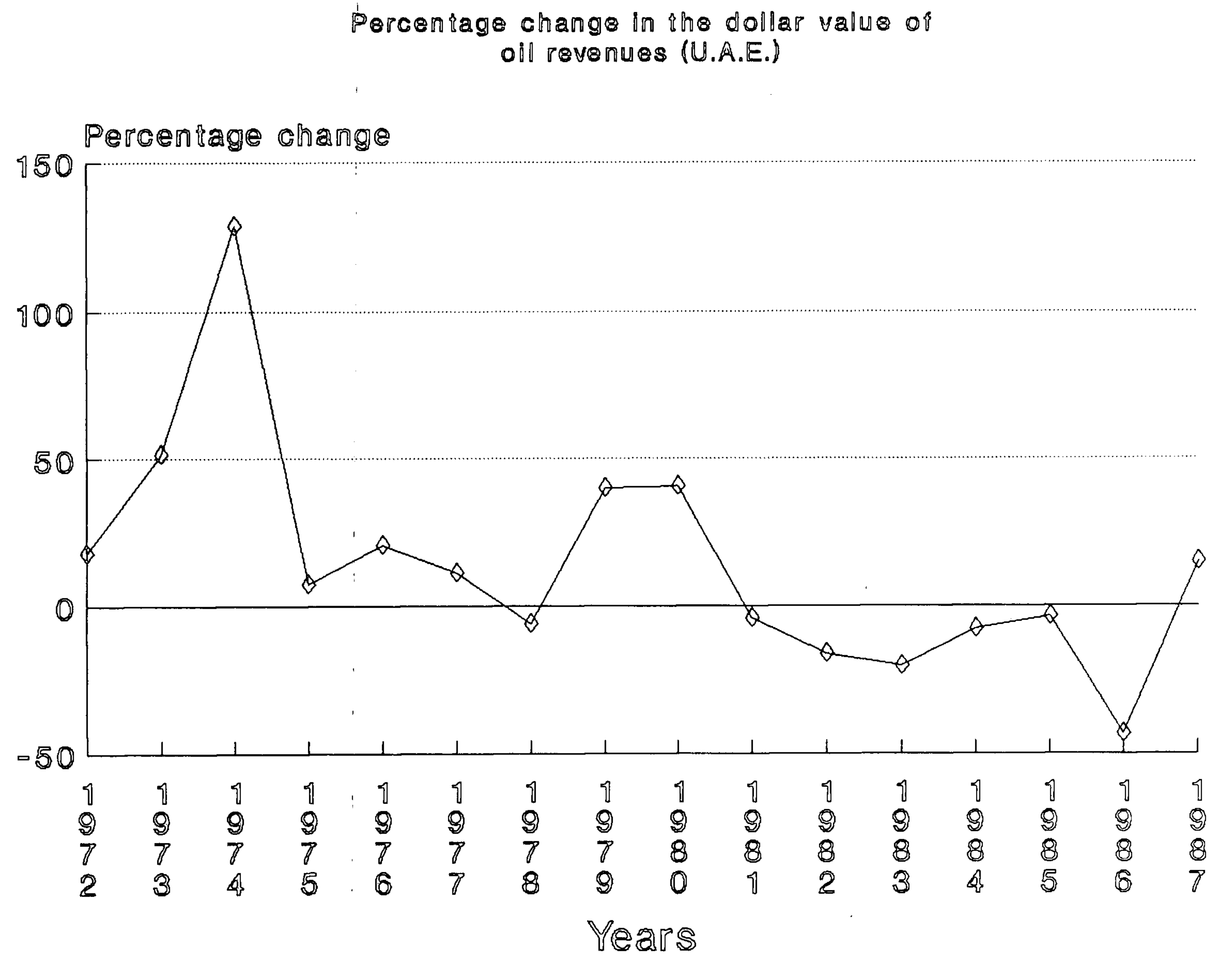

Percentage change in the dollar value of
oil revenues (U.A.E.)
Percentage change
150
100
50
0
-50
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
Years

Figure 9

expenditure achieved almost zero growth rate in 1984, with a deficit of about 15.6 million Bahraini dinar.

A rise in oil revenues recorded for Kuwait in 1979, resulted in large surpluses, although government spending rose. However, a contrasting effect of oil revenues on spending and the budget can be seen in 1980, 1981 and 1983. In 1981, the accumulated surpluses from past years helped to improve the budget situation, in spite of the reduction in oil revenues. However in 1982, just a year after a surplus of more than 3 billion Kuwaiti dinars, a deficit of more than 730 million dinars was evident. Similar behavior persisted, with the worst deficit emerging in 1986, when oil revenues slumped by more than 47 percent.

Table (21) reports the Omani situation, where development plans started late, as oil production began in the late 1960's. Thus, it is not be unlikely that deficits may persist, or increase at times when improvements or declines in oil revenues are smaller than those experienced by other GCC member states. For example, a decline of only 7.14 percent in 1982, accompanied by a rise of only 13.49 percent in government expenditures, resulted in a deficit of more than 175 million RO. The year 1986 proved to be the worst in terms of its impact on the budget situation. A reduction of more than 64 percent in oil revenues, which is substantial for any of the GCC economies, resulted in doubling the deficit to a record high. The short-lived revival in 1987 improved revenues and the deficit, although it was added to by the decline in government spending. The latter decline may be explained by the government's effort to retire some of its deficit, by shifting some of the rise in revenues to that direction.

As shown in Table (22), the comparative decline in oil revenues between 1980 and 1981 resulted in slicing the Qatari surpluses by more than half. Moreover, as oil revenues recorded downward trends, for example in 1986, government spending responded with almost no change, while more than half the annual budget was financed by debt.

The situation for Saudi Arabia is not much better. A surplus of more than 111

Year	% Oil revenues	% Govt. Exp.	Budget situation
1975	-9.56	51.64	16.70
1976	16.70	53.05	-4.20
1977	21.18	23.92	12.60
1978	5.27	16.25	-11.20
1979	29.51	-11.42	49.80
1980	44.88	22.02	128.50
1981	19.01	18.11	156.40
1982	-21.04	21.18	180.50
1983	-19.57	12.18	-44.60
1984	4.750	0.651	-15.60
1985	-10.48	-5.750	32.90
1986	-21.47	-2.670	-35.30
1987	-0.175	-16.92	-4.00

Source: Tables (41) and (42) in Appendix 1.
Figures for the budget situation are in millions
of the domestic currency.
Govt. Exp.: Government expenditures.

Table 19: The relationship between oil revenues and government's budget in Bahrain (1975-1987)

Year	% Oil revenues	% Govt. Exp.	Budget situation
1975	-23.62	13.98	1,887.0
1976	9.372	12.75	1,513.8
1977	-1.56	25.42	1,134.2
1978	5.98	-0.78	1,753.8
1979	57.64	22.059	4,544.6
1980	3.720	19.91	3,187.8
1981	-25.40	22.05	988.0
1982	-43.94	1.501	-735.0
1983	9.702	-5.63	-936.4
1984	7.382	4.732	-673.0
1985	-2.205	-19.65	-717.1
1986	-47.46	-12.49	-1,014.2
1987	16.468	-6.516	-2.70

Source: Tables (41) and (43) in Appendix 1.
Figures for the budget situation are in millions of the domestic currency.
Govt. Exp.: Government expenditures.

Table 20: The relationship between oil revenues and government's budget in Kuwait (1975-1987)

Year	% Oil revenues	% Govt. Exp.	Budget situation
1975	23.65	34.82	-36.20
1976	8.185	16.64	-75.70
1977	0.425	-10.17	78.40
1978	-4.28	0.200	-51.10
1979	35.90	9.572	103.7
1980	42.17	37.04	34.20
1981	29.41	25.71	97.90
1982	-7.14	13.49	-175.30
1983	2.497	10.60	-183.70
1984	-7.32	13.75	-286.60
1985	18.18	14.26	-333.5
1986	-64.01	-8.67	-692.20
1987	24.80	-17.67	-130.70

Source: Tables (41) and (44) in Appendix 1.
Figures for the budget situation are in millions of the domestic currency.
Govt. Exp.: Government expenditures.

Table 21: The relationship between oil revenues and government's budget in Oman (1975-1987)

billion SR in 1980 has vanished within two years, and was replaced by a deficit of more than 23 billion SR. It is not a coincidence that oil revenues had shown their worst decline in 1983, with a reduction of more than 54 percent. Since then, with the exception of 1987, expenditure has declined continuously, although not by enough to prevent the budget from registering deficits of more than 60 billion Saudi riyals.

Table (24) depicts similar findings for the United Arab Emirates, where a close relationship between oil revenues, government spending and the budget situation is evident. Although the authorities continued in 1981 to benefit from the rise in oil revenues in 1980, as both government spending and the budget increased a year later because oil revenues declined by about 16 percent, the balance of the budget was almost reversed and a deficit of more than 3.87 billion dirhams was recorded.

Consequently, oil revenues are important in terms of their impact on both government expenditures and the budget situation, where the latter would affect the reserve, and can generate public debt as a means of financing expenditure.

Financing deficits has been accomplished either through domestic borrowing, drawing from reserves, or through international borrowing. However, with increasing pressure on the domestic currencies, there has been little attempt to finance the deficits through money creation. The mid 1980's have witnessed the introduction of government bonds and treasury bills in most of the GCC member states. It is known that Kuwait and Saudi Arabia are leading the stage in public borrowing. It may be argued, however, that if no limit is set and strictly enforced on the maximum amount of outstanding borrowing, the stage could be set for a spiral of increases, where at a time of maturity of a certain amount of debt, new bonds are issued to repay the outstanding loans, and spending is expanded further. So far, the authorities have found a means of financing spending, with debt being transferred across generations. However, one may dispute the potential impact of this behavior on wealth (Barro 1974).

Year	% Oil revenues	% Govt. Exp.	Budget situation
1975	-13.33	101.0	1,833
1976	21.13	9.132	3,118
1977	-7.68	23.09	837.0
1978	15.65	-12.26	1,752
1979	45.74	24.49	3,820
1980	39.08	27.95	8,066
1981	-1.79	29.86	4,500
1982	-26.49	-15.55	815.0
1983	-29.20	19.59	-6,439
1984	35.00	-23.18	1,437
1985	-22.30	-15.99	19.00
1986	-72.84	0.567	-4,549
1987	6.493	15.78	-5,572

Source: Tables (41) and (45) in Appendix 1.
Figures for the budget situation are in millions
of the domestic currency.
Govt. Exp.: Government expenditures.

Table 22: The relationship between oil revenues and government's budget in Qatar (1975-1987)

Year	% Oil revenues	% Govt. Exp.	Budget situation
1975	-18.94	63.35	65,064
1976	26.71	84.76	13,257
1977	12.86	26.75	14,331
1978	-13.27	4.154	9,007
1979	42.32	52.33	23,200
1980	54.99	22.99	111,500
1981	8.506	18.50	83,300
1982	-41.27	-15.51	2,460
1983	-54.69	-5.74	-23,768
1984	-22.55	-6.19	-44,853
1985	-26.39	-16.20	-50,439
1986	-37.67	-29.17	-60,944
1987	14.064	23.312	-60,715

Source: Tables (41) and (46) in Appendix 1.
Figures for the budget situation are in millions of the domestic currency.
Govt. Exp.: Government expenditures.

Table 23: The relationship between oil revenues and government's budget in Saudi Arabia (1975-1987)

Year	% Oil revenues	% Govt. Exp.	Budget situation
1975	7.281	45.50	616.0
1976	20.63	61.68	958.0
1977	11.15	86.02	927.0
1978	-5.942	29.61	-1,148
1979	39.99	17.66	731.0
1980	40.72	49.43	4,276
1981	-4.28	33.65	3,794
1982	-16.19	6.802	-3,879
1983	-20.36	-20.29	-2,483
1984	-7.819	-4.00	-2,842
1985	-3.519	1.708	-414.0
1986	-43.67	-17.59	-551.0
1987	14.962	-0.826	-1,984

Source: Tables (41) and (47) in Appendix 1.
Figures for the budget situation are in millions of the domestic currency.
Govt. Exp.: Government expenditures.

Table 24: The relationship between oil revenues and government's budget in the U.A.E. (1975-1987)

E. Exchange Rates, Inflation Rates, and Money Supply in Industrial Countries

Economic changes in the industrial countries have many implications for the economies of the GCC member states. In general, appreciation or depreciation of the currencies of the former countries can affect the GCC member states' wealth and their expected stream of income, denominated in the currencies of their trading partners[54]. For example, appreciation of the dollar against the other partners' currencies will raise the relative value of wealth held in dollars, while lowering that of wealth denominated in the depreciating currencies. Moreover, pegging the domestic currency to the currency of a trading partner will inflict losses or gains in the relative price of the domestic currency in terms of a third currency, whenever this latter currency's price changes in terms of the dollar. In addition, since exchange rate changes can affect the price of exports and imports, they are of importance to the GCC member states which export to, and most importantly, import from the six industrial countries considered in the present model. Consequently, terms of trade can be affected by changes in exchange rates amongst industrial countries.

Over the sampled periods, as Table (25) reveals, the dollar has depreciated on average against the mark, yen and the International Monetary Fund basket, the SDR. However, its biggest relative loss was against the Japanese currency, where it depreciated by about 5.84 percent. In contrast, the dollar appreciated against the Italian lira by about 4.23 percent, and against the British pound by 1.94 percent. Furthermore, the U.S. currency recorded gains against the French franc and the European unit of account of about 0.14 and 1.26 percent, respectively.

Measurement of the possible risk present in these exchange rates reveals that the standard deviation of the SDR price of the dollar was the lowest. This is explicable by the fact that the SDR basket is weighted heavily in terms of the U.S. dollar. On the contrary, the most volatile exchange rate was that of the ECU against the dollar. This can be justified if we look at variations in the sampled

[54]Such potential consequences were discussed in Chapter IV.

Exchange rate	Average change	Standard deviation
E(ff/\$)	0.1366	14.60
E(dm/\$)	-4.537	14.13
E(ll/\$)	4.233	14.06
E(yy/\$)	-5.849	14.13
E(uk/\$)	1.939	14.83
E(SDR/\$)	-1.67	7.38
E(ECU/\$)	1.262	18.09

ff (franc), dm (mark), ll (lira), yy (yen), uk (pound), SDR (SDR) and ECU (ECU).

Table 25: Average change and standard deviation amongst exchange rates of major industrial currencies, the SDR and the ECU baskets vis-á-vis the dollar (1971-1987), except for the ECU (1979-1987), %

European currencies against the dollar. These variations are partially embodied in the variability of the ECU-dollar exchange rate, since these currencies are weighted in the ECU accordingly.

Inflation rates in the trading partners of the GCC member states may produce changes similar to those seen for the exchange rates. Rising prices in Italy, for instance, will put an upward pressure on export prices; hence imports of the GCC member states from Italy may experience price rises. These rises can add to the inflation rate imported by the GCC member states.

The strong German currency has contributed to the low inflation rates experienced in Germany. Table (26) shows that Germany recorded an average rate of inflation of about 3.88 percent and a standard deviation of only 2.12 percent. Examining the average rates for the other countries, it is clear that the Italian and the British rates were the highest. However, there was less dispersion in these rates than was experienced by Japan, where the Japanese rate of inflation averaged 6.35 percent, with a standard deviation of about 7.09 percent.

The relevance of foreign money supply to the GCC member states is embodied in the implied effects that changes in the money supply have on inflation and exchange rates in the industrial countries. Changes in money supply have a direct effect on interest rates in both groups of countries due to the need to remain competitive. Likewise, money growth is linked to changes in prices. It is widely acknowledged by the main stream schools of economic thought, Monetarists, Keynesians and Rational Expectationists, that expansionary monetary policy will cause the price level to rise, thus generating inflation. Consequently, this inflation can be transmitted to the GCC member states via trade. Realizing these potential impacts, Table (27) summarizes the behavior of money supply in the six industrial countries sampled in the model.

The growth rates of money in Italy, France and the U.K. were above the average for the group. Moreover, the variance of these rates has been relatively large, with the U.K. taking the lead; its growth rate averaged about 14 percent, even when

Year	France	Germany	Italy	Japan	U.K.	U.S.
1972	5.99	5.46	5.75	4.74	7.00	3.40
1973	6.91	6.71	10.30	11.07	8.82	5.92
1974	12.90	6.67	17.38	20.81	14.64	10.38
1975	11.10	5.77	15.66	25.24	21.77	8.79
1976	9.24	4.29	15.56	8.95	15.38	5.65
1977	8.87	3.55	15.67	7.86	14.64	6.30
1978	8.78	2.66	11.48	4.10	7.93	7.33
1979	10.13	4.08	13.75	3.62	12.68	10.64
1980	12.55	5.23	19.23	7.47	16.48	12.66
1981	12.57	6.10	16.38	4.78	11.24	9.89
1982	11.16	5.13	15.24	2.72	8.23	5.89
1983	9.18	3.25	13.67	1.92	4.50	3.19
1984	7.14	2.39	10.26	2.16	4.83	4.21
1985	5.60	2.17	8.78	2.02	5.89	3.42
1986	2.50	-0.24	7.09	0.60	3.40	1.92
1987	3.28	0.24	4.63	0.08	4.08	3.54
Geometric mean	7.56	3.88	11.75	6.35	9.51	6.20
S.D.	3.18	2.12	4.36	7.09	5.36	3.20

S.D.: Standard deviation.

Table 26: Inflation rates in industrial countries (1972-1987), %

Year	France	Germany	Italy	Japan	U.K.	U.S.
1972	17.81	13.13	16.49	22.06	24.57	12.15
1973	13.68	8.42	21.06	15.55	24.34	6.34
1974	16.41	6.97	14.61	10.89	12.17	5.23
1975	14.62	10.83	21.87	13.50	6.89	11.94
1976	11.58	7.28	10.07	12.66	10.94	12.81
1977	21.51	9.84	20.06	10.52	9.07	10.04
1978	10.69	9.76	20.73	12.30	13.58	7.42
1979	12.18	5.02	16.44	8.05	11.77	6.01
1980	7.48	4.45	12.78	6.62	16.94	6.81
1981	9.98	3.61	9.70	10.19	24.49	4.55
1982	10.11	6.65	16.23	7.30	10.76	8.36
1983	10.38	5.54	12.83	6.66	12.05	15.09
1984	7.88	5.45	10.23	6.68	11.69	8.67
1985	6.01	7.72	9.91	8.49	10.70	9.13
1986	6.05	6.31	7.82	8.88	20.31	8.61
1987	14.38	5.80	6.47	10.57	19.04	3.64
Geometric mean	11.19	7.02	13.19	10.09	13.82	8.18
S.D.	4.25	2.55	4.99	4.02	5.83	3.21

S.D.: Standard deviation.

Table 27: Money growth rates in industrial countries (1972-1987), %

Italy was considered. In contrast, the monetary authorities in Germany have implemented a restrictive money supply rule compared to the other countries, if variance in the money growth rates is used as well as the average rate of growth, as a measure. German money growth averaged 7.02 percent, and the standard deviation in this rate was 2.55 percent. Accordingly, it may be argued that the U.S. has followed a similar monetary rule to that adopted by Germany, where the U.S. rate averaged about 8.18 percent, with a standard deviation of only 3.21 percent. These rates may be compared to the rates of real economic growth in the industrial countries, as measured by their respective gross domestic product or gross national product. Table (30) in Appendix 1 shows the annual real growth rates for the six industrial countries over the sampled years. In general, Japan recorded the highest average rate of growth compared with the other industrial countries, averaging about 4.21 percent. On the other hand, the U.K. growth rate was the lowest, averaging 2.03 percent. However, the most stable rate was that of France, which had a standard deviation of 1.45 percent. The German real growth rate of output has kept itself within the general average of all the countries, averaging 2.14 percent, with a standard deviation of 1.96 percent.

In summary, the increasing openness of the economies of the GCC member states since the early 1970's has enhanced the interactions between these economies and the industrial countries. It also revealed the importance of the choice of the exchange rate regime followed by the GCC member states . Therefore, empirical testing of the model will incorporate some of potential effects of policies in the more advanced countries on the Gulf economies.

VI.2. Alternative Single Currency Invoicing of Oil

Assuming that oil can be invoiced in a foreign currency, the domestic currencies of the GCC economies may be pegged to a single currency, either the same currency in which oil is invoiced or another currency, or may be fixed in terms of a basket of currencies. Aside from fluctuations in demand for and supply of oil, which affect quantity and price, oil revenues are received in a foreign currency(s), thus introducing an element of exchange risk. This risk is measured by the variance in the exchange rate between the domestic currency of each of the GCC member states and the currency(s) in which oil is invoiced. It is only when the currency(s) of invoicing and pegging coincide that the exchange risk factor is eliminated. However, as we have stressed before, if the authorities in the GCC economies are concerned about the purchasing power of their oil revenues, then the variances in the exchange rates between the currencies of the GCC economies and those of their trading partners, must be examined.

Assume that oil is invoiced in a single currency, j, where $j \neq h$. Then the variance which would need to be minimized is

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + \sigma^2_{e_{h/j}} + [\sigma^2_{p_j}]. \tag{69}$$

It can be implied that if the domestic currency, h, is pegged to currency j in which oil is invoiced, the variance of the exchange rate between h and j vanishes. Although data on nominal value of oil revenues in any currency can be found by using the exchange rate factor, it is the right-hand-side bracket which requires estimating.

There are six possible single currency pegs or invoicing schemes available in the present analysis. The following estimation examines every combination of these currencies. However, the analysis begins by examining the performance of each single currency peg alternative, then uses those results to substitute for the variance of the price level in the above equation.

A. Single Currency Pegs

As indicated in the previous chapter, the choice of a peg will be assessed according to the contribution of each alternative currency peg to the standard deviation in the rate of inflation that the domestic country expects to import.

Based on the rate of inflation in country j, the basic equation of the domestic inflation rate, assuming the GCC member states peg to a single currency, may be expressed as:

$$p_h = p_j - \sum_{i=1}^{5} \alpha_i \xi_{ji}. \tag{70}$$

Accordingly, the variance in this rate can be of the form

$$\sigma^2_{p_h} = \sigma^2_{p_j} + \sum_{i=1}^{5} \alpha_i^2 \sigma^2_{\xi_{ji}} \tag{71}$$

where

p_h =domestic inflation rate

p_j = inflation rate in country j

α_i = trade share with country i

ξ_{ji} = deviations from purchasing power parity

$\sigma^2_{p_h}$ = variance in the domestic inflation rate

$\sigma^2_{p_j}$ = variance in country j's inflation rate

$\alpha_i^2\sigma^2_{\xi_{ji}}$ = weighted variance of deviations from purchasing power parity, $j \neq i$.

The results of the empirical estimation of equation (71) are provided in Tables (28) and (29). It is worth noting that the choice of peg is affected by: a) the rate of inflation in the country to whose currency the domestic currency is pegged; b) the adjusted trade shares (Tables (5) to (10), in Appendix 1), whether import shares or total trade shares are used; c) deviations in exchange rates from purchasing power parity, as estimated for this peg in Table (11) in Appendix 1.

Based on the standard deviation in inflation rates in the industrial countries, the French franc has emerged as the optimal choice of peg for Bahrain, whether total trade or import shares are considered. During the periods sampled, France maintained a more stable rate of inflation, although the average rate was higher than that of Germany, the U.S. or Japan. The standard deviation of the Japanese inflation rate was 7.09 percent, whereas it was only 3.18 percent for France. The ability of the franc to provide an optimal currency peg compared to the mark may be attributed to the fact that the weighted deviations from purchasing power parity between the mark and the yen were much higher than those between the franc and the yen. This has affected the suitability of the mark, although by

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
Dollar	9.27 (6.86)	9.70 (7.49)	10.61 (9.77)	10.77 (9.80)	9.06 (6.22)	10.95 (10.41)
Yen	3.43 (8.61)	3.85 (8.23)	4.76 (7.92)	4.93 (7.53)	3.21 (8.71)	5.11 (7.44)
Franc	9.41 (6.40)	9.83 (6.51)	10.75 (8.03)	10.91 (8.11)	9.19 (6.27)	11.09 (8.74)
Mark	4.74 (6.49)	5.16 (6.62)	6.07 (8.55)	6.24 (8.53)	4.52 (6.34)	6.42 (9.21)
Lira	13.51 (8.08)	13.93 (7.95)	12.52 (10.16)	15.01 (10.30)	13.29 (7.23)	15.19 (10.99)
Pound	11.21 (7.99)	11.64 (8.25)	12.55 (9.43)	12.71 (9.81)	11.00 (7.99)	12.89 (10.40)

α_i = total trade shares
Standard deviations in parenthesis.

Table 28: Mean and standard deviation of the imported weighted inflation under alternative single currency pegs (1971-1987), %

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
Dollar	8.53 (6.30)	9.52 (7.06)	8.98 (8.00)	9.20 (7.07)	8.76 (5.94)	9.31 (7.02)
Yen	2.69 (9.27)	3.67 (8.25)	3.13 (9.52)	3.35 (8.64)	2.91 (8.90)	3.47 (8.48)
Franc	8.67 (5.95)	9.66 (6.29)	9.11 (6.01)	9.34 (5.48)	8.90 (6.00)	9.45 (5.79)
Mark	4.00 (6.06)	4.98 (6.33)	4.44 (6.78)	4.67 (5.71)	4.23 (6.05)	4.78 (5.95)
Lira	12.77 (7.54)	13.75 (7.97)	12.52 (7.82)	13.44 (7.23)	13.00 (7.42)	13.55 (7.43)
Pound	10.47 (7.41)	11.64 (8.05)	10.92 (6.56)	11.14 (6.96)	10.70 (7.63)	11.25 (7.30)

α_i = import shares
Standard deviations in parenthesis.

Table 29: Mean and standard deviation of the imported weighted inflation under alternative single currency pegs (1971-1987), %

only a small amount, as can be seen from Table (29). Furthermore, the mark has fluctuated against the dollar more than the franc, which added to the rise in the domestic inflation rate in the pegging country when the equation was estimated for the mark. The lira and the pound did not fulfill the optimality criterion basically because of the increasing variability in the inflation rate in Italy and the U.K., as well as their greater fluctuations relative to all other currencies of the industrial countries. Moreover, if trade shares, whether total or import, are examined, it is found that Bahrain's trade with France is very limited compared to that with the U.S., the U.K. and Japan. However, as explained earlier, this has done little to reduce the optimality of the franc peg.

Estimation of the model for Kuwait promotes further the use of the franc as a single currency to which the Kuwaiti dinar might have been pegged. As a result of smaller deviations from purchasing power parity and low variance in the French inflation rate, the Kuwaiti rate of inflation would have experienced a standard deviation of 6.51 and 6.29 percent, using total trade and import shares, respectively. It was found from calculations involved in the estimation that the most important factor that may have reduced the optimality of the mark was the level of deviation from purchasing power parity between the mark and the yen on the one hand, and the mark and the lira on the other, weighted by their respective trade shares. Nevertheless, it is worth mentioning that the pound and the yen have failed to meet the optimality condition due to the large variations in their own rates of inflation, and the pound has experienced deviations from purchasing power parity. In fact, had the Japanese rate of inflation been stable, it would have provided the optimal single currency peg for Kuwait.

A peg to the yen proved to be optimal for Oman when total trade shares were used. This was aided by the large share of trade conducted between Oman and Japan; about 57 percent of Oman's trade in 1986. Consequently, the standard deviation in the domestic rate of inflation was low once equation (71) was estimated for the yen. Evidently, the large total trade share had a negative effect on total weighted deviations from purchasing power parity, which in turn would have reduced variability in the imported domestic rate of inflation had the RO been pegged to the yen. In spite of importing about 43 percent of total imports from the U.K., the pound would have not provided the optimal currency peg for Oman, when import shares were substituted in the estimated equation. The U.K. rate of inflation had a large standard deviation, which favored a more stable currency, in this case the franc.

The question of the choice of the optimal single currency peg for Qatar exhibited a similar pattern to that found for Oman. Considering total trade shares, the yen gave rise to the lowest standard deviation in the domestic inflation rate, while the franc was the favored currency when import shares were used. The standard deviation in the former case was 7.53 percent declining to about 5.48 for the latter. This is basically due to the substantial decline in the share of imports from Japan compared to the total trade conducted with Japan for the same period. The share of trade, total and import, with Japan would affect the standard deviation in the domestic inflation rate if the dollar was adopted as a single currency peg. Deviations from purchasing power parity between the U.S. and Japan were large; moreover, when trade-weighted deviations were considered, the dollar's optimality declines.

The consequences of these weighted deviations and the major role trade shares can play are clearly evident in the choice of the single currency peg for Saudi Arabia. Considering the low variability in the U.S. rate of inflation and the relatively smaller shares of Japanese trade with Saudi Arabia, a dollar peg would have provided an optimal peg. Consequently, had the Saudi riyal been pegged to the dollar, variability in the domestic rate of inflation would have been about 6.22 and 5.94 percent, using total trade and import shares, respectively.

Furthermore, the Japanese yen emerged as the optimal choice for the U.A.E., using total trade shares, despite the less stable inflation rate in Japan. This result was a consequence of the large share of total trade conducted between the U.A.E. and Japan. However, the sensitivity of this result can be seen when import shares were used. Estimation of equation (71) for the latter case led to abandoning the yen in favor of the franc. Once import shares were used, standard deviation in the domestic inflation rate was found to be 5.79 and 8.48 percent, with the franc and the yen pegs, respectively.

Thus the results of the estimation of equation (71) reflect the crucial role deviations from purchasing power parity can play. This claim is supportive for the franc which proved to be an optimal choice in many cases. In addition, the variability in the rate of inflation in the industrial countries emerged as an important source of variations in the inflation rates in the GCC member states.

As argued in Chapter III, a unified peg chosen by a group of countries may promote trade among them. However, the findings in the present chapter do not provide a unique single currency to which the GCC member states could have pegged their currencies, and continue to meet the requirement of the optimality criterion. Needless to say, there is no single currency peg that is optimal under the alternative trade shares, when inflation in the industrial countries is considered. The one exception is the dollar for Saudi Arabia.

These findings may also be substituted in equation (69) for the variance of the real value of oil revenues, where the estimation is restricted, at this stage, to oil being invoiced in a single currency[55].

2.1. Invoicing and Pegging to the Same Currency

Consider the case where oil is invoiced in the same currency to which the domestic currency is pegged. Results of the estimation of equation (72) are reported in Tables (30) to (35). However, under the above mentioned invoicing and pegging scheme, standard deviations can be read from each table where the currency of invoicing coincides with the currency of pegging.

[55]Note that total trade shares equal the percentage of total trade conducted with each of the trading partners, with no regard to the currency invoicing of that trade. Lipschitz (1979) has argued that a peg may be chosen according to the total trade invoiced in a currency. Some estimation of this alternative is provided in Appendix VI.A at the end of the present chapter.

The equation to be estimated is

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + \sigma^2_{p_j} + \sum_{i=1}^{5} \alpha_i^2 \sigma^2_{\xi_{ji}} \tag{72}$$

where

j = currency in which oil is invoiced, and to which the domestic currency, h, is pegged

i = currencies of the trading partners, however $j \neq i$.

For Bahrain, the dollar provided the least amount of variability with a standard deviation of about 34.9 percent, considering total trade, and 34.78 percent, if import weights were used to weight movements from PPP. On the contrary, the Japanese yen yielded the least stable standard deviation of about 50 percent. For Kuwait, the pound demonstrated the smallest contribution to the variance of the Kuwaiti dinar real value of oil revenues, where the standard deviation would have been about 37.90 percent. However, the yen has continued to introduce the largest standard deviation, which reached about 45.26 percent. The dollar provided the optimal currency for both pegging and invoicing for Oman, Qatar and the U.A.E. For Oman, it contributed about 39.42 and 39.02 percent, considering total and import weights, respectively. This can be compared to the yen, which would have resulted in a standard deviation of about 46 percent. For Qatar, the dollar remained the optimal choice; the yen would have increased variations in the domestic currency real value of oil revenues by more than 50 percent. Measuring the optimality of the dollar for the United Arab Emirates gave a standard deviation of about 40 percent, which was slightly lower than that which would have resulted from the adoption of a pound pegging and invoicing alternative. The pound yielded an optimal choice for pegging the Saudi riyal, as well as invoicing Saudi oil. Using total weights, the lira would have resulted in large deviations, whilst the yen would have been the least optimal choice had import weights been used.

A major factor that has contributed to the results was the covariance between oil revenues expressed in terms of the numeraire, and the exchange rates between

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	37.31	38.67	41.84	46.36	54.22	40.89
import	37.23	38.63	41.50	45.97	54.19	40.36
Mark						
total	37.44	39.24	42.82	47.07	54.41	41.46
import	37.37	39.20	42.49	46.69	54.38	40.94
Lira						
total	41.38	43.81	46.31	51.68	57.67	45.35
import	41.32	43.78	46.00	51.33	57.64	44.87
Yen						
total	51.03	46.80	47.60	52.51	60.18	47.77
import	50.98	46.77	47.30	52.17	60.15	47.32
Pound						
total	37.36	38.71	40.89	46.64	54.11	41.21
import	37.29	38.68	40.54	46.26	54.08	40.68
Dollar						
total	37.74	41.42	41.67	46.12	55.88	42.66
import	37.67	41.39	41.32	45.73	55.85	42.16

total and import refer to α_i.

Table 30: Standard deviation of the domestic currency's real value of oil revenues with a peg to the franc and alternative single currency invoicing (1971-1987), %

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	37.88	39.22	42.43	46.88	54.61	41.49
import	37.81	39.17	42.11	46.45	54.58	40.89
Mark						
total	36.90	38.72	42.43	46.70	54.04	41.05
import	36.82	38.67	42.11	46.27	54.00	40.45
Lira						
total	41.95	44.35	46.90	52.19	58.08	45.95
import	41.89	44.31	46.61	51.81	58.05	45.41
Yen						
total	51.03	46.80	47.67	52.56	60.18	47.85
import	50.98	46.76	47.39	52.18	60.15	47.33
Pound						
total	37.93	39.27	41.50	47.16	54.51	41.81
import	37.86	39.22	41.17	46.73	54.47	41.21
Dollar						
total	37.58	41.28	41.61	46.05	55.76	42.60
import	37.51	41.23	41.28	45.61	55.73	42.02

total and import refer to α_i.

Table 31: Standard deviation of the domestic currency's real value of oil revenues with a peg to the mark and alternative single currency invoicing (1971-1987), %

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	39.08	40.34	43.59	47.96	55.35	42.75
import	38.97	40.34	43.11	47.40	55.38	41.97
Mark						
total	39.27	40.94	44.59	48.70	55.59	44.35
import	39.17	40.95	44.12	48.15	55.61	42.59
Lira						
total	40.32	42.77	45.52	50.99	61.38	44.60
import	40.21	42.77	45.05	50.46	56.84	43.86
Yen						
total	51.90	47.71	48.67	53.50	60.83	48.91
import	51.82	47.71	48.24	53.00	60.85	48.23
Pound						
total	38.48	39.75	42.08	47.71	54.79	42.46
import	38.37	39.75	41.58	47.14	54.81	41.68
Dollar						
total	38.61	42.18	42.63	47.01	56.37	43.67
import	38.51	42.19	42.13	46.43	56.39	42.91

total and import refer to α_i.

Table 32: Standard deviation of the domestic currency's real value of oil revenues with a peg to the lira and alternative single currency invoicing (1971-1987), %

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	39.90	41.07	43.42	48.03	56.06	42.63
import	40.04	41.08	44.08	48.21	56.09	42.82
Mark						
total	39.48	41.09	44.22	48.27	55.87	42.68
import	39.63	41.09	44.54	48.46	55.89	42.68
Lira						
total	43.20	45.44	47.57	52.74	59.02	46.43
import	43.33	45.45	47.86	52.91	59.04	46.60
Yen						
total	49.71	45.26	45.79	50.81	59.09	45.77
import	49.83	45.27	46.10	50.98	59.12	45.95
Pound						
total	38.74	39.95	41.74	47.31	55.10	41.82
import	38.89	39.95	42.07	47.50	55.13	42.01
Dollar						
total	38.00	41.57	41.48	45.87	56.08	42.26
import	38.16	41.57	41.82	46.07	56.11	42.45

total and import refer to α_i.

Table 33: Standard deviation of the domestic currency's real value of oil revenues with a peg to the yen and alternative single currency invoicing (1971-1987), %

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	38.71	40.06	43.11	47.58	55.21	42.28
import	38.60	40.02	42.58	47.07	55.16	41.62
Mark						
total	38.84	40.61	44.07	48.27	55.40	42.83
import	38.73	40.57	43.55	47.77	55.35	42.19
Lira						
total	42.05	44.48	46.92	52.29	58.17	46.05
import	41.95	44.44	46.43	51.83	58.12	45.45
Yen						
total	51.15	46.96	47.74	52.69	60.29	47.99
import	51.06	46.92	47.25	52.24	60.25	47.42
Pound						
total	36.54	37.95	40.16	46.07	53.56	40.57
import	36.41	37.91	39.58	45.54	53.51	39.89
Dollar						
total	38.13	41.82	42.04	46.52	56.16	43.11
import	38.02	41.78	41.49	46.00	56.11	42.47

total and import refer to α_i.

Table 34: Standard deviation of the domestic currency's real value of oil revenues with a peg to the pound and alternative single currency invoicing (1971-1987), %

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	37.39	38.84	42.21	46.68	54.21	41.27
import	37.29	38.76	41.83	46.19	54.18	40.55
Mark						
total	36.96	38.88	42.70	46.95	54.02	41.34
import	36.86	38.80	42.33	46.45	53.99	40.62
Lira						
total	40.09	42.68	45.43	50.89	56.69	44.46
import	40.00	42.61	45.08	50.43	56.66	43.79
Yen						
total	49.43	45.14	46.15	51.19	58.77	46.34
import	49.36	45.07	45.81	50.74	58.75	45.70
Pound						
total	36.31	37.80	40.24	46.06	53.33	40.57
import	36.20	37.71	39.84	45.56	53.29	39.84
Dollar						
total	34.89	38.94	39.42	44.09	53.93	40.48
import	34.78	38.86	39.02	43.56	53.90	39.74

total and import refer to α_i.

Table 35: Standard deviation of the domestic currency's real value of oil revenues with a peg to the dollar and alternative single currency invoicing (1971-1987), %

the numeraire and the other currencies in which oil may be invoiced and to which the domestic currency is pegged. For example, the exchange rate between the dollar and the yen, where the yen has emerged as the least optimal currency, has moved in the same direction as have oil revenues in terms of the numeraire. The covariance between these two series has been found to be positive and about 513.38. Although the pound did not constitute an optimal choice, it resulted in a standard deviation in the Bahraini dinar's value of oil revenues that was lower than that obtained with the yen. This may be explained by the negative covariance between the pound's relative value of the numeraire and oil revenues in terms of the pound (-59.60). The optimality of the pound for Kuwait may be explained in a similar fashion. The above covariance was found to be -308.18, which has reduced the standard deviation of the Kuwaiti dinar value of oil revenues.

To sum up, the covariances have played a major role in determining the optimality of the choice of currency for invoicing oil, and to which the currencies of the GCC member states may be pegged.

The tabulated results were subjected to statistical testing to measure the significance of the differences between the variances. Indeed it is the difference between the highest and the lowest variance in each combination that was subjected to testing, because this represents the two extremes. (These extremes are reported in the summary Tables (65) to (72) for each combination at the end of this chapter). The null hypothesis postulates equal variances, whereas the alternative states that the opposite is true[56]. As reported in Table (36), with a level of significance assumed to be 5 percent, there appears to be no evidence to support the alternative hypothesis[57].

[56] The test is: $F = \sigma_1^2/\sigma_2^2$, which is distributed as an F distribution, with $\alpha/2$, and $n_1 - 1, n_2 - 1$, degrees of freedom. The test is cited by: W. Daniel and J. Terrell, *Business Statistics: Basic Concepts and Methodology*. 4th edition (Boston: Hughton Mifflin Company, 1986), p. 269.

[57] Tabulated F-value for the whole data range, 1971-1987, is 2.86 ($n_1 = 16, n_2 = 16$). For the ECU data range, 1979-1987, F-value is 4.99 ($n_1 = 8, n_2 = 8$).

Country	Calculated F-value	Critical F-value
Bahrain	1.432	2.86
Kuwait	1.194	2.86
Oman	1.181	2.86
Qatar	1.170	2.86
Saudi Arabia	1.147	2.86
United Arab Emirates	1.156	2.86

Source: The calculated F-values were derived from Table (65), cited at the end of this chapter.

Table 36: Calculated and critical F-values when the domestic currencies are pegged to and oil is invoiced in the same single currency (1971-1987)

2.2. Invoicing in One Currency and Pegging to Another

On the other hand, consider an alternative scheme where the currency of invoicing differs from that of pegging. Then the equation to estimate is

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_k} + \sigma^2_{e_{j/k}} + [\sigma^2_{p_j} + \sum_{i=1}^{5} \alpha_i^2 \sigma^2_{\xi_{ji}}] \tag{73}$$

where

j = currency to which h is pegged

k = currency in which oil is invoiced

i = currencies of the trading partners, however $j \neq i$.

There is overwhelming evidence to support a peg to the dollar, while invoicing oil in the pound (results may be read from Tables (30) to (35)). Moreover, a yen invoicing combined with a lira peg provided the worst choice for all countries. For the Saudi riyal, this choice would have resulted in less stability in the variance of the real value of oil revenues than would any other currency. It would have also resulted in a standard deviation of about 61 percent.

However, an effect of covariances, similar to that described above, is present. Currencies which have shown positive and large covariances with respect to the numeraire currency and the value of oil in terms of the numeraire have suffered more in terms of their optimality. In particular, this applies to the yen and the lira. Meanwhile, the large negative covariance between the pound's nominal value of oil revenues, and the exchange rate between the numeraire currency, the dollar, and the pound, has contributed to the optimality of pegging the currencies of the GCC countries to the dollar, whilst invoicing oil in the British pound.

Statistical inference may be employed to determine the significance of the differences in the contribution of each combination to the variance in the real value of oil revenues. Explicitly, looking over the previous six tables, it may be argued that the differences in the standard deviations are ' small ', and may be considered insufficient to induce a policy change in selecting a currency in which oil is to be invoiced, or a currency to which the domestic currency is pegged.

As reflected by Table (37), similar conclusions to those obtained in the previous section, were arrived at when testing of differences of variances was conducted. Consequently, if statistical evidence is to be accepted, the choice of any combination of single currency pegs and invoicing would be accepted to the authorities in the GCC countries.

2.3. Invoicing in a Single Currency and Pegging to a Basket

Single currency pegs may not seem optimal for the individual GCC member states. Different single pegs may discourage intra-GCC trade as a result of variations in the exchange rates of the currencies to which the currencies of the GCC member states are pegged. Furthermore, with diversified trade patterns, prices in the domestic markets may be more volatile to exchange rate fluctuations among the GCC's trading partners. Alternatively, a trade basket has been viewed as being better if diversified trade patterns were allowed for. A basket peg can dampen the effects of deviations from purchasing power parity amongst trading partners. Moreover,

Country	Calculated F-value	Critical F-value
Bahrain	1.433	2.86
Kuwait	1.265	2.86
Oman	1.221	2.86
Qatar	1.174	2.86
Saudi Arabia	1.141	2.86
United Arab Emirates	1.227	2.86

Source: The calculated F-values were derived from Table (66), cited at the end of this chapter.

Table 37: Calculated and critical F-values when the domestic currencies were pegged to one currency and oil is invoiced in another (1971-1987)

if trade shares are used as an indicator upon which the basket weighting scheme is based, then fluctuations amongst the currencies of trading partners, marked by similar fluctuations between the domestic currency and those of the trading partners, would have an offsetting effect on the average domestic price changes.

B. Trade-Weighted Basket Peg

This view is tested empirically for the GCC member states where, first, total trade shares are used to select the weights of the basket. and second, an import-weighted basket is estimated.

Utilization of trade shares as alternative weights will allow us to rewrite equations (70) and (71) as

$$p_h = \sum_{i=1}^{6} \beta_i p_i \tag{74}$$

and the variance is estimated according to

$$\sigma_{p_h}^2 = \sum_{i=1}^{6} \beta_i^2 \sigma_{p_i}^2 \tag{75}$$

where
i = trading partners included.

It is worth mentioning that since trade-weighted baskets set $\beta_m = \alpha_m$, deviations from purchasing power parity no longer induce any influence on the domestic price level or its variability. Consequently, a peg to a basket of currencies of trading partners will allow the GCC member states to import a trade-weighted average of inflation rates and price stability from their trading partners. The results of the estimation are reported in Table (38), where the weights used are those provided in Tables (5) to (10) of Appendix 1.

The evidence reveals that the use of import shares as a weighting scheme substantially reduces the standard deviation in the imported element in the domestic rate of inflation. Examining the stability of the rate of inflation in the industrial countries, it can be argued that countries which trade more with Japan and the U.K. would be importing a more unstable rate of inflation than countries that conduct less trade with these two industrial countries. For example, Saudi Arabia which relatively trades less with Japan and the U.K. than most of the other GCC member states, has experienced the least instability in the imported rate of inflation. Applying total trade shares, the standard deviation in the rate of inflation was only 2.38 percent; using import shares reduced the same deviation to about 2.11 percent.

However, countries like Oman, Qatar and the U.A.E. would have imported a less stable rate of inflation than Saudi Arabia. This is explained by the trade patterns of these countries with respect to Japan and the U.K. For example, the weighted averages of variability imported from Japan and the U.K. by Oman would have been 16.29 and 5.30, respectively, if total trade weights were used. Note that when import shares were substituted in the estimated equation, the standard deviation reduces to only 2.80 percent. This increase in stability is explained by the decline

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
Total trade shares						
Mean	7.34	7.88	7.60	7.52	7.70	7.30
S.D.	2.67	2.96	4.24	4.31	2.38	4.67
Import shares						
Mean	7.59	7.47	8.24	8.01	7.76	7.90
S.D.	2.09	2.77	2.80	2.42	2.11	2.55

S.D.: Standard deviation.

Table 38: Imported weighted inflation based on a trade-weighted basket peg (1971-1987), %

of the weight of the yen in the basket and the consequent rise of the weights of the more stable (less susceptible to inflation) currencies, such as the mark and the dollar. For Qatar, the effect of the yen is clearly present in the results, once total trade shares were used, where Japan's share was about 60 percent. However, when import shares were used, the instability in the domestic rate of inflation declines to about 2.42 percent. This may be attributed to the decline in exports from Japan to Qatar, which now account for only 25 percent the total goods imported by this country. A similar argument can be presented for the U.A.E., where the standard deviation in the rate of inflation would decline from 4.67 using total trade shares to about 2.55 percent if import shares were used.

Moreover, baskets that are based on import shares would have contributed greater stability to the domestic rate of inflation in all GCC member states, when the rates of inflation in the trading partner countries were used in the estimation of the model. Table (38) shows only minor violations to this conclusion.

C. Special Drawing Rights Basket Peg

Defined as a weighted average of a basket of five currencies, the SDR will provide a common peg for the GCC member states. Such a peg may reduce the variability in the cross exchange rates amongst the GCC member states, and can contribute to the aim of coordinating monetary policy, which is viewed as a target by the Gulf Cooperation Council. Further modification of the basic equations of this section, (70) and (71), will be necessary to allow for the fact that not every currency of the trading partners is represented in the weighting scheme of the SDR. Although reviewed every five years, the current SDR configuration includes the franc, dollar, mark, pound and the yen. Although the weights of these currencies vary as bilateral exchange rates amongst the included currencies change, the initial weights and number of units of each currency were reported in Table (14) in Chapter V.

Since the Italian currency is not included in the SDR weight, equations (70) and (71) can be extended and modified to take this fact into account. Accordingly, the equations to be estimated are

$$\begin{aligned} p_h \;=\; & \beta_{us}p_{us} + \beta_{uk}p_{uk} + \beta_{dm}p_{dm} + \beta_{yen}p_{yen} + \beta_{ff}p_{ff} + (\beta_{uk} - \alpha_{uk}) \\ & \xi_{usuk} + (\beta_{dm} - \alpha_{dm})\xi_{usdm} + (\beta_{yen} - \alpha_{yen})\xi_{usyy} + (\beta_{ff} - \alpha_{ff}) \\ & \xi_{usff} + (-\alpha_{ll})\xi_{usll} \end{aligned} \tag{76}$$

or conventionally

$$p_h = \sum_{i=1}^{5} \beta_i p_i + \sum_{m=1}^{4} (\beta_m - \alpha_m)\xi_{km} - \alpha_{ll}\xi_{kll} \tag{77}$$

and the variance can be expressed as

$$\sigma^2_{p_h} = \sum_{i=1}^{5} \beta_i^2 \sigma^2_{p_i} + \sum_{m=1}^{4} (\beta_m - \alpha_m)^2 \sigma^2_{\xi_{km}} + \alpha^2_{ll}\sigma^2_{\xi_{kll}} \tag{78}$$

where

i = the currencies included in the SDR

m = the currencies included in the SDR, excluding k

k = the numeraire, the dollar in the present analysis.

The implied mean and standard deviation in the domestic inflation rate for the GCC member states with the SDR peg, are tabulated in Table (39). In general, efficiency is lost when the SDR weighting scheme is used relative to the efficiency obtained when import shares were used in the estimation. Presumably, this result was not unexpected, because SDR weights do not shield the domestic rate of inflation from disturbances caused by deviations from purchasing power parity amongst the trading partners. Since β_m does not equal α_m in the estimated equations, efficiency was expected to be lower for the SDR peg than for the trade-weighted basket peg. As argued by Crockett and Nsouli:

> In general, one can say that the case for pegging to the SDR will be stronger, the smaller the deviations of the SDR basket from the import-weighted basket and the greater the level of intra-regional trade that will occur[58].

[58] A. Crockett, and S. Nsouli, " Exchange Rate Policies for Developing Countries, " *Journal of Development Studies*, (January, 1977), p. 133.

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
α_i =total shares						
Mean	7.78	5.59	9.12	9.28	9.28	7.57
S.D.	3.73	5.04	7.13	7.29	3.64	8.06
α_i =import shares						
Mean	7.04	5.60	7.49	7.71	7.08	6.07
S.D.	3.22	4.04	5.19	3.66	3.08	3.80

S.D.: Standard deviation.

Table 39: Imported weighted inflation based on a peg to the SDR (1971-1987), %

Table (39) depicts the standard deviation in the domestic inflation rate resulting from an SDR peg. Thus, under the SDR basket peg, the high instability in the rate of inflation experienced in the some industrial countries would be transmitted to the rate of inflation in the GCC member states. It is therefore not surprising that the standard deviation in the price level has increased across the GCC countries. Remarkably, the Saudi standard deviation continues to be the smallest, followed by that of Bahrain. Examination of the differences between SDR weights and trade shares, as expressed in Tables (12) and (13) in Appendix 1, shows that these differences are small in absolute value for the most stable currencies.

For countries which have the greatest differences with respect to the pound and the yen, as do Oman, Qatar and the U.A.E., the standard deviation in the domestic inflation rate was high, with values of 7.13, 7.29 and 8.06 percent, respectively, when differences between total trade shares and SDR weights were applied.

The weighting scheme involved in the SDR may be viewed as narrow for countries which trade more with partners whose currencies are not weighted in the SDR. Furthermore, the particular representation of a currency in the SDR basket may not closely reflect the domestic country's trade patterns. For example, for countries which trade heavily with Japan, the SDR assigns low weight to the yen; thus, pegging to the SDR will partially insulate the domestic economy from fluctuations in the yen price of other currencies. Consequently, the domestic price level is expected to be more variable, as the evidence suggests from the results reported in this section.

D. European Currency Unit Basket Peg

This unit was created in January 1, 1979 as a part of the European Monetary System, EMS. Although it does not serve the main purpose of money, the ECU is aimed to be a numeraire for the exchange rates between the member states, who receive ECU's in exchange for gold and dollar reserve in the European Monetary Co-operation Fund, EMCF.

The weights of the national currencies included as of September 17, 1984 are listed in Table (15) of Chapter V. Although the unit is designed to be used by the monetary authorities in the participating countries, the evidence shows that there has been an increasing use of private ECU's, that is ECU-denominated financial means aside from those defined in the context of the EMS. For example, a study by the IMF noted that in 1982, ECU-denominated time deposits and saving accounts emerged. Furthermore, in 1983 a credit card based on the same denomination appeared, and in the same year the World Bank denominated some bonds in ECU[59]. Consequently, the model is estimated next assuming the GCC member states peg their national currencies to this basket. Before we report the results of the estimation, three issues require further attention. First, the assumption that the GCC member states trade with only six industrial countries will be preserved. Second, the weighting scheme of the ECU is defined for only nine members, i.e. before the inclusion of Greek drachma in the ECU. Third, the dollar continues to be used as the numeraire currency with which deviations from purchasing power parity with respect to other trading partners are measured.

The significance of the first and third assumptions is contained in the comparison of the performance of the alternative pegs, thus using the same trade shares and numeraire. The second assumption is activated for convenience, because the inclusion of the money supply and price levels of Greece would bias the results more than its exclusion. If it was included, then the variance in its inflation rate and money growth rate would have been included for the whole sampled period; however, it was not a member of the EMS until 1986.

Examining the performance of inflation rate and the rate of money growth in the ECU-member countries and the other trading partners (Japan and the U.S. for all GCC member states), as reported in Tables (40) and (41), reveals a discrepancy in the standard deviations. With respect to the variability in the inflation rate, as measured by its standard deviation, the Italian and the Irish rates have recorded

[59]The Role of the SDR in the International Monetary System, *IMF Occasional Paper*, no. 51 (Washington: IMF, March 1987), p. 48.

Country	Mean	Standard deviation
Belgium	5.40	2.68
Denmark	7.15	3.22
France	8.00	4.00
Germany	3.03	2.34
Ireland	10.17	6.14
Italy	11.91	5.43
Luxembourg	5.09	3.47
Netherlands	3.30	2.69
U.K.	7.33	4.50
Japan	2.72	2.38
U.S.	5.60	3.74

Table 40: Mean and standard deviation of the inflation rates in the ECU member states, Japan and the U.S. (1980-1987), %

Country	Mean	Standard deviation
Belgium	6.55	2.25
Denmark	12.77	5.87
France	9.03	2.78
Germany	5.69	1.27
Ireland	9.85	4.72
Italy	10.75	3.10
Luxembourg	10.04	12.70
Netherlands	5.36	1.67
U.K.	15.75	5.21
Japan	8.17	1.60
U.S.	8.11	3.47

Table 41: Mean and standard deviation of the money growth rate in the ECU member states, Japan and the U.S. (1980-1987), %

the least stability, 5.43 and 6.14 percent, respectively. Furthermore, the means of their inflation rates were the highest, with values of about 11.91 percent in Italy, and about 10.17 percent in Ireland. As has been so throughout the sampled periods, the German inflation rate is found to have the least degree of instability, and the lowest average. Moreover, the exclusion of the mid 1970's from the sample has drastically reduced the instability in the Japanese inflation rate. The average of this rate declined from 6.35 percent in the first sample, to about 2.72 percent when the 1980's were considered. Similarly, the standard deviation declined by more than twice its value in the early sample relative to the present sample, i.e. from 7.09 to 2.38 percent. However, for the other industrial countries included in all of the estimations of the model, the standard deviation in the inflation rate has been slightly higher for the U.S., Italy, Germany and France.

Based upon the introduction of the ECU as an alternative peg, and taking into consideration the assumptions outlined in the beginning of this section, the relevant average inflation rate equation is

$$p_h = \sum_{i=1}^{9} \beta_i p_i + \sum_{m=1}^{4} (\beta_m - \alpha_m)\xi_{kmi} + (-\alpha_{yy})\xi_{kyy}. \tag{79}$$

Similarly, the variance is estimated according to

$$\sigma^2_{p_h} = \sum_{i=1}^{9} \beta_i^2 \sigma^2_{p_i} + \sum_{m=1}^{4} (\beta_m - \alpha_m)^2 \sigma^2_{\xi_{km}} + \alpha^2_{yy} \sigma^2_{\xi_{kyy}} \tag{80}$$

where

i = the currencies included in the ECU

m = currencies of the trading partners which are members of the ECU

k = numeraire, the dollar .

In general, an ECU basket peg has proved to be inferior to trade-weighted baskets or the SDR basket pegs. The results of the estimation are reported in Table (42).

It can be argued that countries which conduct most of their trade with currencies which are not represented in the ECU, such as the yen, have suffered the most

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
α_i =total shares						
Mean	8.60	9.19	9.98	10.15	8.52	10.51
S.D.	7.55	8.37	11.25	11.22	7.20	12.05
α_i =import shares						
Mean	7.68	8.85	7.87	8.11	8.10	8.43
S.D.	6.15	7.57	8.51	6.74	6.37	7.16

S.D.: Standard deviation.

Table 42: Imported weighted inflation based on a peg to the ECU (1979-1987), %

in terms of optimality for a given variability in deviations from purchasing power parity. For example, using the ECU-total trade weight difference, the weighted deviations from purchasing power parity of the dollar with respect to the yen contributed about 76.8 percent to the imported variability in Oman's rate of inflation. However, once the smallest import share with Japan was used, the same deviation declined to 10.74 percent. On the contrary, the share of imports to Oman from the U.K. is large, but the weight of the pound in the ECU is comparably small. Consequently, the contribution of deviations from purchasing power parity of the pound to the standard deviation in Omani inflation rate was large.

For Qatar and the U.A.E., for whom total trade with Japan was about 60 and 65 percent, respectively, the ECU peg has resulted in less stable inflation rates. Another factor that has added to the increased the level of domestic inflation rates of the GCC member states, is the divergence of ECU assigned weight from trade shares. The German mark is given about 33 percent of the total ECU weight, but the GCC member states conduct less trade with Germany, thus the difference between the ECU weight and the trade share is large. Consequently, the domestic inflation rate would be less stable, since weighted deviations from purchasing power parity are not penalized. For Bahrain, the ECU peg is more optimal than for the other GCC member states, when import shares were applied. This may be attributed to Bahrain's smaller share of imports from Japan, only 16.66 percent, Moreover, the Saudi standard deviation, using total trade difference was only 7.20 percent, enhancing further the importance of trade shares with members of the ECU and the other trading partners.

Thus, the ECU seems to introduce greater variability in the domestic price level, relative to trade-weighted baskets, when foreign inflation rates are used. To sum up, this demonstrates the importance of trade weights in the selection of a basket peg. Thus a basket which is composed of a greater number of currencies by no means implies greater efficiency. Table (43) summarizes the various results of the model under the alternative currency pegs and shows which peg yields the least variability in the inflation rate in the GCC member states.

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
Single peg						
α_i = total	franc	franc	yen	yen	dollar	yen
S.D.	6.40	6.51	7.92	7.53	6.22	7.44
α_i = import	franc	franc	franc	franc	dollar	franc
S.D.	5.95	6.29	6.01	5.48	5.94	5.79
Import basket	2.09	2.77	2.80	2.42	2.11	2.55
Total basket	2.67	2.96	4.24	4.31	2.38	4.67
SDR peg						
α_i = total	3.73	5.04	7.13	7.29	3.64	8.06
α_i = import	3.22	4.04	5.19	3.66	3.08	3.80
ECU peg						
α_i = total	7.55	8.37	11.25	11.22	7.20	12.05
α_i = import	6.15	5.57	8.51	6.74	6.37	7.16

All figures are defined as standard deviation.

Table 43: Summary of results of the weighted imported inflation rate based on alternative pegs

These findings may also be substituted in equation (69) to estimate the contribution of each basket peg to the total variations in the domestic currency's real value of oil revenues.

Alternatively, even though oil is invoiced in a single currency, the currencies of the economies of the GCC can be pegged to baskets of currencies. If this were the case, then the variance of the exchange rate between the currency in which oil is invoiced and the currencies included in the baskets would affect the optimality of this scheme. In the present analysis, the domestic currencies may be pegged to a total trade-weighted basket, an import-weighted basket, the SDR basket or the ECU basket.

The equation to be estimated if the domestic currency is pegged a trade-weighted basket is

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + \sigma^2_{e_{b/j}} + \sum_{i=1}^{6} \beta_i^2 \sigma^2_{p_i} \tag{81}$$

where

j = currency in which oil is invoiced

b = a trade-weighted basket to which h is pegged

i= currencies included in b.

On the other hand, a single-currency invoicing scheme combined with a peg to the SDR, yields

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + \sigma^2_{e_{sdr/j}} + \sum_{i=1}^{5} \beta_i^2 \sigma^2_{p_i} + \sum_{s=1}^{4} (\beta_s - \alpha_s)^2 \sigma^2_{\xi_{ks}} + \alpha_{ll}^2 \sigma^2_{\xi_{kll}} \tag{82}$$

where

sdr = SDR-weighted basket

j = currency in which oil is invoiced

s = member currencies in the SDR, less k

k = numeraire; the dollar is used in this analysis.

Note that for the numeraire, $\sigma^2_{\xi_{kk}} = 0$, which is why the index on the second summation sign is 4, excluding the U.S., which is used as the numeraire, and Italy, since the lira is not included in the SDR.

A peg to the ECU, when oil is invoiced in currency j, implies the following equation is be estimated:

$$\sigma^2_{rvor_h} = \sigma^2_{nvor_j} + \sigma^2_{e_{ecu/j}} + \sum_{i=1}^{9} \beta_i^2 \sigma^2_{p_i} + \sum_{c=1}^{4} (\beta_c - \alpha_c)^2 \sigma^2_{\xi_{kc}} + \alpha^2_{yy} \sigma^2_{\xi_{kyy}} \qquad (83)$$

where

i= member currencies in the ECU

c= currencies of the trading partners which are included in the ECU.

Estimation of the model under these alternatives yielded those results reported in Tables (44), (45) and (46).

Invoicing in the dollar has proved superior for Bahrain, Oman and Qatar, whatever is adopted as the basket peg. From examination of the standard deviations of $\sigma^2_{rvor_h}$ under these baskets (excluding the ECU for the time being), similar values may be deduced for each country under the alternative baskets. For example, the standard deviations for Bahrain were in the region of 34 percent in all three cases. The pound would have resulted in the smallest variations for Kuwait and Saudi Arabia, whether total trade-weighted, import-weighted or the SDR baskets were considered. For the U.A.E., the dollar has emerged as the optimal choice if import weights were used as the basis for the peg. Moreover, the yen has remained in a less advantageous position, contributing larger variations than all the other currencies except the lira, which yielded less optimal results for two countries.

A peg to the ECU would have not changed the optimal currencies by a great deal; however, the mark has emerged as the least optimal currency for all countries except Oman, for which the lira was the source of greatest instability, leading to a standard deviation of about 45 percent. The yen would have provided less instability in the real value of oil revenues in terms of the domestic currencies of Saudi Arabia and the U.A.E., although only if the total trade weight and the ECU weight difference were used for the latter country. For Saudi Arabia, a peg to the

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	37.31	38.69	42.05	46.55	54.21	41.12
import	37.19	38.64	41.48	45.94	54.16	40.33
Mark						
total	36.89	38.73	42.52	46.79	54.02	41.19
import	36.77	38.67	42.39	46.24	53.97	40.43
Lira						
total	40.19	42.66	45.52	50.99	56.78	44.65
import	40.06	42.62	44.94	50.33	56.73	43.72
Yen						
total	49.25	44.79	45.42	50.49	58.70	45.45
import	49.33	44.78	45.58	50.53	58.71	45.45
Pound						
total	36.20	37.64	39.92	45.86	53.33	40.35
import	36.06	37.59	39.29	45.27	53.27	39.58
Dollar						
total	34.81	38.89	39.44	44.10	53.88	40.51
import	34.69	38.80	38.99	43.51	53.84	39.68

total and import refer to α_i.

Table 44: Standard deviation of the domestic currency's real value of oil revenues with a peg to a trade-weighted basket and alternative single currency invoicing (1971-1987), %

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	37.53	39.00	42.20	46.70	54.38	41.28
import	37.48	38.90	41.92	46.93	54.17	41.32
Mark						
total	37.08	39.00	42.66	46.93	54.17	41.32
import	37.03	38.90	42.38	46.51	54.63	40.70
Lira						
total	40.42	43.01	45.60	52.05	56.99	43.92
import	40.38	42.92	45.33	50.53	56.96	43.34
Yen						
total	49.56	45.29	46.16	51.22	58.95	46.37
import	49.53	45.20	45.90	50.83	58.92	45.82
Pound						
total	36.51	38.02	40.28	46.12	53.54	40.63
import	36.46	37.91	39.98	45.69	53.30	40.00
Dollar						
total	34.67	38.77	39.08	43.81	53.86	40.17
import	34.62	38.66	38.77	43.35	53.82	39.53

total and import refer to α_i.

Table 45: Standard deviation of the domestic currency's real value of oil revenues with an SDR peg and alternative single currency invoicing (1971-1987), %

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	35.30	32.25	43.51	48.48	42.07	34.86
import	35.03	32.05	42.88	47.64	41.94	33.48
Mark						
total	36.12	34.13	44.31	50.35	43.54	36.31
import	35.85	33.95	43.69	49.55	43.41	34.99
Lira						
total	35.74	33.49	45.31	49.68	43.16	36.15
import	35.47	33.30	44.71	48.86	43.03	34.83
Yen						
total	29.18	28.44	38.81	44.50	36.49	27.54
import	28.85	28.21	39.11	43.59	36.34	27.91
Pound						
total	31.04	27.51	36.77	44.38	36.65	28.62
import	30.73	27.28	36.03	43.46	36.50	26.93
Dollar						
total	25.84	27.72	35.82	39.41	37.96	28.92
import	25.47	27.49	35.05	38.37	37.81	27.25

total and import refer to α_i.

Table 46: Standard deviation of the domestic currency's real value of oil revenues with an ECU peg and alternative single currency invoicing (1979-1987), %

yen would have resulted in standard deviations of 36.49 and 36.34 percent, using the total trade and the import weight differences, respectively. It is worth noting that, a comparison between the three baskets mentioned previously, namely the total trade-weighted, the import-weighted, and the SDR baskets, and the ECU basket, may not be wise at this stage. This is because a different data range was used for the ECU basket relative to that used for the other three baskets (estimation over the same range is conducted later for some cases).

The optimality of an invoicing currency combined with a pegging basket, depended on the variance of the nominal value of oil revenues in terms of that currency, the variance between this currency and the currencies in the basket, and the variance of the weighted inflation rate. However, the first factor was found to be of great importance. Note that the variance of this factor is affected by the covariance between the numeraire (the dollar) and the currency in which oil may be invoiced.

Consider the case of the dollar, which was found to be the optimal currency for invoicing the oil exports of Bahrain, Oman, Qatar and the U.A.E. The standard deviation of real value of oil revenues in Bahraini dinars is lower under a dollar than under a yen invoicing scheme. Moreover, an import-weighted peg would have contributed about 4.36 percent to the variance of $\sigma^2_{rvor_h}$, compared to 7.12 percent if the BD had been pegged to a total trade-weighted basket. Another contribution associated with the choice of a peg is evident in the total variation between the currency of invoicing and the basket, $\sigma^2_{e_{b/j}}$, where j is the invoicing currency. Thus, although $\sigma^2_{e_{b/y}}$ is lower than that under the dollar, the dollar provided an optimal invoicing currency, because the yen was positively related to the value of oil revenues expressed in dollars. This may be more evident for Oman. In that case, the variance between the yen and the basket was only 10.92 percent, whilst its counterpart in terms of the dollar was about 79 percent. Not surprisingly, the dollar was superior to the yen, due to large variations in the variance of oil revenues in terms of the yen.

Country	Calculated F-value	Critical F-value
Bahrain	1.430	2.86
Kuwait	1.204	2.86
Oman	1.190	2.86
Qatar	1.181	2.86
Saudi Arabia	1.069	2.86
United Arab Emirates	1.173	2.86

Source: The calculated F-values were derived from Table (67), cited at the end of this chapter.

Table 47: Calculated and critical F-values under alternative single currency invoicing combined with basket, trade-weighted and SDR-weighted, pegs (1971-1987)

The covariance terms have reduced the variance in the real value of oil revenues for the U.A.E., although not sufficiently to favor the pound over the dollar. Nevertheless, the variance of oil revenues in terms of the pound was 1,537 percent compared to 1,530 in terms of the dollar. Moreover, $\sigma^2_{e_{b/uk}}$ was 22 percent, lower than the value of 38 percent recorded for the dollar. This has resulted in a close race between the dollar and the pound, with the two currencies implying a standard deviation in the dirham's real value of oil revenues of about 39.58 and 39.68 percent, respectively.

However, there is no statistical evidence to favor one combination of peg and invoice over another. Clearly, from the calculated and the critical F-values given in Tables (47) and (48), none of the differences between the estimated variances is significant.

Country	Calculated F-value	Critical F-value
Bahrain	1.418	4.99
Kuwait	1.251	4.99
Oman	1.264	4.99
Qatar	1.312	4.99
Saudi Arabia	1.198	4.99
United Arab Emirates	1.348	4.99

Source: The calculated F-values were derived from Table (68), cited at the end of this chapter.

Table 48: Calculated and critical F-values under a single currency invoicing and a peg to the ECU (1979-1987)

VI.3. Invoicing in Alternative Baskets and Pegging to a Single Currency

The results arrived at from estimation of the model concerning the alternative single currency and basket of currencies pegs may be utilized to determine the optimality of pegging oil in a basket of currencies. The standard deviations of the domestic currency's real value of oil revenues for these baskets are reported in Tables (49), (50), and (51).

Invoicing in a trade-weighted basket, while the domestic currency is pegged to j, yields the following equation to estimate[60]:

$$\sigma^2_{rvor_h} = \sum_{i=1}^{6} \theta_i^2(\sigma^2_{nvor_i} + \sigma^2_{e_{j/b}}) + [\sigma^2_{p_j} + \sum_{m=1}^{5} \alpha^2_m \sigma^2_{\xi_{jm}}] \tag{84}$$

where

i = currencies of the trading partners

j = currency to which h is pegged

[60] Refer to Appendix VI.B for further explanation of some technical aspects of the calculations of variances.

m = currencies of the trading partners, less j
b = trade-weighted basket.

Alternatively, invoicing oil in the SDR, while h is pegged to j, requires estimation of the following equation:

$$\sigma^2_{rvor_h} = \sum_{i=1}^{5} \theta_i^2 (\sigma^2_{nvor_i} + \sigma^2_{e_{j/sdr}}) + [\sigma^2_{p_j} + \sum_{m=1}^{5} \alpha^2_m \sigma^2_{\xi_{jm}}] \tag{85}$$

where
i = currencies included in the SDR
m = currencies of the trading partners, less j
j = currency to which h is pegged.

However, if oil is invoiced in the ECU basket, while h is pegged to j, then

$$\sigma^2_{rvor_h} = \sum_{i=1}^{9} \theta_i^2 (\sigma^2_{nvor_j} + \sigma^2_{e_{j/ecu}}) + [\sigma^2_{p_j} + \sum_{m=1}^{5} \alpha^2_m \sigma^2_{\xi_{jm}}] \tag{86}$$

where
i = currencies included in the ECU
m = currencies of trading partners less j
j = currency to which h is pegged.

From examination of the fulfillment of the optimality condition under a total trade-weighted basket (h is pegged to a single currency), it may be observed that the dollar has emerged as an optimal single peg for all member states of the GCC except Qatar, for which the pound was more optimal. For instance, a dollar peg would have resulted in a standard deviation of about 20.65 percent, compared to a standard deviation of 22.08 percent if the lira was the currency to which the Bahraini dinar was pegged. Alternatively, if an import weighted basket was used to price oil, the overall variations would have declined for all countries. In particular, the decline would be drastic for Qatar and the U.A.E., where standard deviations were cut by more than 10 percent in most cases. Moreover, the decline in the standard deviations for invoicing in an import-weighted basket relative to a total trade-weighted basket, was smallest for Bahrain, Kuwait and Saudi Arabia, with

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	21.60	22.36	29.81	33.29	26.38	32.55
import	18.44	21.44	22.17	22.00	24.99	20.24
Mark						
total	21.60	22.36	29.81	33.29	26.38	32.55
import	18.52	21.27	22.26	22.13	25.64	20.34
Lira						
total	22.54	23.01	30.85	34.26	26.76	33.65
import	19.25	22.06	23.08	22.77	25.49	21.03
Yen						
total	22.08	22.52	28.93	32.30	26.92	33.50
import	19.90	21.55	23.55	23.02	25.82	21.04
Pound						
total	22.06	22.93	30.07	32.23	26.38	32.96
import	18.88	21.83	22.27	22.33	25.42	20.64
Dollar						
total	20.65	22.00	29.33	32.82	26.05	31.92
import	18.21	20.90	21.71	22.03	24.72	20.10

total and import refer to α_i.

Table 49: Standard deviation of the domestic currency's real value of oil revenues with invoicing in a trade-weighted basket and single currency pegs (1971-1987), %

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	37.22	25.40	42.63	41.05	28.91	42.32
import	33.14	25.34	42.30	40.61	28.86	41.81
Mark						
total	33.23	25.50	42.72	41.14	28.95	42.41
import	33.15	25.43	42.41	40.65	28.89	41.82
Lira						
total	33.98	25.86	43.68	42.01	29.29	43.43
import	33.90	25.87	43.20	41.37	28.39	42.67
Yen						
total	32.74	25.52	41.04	39.76	29.19	40.51
import	32.92	25.53	41.38	39.98	27.95	40.72
Pound						
total	33.51	25.92	42.81	41.36	29.35	42.60
import	33.37	25.86	42.27	40.77	28.24	41.95
Dollar						
total	32.31	24.84	41.42	40.22	29.28	41.16
import	32.19	24.72	41.04	39.64	28.44	40.43

total and import refer to α_i.

Table 50: Standard deviation of the domestic currency's real value of oil revenues with a single currency peg and invoicing in an export-weighted basket (1971-1987), %

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	19.83	21.07	21.96	24.29	28.54	22.39
import	19.68	21.01	21.31	23.55	28.49	21.42
Mark						
total	19.85	21.10	22.15	24.43	28.55	22.57
import	19.71	21.01	21.53	23.59	28.49	21.45
Lira						
total	20.63	21.75	23.01	25.27	28.88	23.54
import	20.42	21.76	22.07	24.18	28.93	22.10
Yen						
total	20.75	21.76	22.02	24.19	29.25	22.01
import	21.03	21.77	22.64	24.56	29.31	22.39
Pound						
total	20.46	21.74	22.58	24.90	29.02	23.15
import	20.24	21.66	21.54	23.92	28.92	21.94
Dollar						
total	19.82	21.25	22.52	24.78	28.42	22.96
import	19.63	21.10	21.81	23.83	28.36	19.22

total and import refer to α_i.

Table 51: Standard deviation of the domestic currency's real value of oil revenues with a single currency peg and invoicing in an SDR basket (1971-1987), %

a value of no more than 1 percent in some cases. On the other hand, a peg to the yen would have resulted in the largest variations for all countries, except Kuwait. For Qatar, a peg to the franc, whilst oil is invoiced in an import-weighted basket, would have contributed the smallest amount of variation, about 22 percent, with the largest recorded under a peg to the yen.

Oil may be invoiced in the SDR, where weights are fixed for some years. Consideration of this alternative yielded drastic changes in the optimality of currencies used as single pegs. The dollar has retained its optimality for Bahrain, resulting in a standard deviation of about 19.63 percent; the yen has remained the least appealing alternative single currency peg for this country. The franc has emerged as an optimal alternative for Kuwait, Oman and Qatar, with standard deviations of 21.07, 21.96 and 24.29 percent, respectively (using the total trade weights as the basis of differencing). Of three countries, it is Kuwait that has the smallest difference in the standard deviations resulting from the more optimal currency peg, the franc, compared to that derived from a peg to the yen, the least optimal. Comparing the three baskets, an import-weighted basket invoicing scheme would have, in general, resulted in an optimal choice with less regard to the single currency peg adopted by each member country.

Table (50) cites the results obtained from the model assuming that oil is paid for according to an export-weighted basket. It may be observed from the results that there is a rise in the standard deviation of the real value of oil revenues in terms of the domestic currency for every country, under any single currency peg, except a peg to the yen (both total and import weights for PPP), and a peg to the pound (import weights for PPP). Moreover, for some countries, like the U.A.E., variations resulting from this basket have almost doubled.

Invoicing oil in the European Currency Unit may constitute an alternative to other baskets. The value of the ECU is targeted by the participating countries, thus its relative market value may be viewed as more stable. Table (52) presents the results under an ECU invoicing scheme.

	Bahrain	Kuwait	Oman	Qatar	SaudiArabia	U.A.E.
Franc						
total	16.77	15.75	20.43	22.91	19.75	14.06
import	16.60	15.66	19.72	22.12	19.66	12.44
Mark						
total	16.77	15.64	20.62	23.04	19.74	17.52
import	16.61	15.52	19.95	22.16	19.64	16.04
Lira						
total	17.49	16.41	21.37	23.79	19.90	18.51
import	17.25	16.31	20.36	22.62	19.97	16.64
Yen						
total	18.13	16.96	20.74	23.03	21.00	17.06
import	18.45	16.97	21.28	23.42	21.08	17.54
Pound						
total	18.00	17.14	21.49	23.99	20.84	18.69
import	17.75	17.04	20.39	22.97	20.71	17.16
Dollar						
total	16.80	16.03	20.58	23.46	19.61	18.02
import	16.58	15.83	19.80	22.46	19.52	16.30

total and import refer to α_i.

Table 52: Standard deviation of the domestic currency's real value of oil revenues with a single currency peg and invoicing in an ECU basket (1979-1987), %

A peg to the dollar would provide a standard deviation of 16.58 percent in the real value of oil revenues for Bahrain, thus yielding an optimal peg, if α_m = import shares. A slight gain in optimality would favor a franc peg relative to a peg to the mark, if α_m = total trade shares. However, the mark leads to the minimum standard deviation for Kuwait. For Oman, the franc provides the least instability in the real value of oil revenues expressed in terms of riyal Omani. It is for the U.A.E. where the franc is more appealing, resulting in a standard deviation of only 14.06 and 12.48 percent, for α_m = total trade weights, and import weights, respectively.

To sum up, of these baskets, and apart from the ECU, an import-weighted basket invoicing scheme has proved to be an optimal combination with the dollar for Bahrain, Kuwait and Saudi Arabia. The franc peg provided the smallest amount of variability in the domestic currency's real value of oil revenues, if combined with an import basket invoicing policy, for Qatar and for Oman, and using a denomination scheme which is based on the SDR. For the U.A.E., a peg to the dollar would be an optimal choice, if the SDR is used to determine the weight of currencies according to which oil would be invoiced.

Analysis of the contribution of the various factors to the real value of oil revenues in the domestic currencies of the GCC member states, has revealed several points. It was found that for Saudi Arabia, the variance of the imported weighted rate of inflation under a dollar peg, was smaller than under other single currency pegs. In addition, the import-weighted variations in the nominal value of oil revenues in other currencies, have been relatively large. Moreover, differences between trade shares and basket weights have, in many cases, shown a substantial impact on the optimality of several currencies. This may be attributed to the large weight the SDR assigns to the dollar, which in turn, led to a rise in the contribution of variations in the dollar's nominal value of oil revenues to the total variance of the domestic currency's real value of oil revenues. The evidence on the optimal combination for Kuwait supports this argument. A large import share from Japan has diminished the optimality of an import-invoiced basket for the U.A.E., and favors the SDR basket. This share has raised the imported variations in the percentage of oil revenues denominated in yen (about 174.5 percent), compared to only 45.89 percent, with the SDR basket. For Oman, the relatively low standard deviation in the RO's real value of oil revenues, if the riyal was pegged to the franc, with oil invoiced in the SDR may be attributed to a large extent to the smaller variance in the imported weighted inflation, a value of 36.12 percent, compared to 64 percent recorded for the numeraire currency.

Less optimal results were recorded under an invoicing scheme based on export shares. A major contribution to this conclusion has to do with the effect of export shares. Indeed, since a large percentage of oil exports was directed to Japan, the instability in the nominal of oil revenues in terms of the yen would have been manifested in the domestic currency's real value of oil revenues. Thus for the member countries of the GCC which export most of their oil to Japan, such as Oman (89.02 percent), Qatar (76.65 percent) and the U.A.E. (87.99 percent), the loss in terms of optimality would have been great had they invoiced oil in terms of an export-weighted basket.

Testing the significance of these findings reveals little support for a policy of favoring a combination of the above invoicing schemes and single currency pegs, over another scheme. As shown in Table (53), the evidence does not support the alternative hypothesis.

VI.4. Invoicing in and Pegging to the Same Basket

An alternative combination of choosing an invoicing and pegging scheme would involve invoicing oil in the same basket to which the domestic currency is pegged. If the basket adopted is trade-weighted, then the variance in the domestic currency's real value of oil revenues would be

$$\sigma^2_{rvor_h} = \sum_{i=1}^{6} \beta_i^2(\sigma^2_{nvor_i}) + [\sum_{i=1}^{6} \beta_i^2 \sigma^2_{p_i}] \tag{87}$$

Country	Calculated F-value	Critical F-value
Bahrain	1.866	2.86
Kuwait	1.240	2.86
Oman	2.049	2.86
Qatar	1.909	2.86
Saudi Arabia	1.184	2.86
United Arab Emirates	2.259	2.86

Source: The Calculated F-values were derived from Table (69), cited at the end of this chapter.

Table 53: Calculated and critical F-values under alternative basket invoicing schemes and single currency pegs (1971-1987)

where

i = currencies included in the trade-weighted basket

β_i = represent total trade shares and import shares, however, estimated for the two cases separately.

Moreover, if the GCC member states adopt the SDR basket for invoicing oil and pegging the domestic currency, then the variability in the domestic currency's real value of oil revenues is given by

$$\sigma^2_{rvor_h} = \sum_{i=1}^{5} \beta_i^2(\sigma^2_{nvor_i}) + [\sum_{i=1}^{5} \beta_i^2 \sigma^2_{p_i} + \sum_{s=1}^{4} (\beta_s - \alpha_s)^2 \sigma^2_{\xi_{ks}} + \alpha^2_{ll} \sigma^2_{\xi_{kll}}] \tag{88}$$

where

i = currencies included in the SDR

s = currencies included less k.

However, pegging and invoicing in terms of the ECU would yield

$$\sigma^2_{rvor_h} = \sum_{i=1}^{9} \beta_i^2(\sigma^2_{nvor_i}) + [\sum_{i=1}^{9} \beta_i^2 \sigma^2_{p_i} + \sum_{c=1}^{4} (\beta_c - \alpha_c)^2 \sigma^2_{\xi_{kc}} + \alpha^2_{yy} \sigma^2_{\xi_{kyy}}] \tag{89}$$

where

i = currencies included in the ECU

c = currencies of the trading partners which are included in the ECU.

Comparison of the performance of total trade-weighted, import-weighted, SDR-weighted and ECU-weighted baskets leads to preference for an import-weighted basket.

Tables (54) and (55) summarize the results of the estimation under each alternative basket. If the ECU is set aside for the present, the evidence ranks an import-weighted basket first, providing a standard deviation of 17.22, 19.87 and 21.00 percent, for Bahrain, Kuwait and Qatar, respectively. The SDR basket emerges as the only exception for Oman (α_m = import shares). Table (55) shows the standard deviation in the real value of oil revenues expressed in terms of the domestic currencies of the GCC member states, if oil is invoiced in the ECU basket and the domestic currencies are also pegged to the ECU. It is worth noting that although the range over which the estimation for the ECU basket was shorter than that used for the other baskets (the ECU was introduced in 1979), in general the improvement in optimality is relatively small. Nonetheless, the ECU reduces the standard deviation for Saudi Arabia to about 19.65 percent, compared to a value of 24.09 percent for optimality derived under the import-weighted basket. For Qatar, the ECU basket introduced greater instability in the real value of oil revenues.

A comparison of the total trade-weighted, import-weighted and the ECU baskets over the same data range, is cited in Table (55). The estimation was conducted over the period from 1979-1987 (however one observation was lost in defining percentage change). It can be inferred that the import-weighted basket has out-performed the other two baskets, with reference to the postulated optimality criterion. For Saudi Arabia the import-weighted basket provides a standard deviation of 15.89 percent, compared to 19.65 percent recorded under the ECU basket.

Country	Total trade basket	Import basket	SDR basket	
			α_i = total	α_i =import
Bahrain	20.18	17.22	18.96	18.87
Kuwait	20.89	19.87	20.51	20.29
Oman	27.97	20.98	21.50	20.94
Qatar	31.62	21.00	23.90	23.05
Saudi Arabia	25.41	24.09	27.97	27.90
U.A.E.	30.53	19.02	21.99	20.18

Table 54: Standard deviation of the domestic currency's real value of oil revenues based on invoicing and pegging to the same basket (1971-1987), %

Country	Total basket	Import basket	ECU basket	
			α_i = total	α_i = import
Bahrain	13.72	13.18	17.19	16.62
Kuwait	13.55	12.92	16.46	16.06
Oman	23.00	18.53	21.78	20.50
Qatar	27.10	19.51	24.09	22.35
Saudi Arabia	16.89	15.89	19.94	19.65
U.A.E.	18.04	12.45	19.01	16.36

Table 55: Standard deviation of the domestic currency's real value of oil revenues based on invoicing and pegging to the same basket (1979-1987), %

Furthermore, for the U.A.E. and Bahrain, the import-weighted basket resulted in standard deviation of less than 13 percent, compared to more than 16 percent obtained under the ECU basket.

The gain in terms of optimality with invoicing and pegging to an import-weighted rather than the ECU and the total trade-weighted basket, is attributed to a large degree to trade shares, as well as basket weights. It may be argued that the large degree of risk associated with the ECU is caused by large variations in the nominal value of oil revenues in terms of the mark. However, since the mark retains a weight of 33 percent in the ECU, the positive covariation between oil revenues in terms of the dollar and the exchange rate between the mark and the numeraire was large and reflected heavily in the domestic currency's real value of oil revenues. Moreover, the variance of the weighted imported rate of inflation, is larger under the ECU peg relative to other basket pegs.

Furthermore, for countries which conduct most of their international trade with Japan, a total trade-weighted basket peg and invoicing alternative would have resulted in greater risk in terms of the domestic currency's real value of oil revenues. For example, the empirical estimation of this alternative peg and invoicing basket gave contributions of 441.34, 658.32 and 301.94 percent to the risk measure for Oman, Qatar and the United Arab Emirates, respectively. Meanwhile, for Bahrain, Kuwait and Saudi Arabia, which conduct a smaller share of their total trade with Japan compared to the three above mentioned countries, the transmission channel has been narrower, and consequently smaller differences were observed in terms of the standard deviation in the domestic currency's real value of oil revenues, between a total trade-weighted basket, and an import-weighted basket. The highest contribution caused by the yen was only 104.07 percent, recorded for Saudi Arabia.

Despite these differences in the contribution of individual currencies to the total variability in the domestic currency's real value of oil revenues, testing the significance of differences between the variances under alternative combinations of

Country	Calculated F-value	Critical F-value
Bahrain	1.177	2.86
Kuwait	1.051	2.86
Oman	1.335	2.86
Qatar	1.505	2.86
Saudi Arabia	1.161	2.86
United Arab Emirates	1.605	2.86

Source: The calculated F-values were derived from Table (70), cited at the end of this chapter.

Table 56: Calculated and critical F-values under invoicing in and pegging to the same basket (1971-1987)

pegging and invoicing in the same weighted basket reveals no violations of the null hypothesis. (This hypothesis states that variances are equal.) Tables (56) and (57) report the calculated and the critical F-values.

VI.5. Invoicing in One Basket and Pegging to Another Basket

In addition to invoicing oil in the same weighted basket that the domestic currency is pegged to, the GCC member states may argue for invoicing oil in a basket, whilst their currencies would be pegged to another basket. In this case, there are several possibilities for combining alternative baskets, with the objective of minimizing any of the following variances, depending on the chosen combination of invoicing and pegging. The variances are

$$\sigma^2_{rvor_h} = \sum_{i=1}^{6} \theta_i^2(\sigma^2_{nvor_i} + \sigma^2_{e_{sdr/b}}) + [\sum_{j=1}^{5} \beta_j^2 \sigma^2_{p_j} + \sum_{s=1}^{4} (\beta_s - \alpha_s)^2 \sigma^2_{\xi_{ks}} + \alpha_{ll}^2 \sigma^2_{\xi_{kll}}] \quad (90)$$

Country	Calculated F-value	Critical F-value
Bahrain	1.304	4.99
Kuwait	1.274	4.99
Oman	1.241	4.99
Qatar	1.389	4.99
Saudi Arabia	1.254	4.99
United Arab Emirates	1.526	4.99

Source: The calculated F-values were derived from Table (71), cited at the end of this chapter.

Table 57: Calculated and critical F-values based on pegging to and invoicing in the same basket (1979-1987)

where

i = currencies included in the trade-weighted basket (total or import weights)

j = currencies included in the SDR

s = currencies included in the SDR less k

k = numeraire, the dollar.

The above equation would be relevant if oil in invoiced in a trade-weighted basket, whilst h is pegged to the SDR.

However, if oil is invoiced in the same basket, while the domestic currency is pegged to the ECU, then the above variance will be

$$\sigma^2_{rvor_h} = \sum_{i=1}^{6} \theta_i^2(\sigma^2_{nvor_i} + \sigma^2_{e_{ecu/b}}) + [\sum_{j=1}^{9} \beta_j^2 \sigma^2_{p_j} + \sum_{c=1}^{4} (\beta_c - \alpha_c)^2 \sigma^2_{\xi_{kc}} + \alpha^2_{yy} \sigma^2_{\xi_{kyy}}] \quad (91)$$

where

i = currencies included in the trade-weighted basket

j = currencies included in the ECU

c = currencies of the trading partners which are included in the ECU

k = numeraire.

Alternatively, the domestic currencies may be pegged to a trade-weighted basket, while oil is invoiced in the SDR. This yields the following equation to be estimated:

$$\sigma^2_{rvor_h} = \sum_{i=1}^{5} \theta_i^2 (\sigma^2_{nvor_i} + \sigma^2_{e_{b/sdr}}) + [\sum_{j=1}^{6} \beta_j^2 \sigma^2_{p_j}] \tag{92}$$

where

i = currencies included in the SDR

j = currencies included in the trade-weighted basket.

Pegging to the ECU with oil invoiced in the SDR yields

$$\sigma^2_{rvor_h} = \sum_{i=1}^{5} \theta_i^2 (\sigma^2_{nvor_i} + \sigma^2_{e_{ecu/sdr}}) + [\sum_{j=1}^{9} \beta_j^2 \sigma^2_{p_j} + \sum_{c=1}^{4} (\beta_c - \alpha_c)^2 \sigma^2_{\xi_{kc}} + \alpha^2_{yy} \sigma^2_{\xi_{kyy}}] \tag{93}$$

where

i= currencies included in the SDR

j= currencies included in the ECU

c= currencies of the trading partners which are included in the ECU.

Nevertheless, oil may be invoiced in the ECU basket, but a trade-weighted basket may be adopted as a peg. In this case the aim would be to minimize

$$\sigma^2_{rvor_h} = \sum_{i=1}^{9} \theta_i^2 (\sigma^2_{nvor_i} + \sigma^2_{e_{b/ecu}}) + [\sum_{j=1}^{6} \beta_j^2 \sigma^2_{p_j}] \tag{94}$$

where

i = currencies included in the ECU

j = currencies included in the trade-weighted basket.

Furthermore, the member countries of the GCC may choose to adopt baskets in which the weights are predetermined. Thus, adopting the ECU as a basket for invoicing oil and the SDR as a pegging choice requires minimizing

$$\sigma^2_{rvor_h} = \sum_{i=1}^{9} \theta_i^2 (\sigma^2_{nvor_i} + \sigma^2_{e_{sdr/ecu}}) + [\sum_{j=1}^{5} \beta_j^2 \sigma^2_{p_j} + \sum_{s=1}^{4} (\beta_s - \alpha_s)^2 \sigma^2_{\xi_{kx}} + \alpha^2_{ll} \sigma^2_{\xi_{kll}}] \tag{95}$$

where
i = currencies included in the ECU
j = currencies included in the SDR
s = currencies included in the SDR, less k.

Alternatively, if oil is invoiced in a trade-weighted basket which is different than a trade-weighted basket to which the domestic currency is pegged, the equation to be estimated becomes

$$\sigma^2_{rvor_h} = \sum_{i=1}^{6} \theta_i^2 (\sigma^2_{nvor_i} + \sigma^2_{e_{b/d}}) + [\sum_{j=1}^{6} \beta_j^2 \sigma^2_{p_j}] \tag{96}$$

where
i = currencies included in basket d
j = currencies included in basket b
(b and d are different trade-weighted baskets).

These equations were estimated individually in the search for the combination that would minimize variability of the domestic currency's real value of oil revenues, $\sigma^2_{rvor_h}$. The results are cited and discussed in this section. Note that the ECU's data range is shorter than the others (the ECU was introduced in 1979), and it may be that a comparison between alternative baskets, can not always be drawn.

The estimation is conducted in the first case for the complete data range, 1971 to 1987, where the results are reported in Tables (58), (59) and (60).

Overwhelmingly, an invoicing scheme weighted according to import shares from each of the trading partners, combined with a peg to a total trade-weighted basket, would have resulted in an optimal policy choice. For Bahrain, this choice would have yielded a standard deviation of about 16.64 percent, compared to a less stable alternative resulting in a standard deviation of 30.8 percent, had invoicing of oil been based on export share basket with the BD pegged to the SDR. Note that the choice of invoicing oil in an export-weighted basket is less stable, irrelevant to the basket peg adopted. For Kuwait, this would have introduced a standard deviation of more than 23 percent, compared to only 19.09 percent under the optimal choice

Country	Invoice: Total Peg: Import	Invoice: Import Peg: Total	Invoice: Export Peg: Total	Invoice: Export Peg: Import
Bahrain	19.48	16.64	30.63	30.64
Kuwait	19.96	19.09	22.71	22.69
Oman	26.57	20.21	38.57	38.69
Qatar	30.28	20.57	37.73	37.68
Saudi Arabia	24.95	23.71	27.23	27.38
U.A.E.	28.93	18.66	38.17	38.11

Table 58: Standard deviation of the domestic currency's real value of oil revenues (1971-1987), %

Country	Invoice: SDR basket Peg: Total basket	Invoice: SDR basket Peg: Import basket
Bahrain	18.54	18.43
Kuwait	19.91	19.88
Oman	20.73	20.34
Qatar	23.16	22.68
Saudi Arabia	27.65	27.61
U.A.E.	21.05	20.40

Table 59: Standard deviation of the domestic currency's real value of oil revenues (1971-1987), %

Country	Total		Import		Export	
	α_i = t	α_i = m	α_i = t	α_i = m	α_i = t	α_i = m
Bahrain	19.78	19.69	16.87	16.76	30.89	30.83
Kuwait	21.49	20.27	19.59	19.36	23.21	23.02
Oman	27.47	27.03	20.99	20.41	39.35	39.05
Qatar	31.20	30.56	21.40	20.45	38.86	38.34
Saudi Arabia	25.16	25.09	26.27	26.20	27.59	27.52
U.A.E.	30.11	29.26	19.79	18.47	39.13	38.48

m = import shares, t = total trade shares.

Table 60: Standard deviation of the domestic currency's real value of oil revenues with an SDR peg and alternative invoicing baskets (1971-1987), %

mentioned above. Moreover, for Oman, the optimality of an import-weighted basket for invoicing combined with a total trade-weighted basket for a peg, led to a standard deviation of only 20.21 percent, relative to the least stable choice of invoicing in an export-weighted basket while pegging to the SDR, which would have greater uncertainty in the domestic currency's real value of oil revenues, with a standard deviation of 39.35 percent. A similar conclusion can be drawn for Qatar, where the former combination resulted in 20.57 percent, compared to about 38 percent implied by the latter basket combination. The statistical evidence reveals less discrepancy with respect to the combination of peg and invoicing choice, provided export shares were utilized in either basket. For example, invoicing oil in an export-weighted basket while pegging to the SDR, and invoicing in an export-weighted basket, whilst the Saudi riyal is pegged to either an import-weighted or a total trade-weighted baskets, would all have resulted in a standard deviation of about 27 percent. The choice of the optimal invoicing and pegging combination for the U.A.E. has strengthened the optimality of an import-weighted invoicing basket, and has further weakened the argument for the least stable alternative, an export-weighted basket invoicing scheme combined with an SDR peg.

It is worth noting that there appears to be no case for reciprocality with respect to the findings. That is to say, the tables of results do not lead to the conclusion that if an import-weighted basket is optimal for invoicing oil when combined with a total trade-weighted basket peg, then invoicing in a total trade-weighted basket combined with an import-weighted basket peg, would be optimal.

Extending the argument would be possible if the availability of the ECU is considered as either an invoicing basket or a basket to which any currency of the GCC member states may be pegged. In general, the ECU invoicing scheme is optimal if combined with a total trade-weighted basket or an import-weighted basket; however, this conclusion may be revised if the estimation over the same data range is conducted for the combination of total trade-weighted and import-weighted baskets. The results of these alternatives are reported in Tables (61), (62) and (63).

First, consider baskets which involve the ECU as either a basket peg or a basket in which oil may be invoiced. Results obtained for the various schemes were fairly similar for a particular country, if export baskets were excluded. For example, the best combination for Bahrain yields a standard deviation of 14.19 percent, which is not particularly good compared to the highest level of variation of about 16 percent (Tables (61) and (62)). For Kuwait, similar results may be obtained, but with greater absolute differences. An ECU invoicing combined with an import-weighted basket peg, resulted in a standard deviation of 12.40 percent, which increases at an increasing rate; the highest value of about 16.53 percent was recorded for an ECU peg and an SDR invoicing scheme. Furthermore, the differences are large for Oman. For example, an ECU invoicing combined with a total trade-weighted basket implied a standard deviation of 17.28 percent; that can be compared to a standard deviation of more than 25 percent, had the reciprocal scheme been adopted by the Omani authorities over the years from 1979 until 1987. The optimal choice of invoicing and pegging concluded for Oman emerged as an optimal choice for Qatar. The results for Saudi Arabia are quite similar under most alternative combinations of baskets. Nonetheless, an export invoicing basket is not the least favorable option, this position is taken up by the SDR invoicing scheme combined with an ECU pegging scheme.

To sum up, if oil was invoiced in an ECU-weighted basket, then for the GCC countries either a total trade-weighted basket or an import-weighted basket would be an optimal peg. In addition, except for Saudi Arabia, an ECU peg would yield the least stable variance in the domestic currency's value of oil revenues, if oil was invoiced in terms of the percentage of exports the GCC countries transported to the six industrial countries.

An additional comparison may be adopted between the ECU invoicing scheme, as reported in Table (61), and the data in Table (63), where the model is estimated with the assumption that the data range covering the estimation is compatible with that of the ECU. In all cases analyzed, an import-weighted basket invoicing alternative combined with a total trade-weighted basket peg has emerged as the optimal

Country	Total basket	Import basket	SDR basket	
			α_i = total	α_i =import
Bahrain	14.19	14.26	15.48	15.40
Kuwait	12.56	12.40	14.32	14.15
Oman	17.28	17.59	19.74	19.33
Qatar	20.10	20.12	22.24	21.31
Saudi Arabia	17.71	17.53	18.48	18.38
U.A.E.	13.05	13.07	16.42	14.68

Table 61: Standard deviation of the domestic currency's real value of oil revenues with invoicing in an ECU basket and pegging to alternative baskets (1979-1987), %

Country	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	U.A.E.
SDR basket						
α_i =total	16.06	16.53	21.70	23.77	20.86	18.73
α_i =import	15.45	16.14	20.41	22.01	20.59	16.03
Export basket						
α_i =total	20.00	17.91	35.03	35.42	19.79	26.68
α_i =import	19.51	17.55	34.25	34.26	19.48	24.86
Import basket						
α_i =total	15.33	15.50	21.72	22.54	17.98	17.39
α_i =import	14.70	15.09	20.44	20.68	17.67	14.44
Total basket						
α_i =total	15.53	16.01	25.58	29.41	18.49	21.84
α_i =import	14.90	15.65	24.50	28.01	18.18	19.57

Table 62: Standard deviation of the domestic currency's real value of oil revenues with a peg to the ECU and alternative invoicing baskets (1979-1987), %

Country	Invoice: Total basket Peg: Import basket	Invoice: Import basket Peg: Total basket
Bahrain	12.63	12.33
Kuwait	12.28	11.65
Oman	21.47	16.25
Qatar	25.77	18.46
Saudi Arabia	16.41	15.46
U.A.E.	15.89	10.86

Table 63: Standard deviation of the domestic currency's real value of oil revenues based on alternative invoicing and pegging baskets (1979-1987), %

choice. However, the differences, or as they may be called the gains in optimality, are not similar across alternative combinations. For Bahrain and Kuwait, they are small. On the other hand, these differences are larger for Oman, Qatar and the U.A.E., with Saudi Arabia occupying the middle grounds. A noticeable gain in optimality is recorded for the U.A.E., where the standard deviation was less than 11 percent, had the Emirates' dirham been pegged to a total trade-weighted basket, whilst oil was denominated in a basket according to shares of imports.

These results may be subjected to statistical testing to determine whether the gains and loses in optimality are significant. It may be argued that if the differences are not significant, the opportunity loss from adopting any combination of baskets rather than another combination, is relatively small.

Since a large percentage of total trade is conducted between most of the GCC members and Japan, a peg to a total trade-weighted basket would have diminished the impact of fluctuations in the exchange rate between the yen and the numeraire. However, invoicing a large percentage of oil in terms of the yen would have the opposite effect on the stability of the domestic currency's real value of oil revenues. For example, consider Saudi Arabia. Had oil been invoiced in a total trade-weighted basket, where the weight of the yen is relatively large, then a variance of 95.51 percent of the variance of the nominal value of oil revenues, in terms of the yen, would be added to the total variations in $\sigma^2_{rvor_h}$. Alternatively, under the optimal choice, i.e. pegging to the total trade-weighted basket and invoicing in an import-weighted basket, that variance would have declined to 55.55 percent. Similar conclusions would have emerged for the lira and the dollar. Moreover, if import invoicing is combined with the ECU peg, the relatively large import shares of the yen, lira and dollar, would have contributed more instability in the welfare function. This latter scheme of invoicing and pegging would have introduced larger variances into the sum of total variations in the KD's real value of oil revenues. For example, the ECU peg combined with import-weighted invoicing, would have resulted in the yen contributing an individual variance of about 95.31 percent to a total variance of 170.48 percent.

Country	1971-1987		1979-1987	
	Calculated F-value	Critical F-value	Calculated F-value	Critical F-value
Bahrain	1.856	2.86	1.622	4.99
Kuwait	1.215	2.86	1.537	4.99
Oman	1.947	2.86	2.155	4.99
Qatar	1.900	2.86	1.936	4.99
Saudi Arabia	1.166	2.86	1.349	4.99
U.A.E.	2.097	2.86	2.470	4.99

Source: The calculated F-values were derived from Table (72), cited at the end of this chapter.

Table 64: Calculated and critical F-values assuming a peg to one basket and an invoice in another

More evidence favoring a total trade-weighted peg combined with an import weighting scheme for invoicing oil may be seen in the breakdown of total variations in the domestic currency's real value of oil revenues, for countries which conduct most of their total trade with Japan. An invoicing policy based on total trade shares combined with an import-weighted basket peg, would have raised total variations substantially, with the yen alone contributing variances of 596.90 and 388.86 percent for Qatar and Oman, respectively. This may be compared to only 103.42 and 52.97 percent, had the Qatari riyal and the riyal Omani been pegged to a total trade-weighted basket, with oil invoiced in an import-weighted basket.

Table (64) reports the calculated F-values and the critical F-value, using the least and the most stable variances, assuming the domestic currency is pegged to one basket, whilst oil is invoiced in another (5 percent level of significance). It is worth noting, however, that none of the differences between the extreme variances, as cited in Tables (65) to (72), was found to be statistically significant.

To conclude, amongst the factors which can affect the optimality of a combination, the covariance between the exchange rate of the numeraire currency and the currency in which oil is invoiced, and the nominal value of oil revenues expressed in the numeraire has proven to be the most important. Moreover, for basket pegs and invoicing, trade shares have a decisive role in transmitting the impact of instability in covariances, as well as the deviations from PPP. The role of the variance of the imported weighted inflation, has been less significant, although for the ECU, this factor is vital. Amongst the alternative combinations considered for the optimal currency for invoicing oil and the currency peg for pegging the domestic currencies of the GCC member states (single invoicing and basket invoicing, single peg and basket peg alternatives), the results of the estimation favor an invoicing scheme which is based on import shares, combined with a peg to a total trade-weighted basket.

These findings support the generally cited argument that if the domestic currency is to be pegged, then trade-weighted baskets have the tendency to yield optimal results for the domestic economy. Furthermore, testing this hypothesis in the oil market has strengthened the choice of a trade-weighted basket as a basis for invoicing oil.

Country	Lowest variability	Highest variability
Bahrain	dollar(α_i =m)=34.78	yen(α_i =m)=49.83
Kuwait	pound(α_i =m)=37.91	yen(α_i =m)=45.27
Oman	dollar(α_i =m)=39.02	yen(α_i =m)=46.10
Qatar	dollar(α_i =m)=43.56	lira(α_i =t)=50.99
Saudi Arabia	pound(α_i =m)=53.51	lira(α_i =t)=61.38
U.A.E.	dollar(α_i =m)=39.74	yen(α_i =m)=45.95

m, t, refer to import and total trade weights.

Table 65: Standard deviation of the real value of oil revenues in terms of the domestic currency based on invoicing and pegging to the same currency (1971-1987), %

Country	Lowest variability		Highest variability	
	Peg	Invoice	Peg	Invoice
Bahrain	dollar	pound(α_i =m)=36.20	lira	yen(α_i =t)=51.90
Kuwait	dollar	pound(α_i =m)=37.71	lira	yen(α_i =m)=47.71
Oman	dollar	pound(α_i =m)=39.84	lira	yen(α_i =t)=48.67
Qatar	dollar	pound(α_i =m)=45.56	lira	yen(α_i =t)=53.50
Saudi Arabia	dollar	pound(α_i =m)=53.29	lira	yen(α_i =m)=60.85
U.A.E.	dollar	pound(α_i =m)=39.84	lira	yen(α_i =t)=48.91

m, t, refer to import and total trade weights.

Table 66: Standard deviation of the real value of oil revenues in terms of the domestic currency based on invoicing in one currency and pegging to another (1971-1987), %

Country	Lowest variability		Highest variability	
	Invoice	Peg	Invoice	Peg
Bahrain	dollar	SDR(α_i =m)=34.62	yen	SDR(α_i =m)=49.53
Kuwait	pound	SDR(α_i =m)=37.59	yen	SDR(α_i =t)=45.29
Oman	dollar	SDR(α_i =m)=38.77	yen	SDR(α_i =t)=46.16
Qatar	dollar	SDR(α_i =m)=43.35	yen	SDR(α_i =t)=51.22
Saudi A.	pound	import basket=53.27	lira	SDR(α_i =t)=56.99
U.A.E.	dollar	import basket=39.53	yen	SDR(α_i =t)=46.37

m, t, refer to import and total trade weights.

Table 67: Standard deviation of the real value of oil revenues in terms of the domestic currency based on invoicing in one currency and pegging to a basket (trade-weighted vs. SDR, 1971-1987), %

Country	Lowest variability		Highest variability	
	Invoice	Peg	Invoice	Peg
Bahrain	dollar	ECU(α_i =m)=25.47	mark	ECU(α_i =t)=36.12
Kuwait	pound	ECU(α_i =m)=27.28	mark	ECU(α_i =t)=34.13
Oman	pound	ECU(α_i =m)=35.05	mark	ECU(α_i =t)=44.31
Qatar	pound	ECU(α_i =m)=38.37	mark	ECU(α_i =t)=50.35
Saudi A.	yen	ECU(α_i =m)=36.34	mark	ECU(α_i =t)=43.54
U.A.E.	pound	ECU(α_i =m)=26.93	mark	ECU(α_i =t)=36.31

m, t, refer to import and total trade weights.

Table 68: Standard deviation of the real value of oil revenues in terms of the domestic currency based on invoicing in a single currency and pegging to the ECU (1979-1987), %

Country	Lowest variability		Highest variability	
	Invoice	Peg	Invoice	Peg
Bahrain	import	dollar = 18.21	export	lira = 33.98
Kuwait	import	dollar = 20.90	export	pound = 25.92
Oman	SDR(m)	franc = 21.31	export	lira = 43.68
Qatar	import	franc = 22.00	export	lira = 42.01
Saudi A.	import	dollar = 24.72	export	lira = 29.29
U.A.E.	SDR(m)	dollar = 19.22	export	lira = 43.43

m: refers to import shares.

Table 69: Standard deviation of the real value of oil revenues in terms of the domestic currency based on invoicing in a basket and pegging to a single currency (1971-1987), %

Country	Lowest variability	Highest variability
Bahrain	import basket = 17.22	total trade basket = 20.28
Kuwait	import basket = 19.87	total trade basket = 20.89
Oman	SDR(m) = 20.94	total trade basket = 27.97
Qatar	import basket = 21.00	total trade basket = 31.62
Saudi Arabia	import basket = 24.09	SDR(t)= 27.97
U.A.E.	import basket = 19.02	total trade basket = 30.53

m, t: refer to import and total trade shares, respectively.

Table 70: Standard deviation of the real value of oil revenues in terms of the domestic currency based on invoicing in and pegging to the same basket (1971-1987), %

Country	Lowest variability	Highest variability
Bahrain	import basket = 13.18	ECU(t) = 17.19
Kuwait	import basket = 12.92	ECU(t) = 16.46
Oman	import basket = 18.53	total trade basket = 23.00
Qatar	import basket = 19.51	total trade basket = 27.10
Saudi Arabia	import basket = 15.89	ECU(t)= 19.94
U.A.E.	import basket = 12.45	ECU(t) = 19.01

t: refers to total trade shares.

Table 71: Standard deviation of the real value of oil revenues in terms of the domestic currency based on invoicing in and pegging to the same basket (1979-1987), %

	Bahrain	Kuwait	Oman	Qatar	Saudi A.	U.A.E.
1971-1987						
Lowest:						
peg	total	total	total	SDR(m)	total	total
invoice	import	import	import	import	import	import
S.D.	16.64	19.09	20.21	20.45	23.71	18.66
Highest:						
peg	SDR(t)	SDR(t)	SDR(t)	SDR(t)	total	SDR(t)
invoice	export	export	export	export	SDR	export
S.D.	30.89	23.21	39.35	38.86	27.65	39.13
1979-1987						
Lowest:						
peg	total	total	total	total	total	total
invoice	import	import	import	import	import	import
S.D.	12.33	11.65	16.25	18.29	15.46	10.80
Highest:						
peg	ECU(t)	ECU(t)	ECU(t)	ECU(t)	ECU(t)	ECU(t)
invoice	export	export	export	export	SDR(t)	export
S.D.	20.00	17.91	35.03	35.42	20.86	26.68

m, t, refer to import and total trade shares, respectively
S.D.: Standard deviations.

Table 72: Standard deviation of the domestic currency's real value of oil revenues based on a peg to one basket and invoicing in another, %

Appendix VI.A

Adjusting Total Trade Weights

Lipschitz (1979) suggested that choice of a peg may be biased if a country adopts a weighted basket peg, in which weights correspond to trade flows only. In some cases, this may provide a less optimal peg, particularly if trade is invoiced in a vehicle currency (a third currency). In the present thesis, consideration of the GCC member states's trade would require adjusting total trade shares accordingly.

After interviewing exporters, importers and bankers, the author found that most of the exports of these countries consist of either crude oil, or related commodities such as petrochemicals. Moreover, these commodities are invoiced in dollars, with no regard to the direction of trade flows. Thus, while imports remain invoiced in the exporters' currency, it may be argued that total trade with France, Germany, Italy, Japan and the U.K. can be adjusted to equal import shares from these countries. That is because only imports are invoiced in the currencies of these countries. Meanwhile, exports to these countries are invoiced in terms of the U.S. dollar. As a result, the following procedure is adopted.

Total trade with the U.S. $= \sum_{i=1}^{6} x_i / \sum_{i=1}^{6} t_i + m_{us}$.

Total trade with France $= m_{ff} / \sum_{i=1}^{6} t_i$.

Total trade with Germany $= m_{dm} / \sum_{i=1}^{6} t_i$.

Total trade with Italy $= m_{il} / \sum_{i=1}^{6} t_i$.

Total trade with Japan $= m_{yy} / \sum_{i=1}^{6} t_i$.

Country	Franc	Mark	Lira	Yen	Pound	Dollar
Bahrain	3.06	11.82	5.12	10.91	17.14	52.11
Kuwait	5.15	8.45	5.92	21.71	7.74	51.04
Oman	3.09	5.84	2.46	10.09	20.36	58.26
Qatar	4.25	4.75	2.96	8.16	8.99	70.90
Saudi Arabia	4.81	6.23	5.85	11.19	8.90	63.01
U.A.E.	3.41	5.29	4.01	11.31	9.29	66.69

Table 1: Adjusted total trade shares according to currency of trade denomination (1986), %

Total trade with the U.K. = $m_{uk}/\sum_{i=1}^{6} t_i$.

where

m_i = import shares of the GCC from these countries

t_i = total trade share of the GCC with these countries.

Resulted weights are reported in Table (1), whilst Tables (2) and (3) cite some results from the estimation of the model for several cases. However, based on these results, there appear to be no significant differences in the optimal choice.

Country	Invoice in and peg to the same currency	Invoice in a currency and peg to another
Bahrain		
Peg:	dollar	dollar
Invoice:	dollar	pound
S.D.	34.54	35.97
Kuwait		
Peg:	dollar	dollar
Invoice:	dollar	pound
S.D.	38.53	37.37
Oman		
Peg:	dollar	dollar
Invoice:	dollar	pound
S.D.	38.48	39.02
Qatar		
Peg:	dollar	dollar
Invoice:	dollar	pound
S.D.	43.15	45.17
Saudi Arabia		
Peg:	dollar	dollar
Invoice:	dollar	pound
S.D.	53.72	53.12
U.A.E.		
Peg:	dollar	dollar
Invoice:	dollar	pound
S.D.	39.32	39.41

S.D.: Standard deviation.

Table 2: Standard deviation of the domestic currency's real value of oil revenues (1971-1987), %

Country	Invoice: Total Peg: Total	Invoice: Total Peg: Import	Invoice: Import Peg: Total
Bahrain	14.14	14.46	12.84
Kuwait	14.82	14.80	12.52
Oman	21.15	21.46	17.84
Qatar	26.99	27.36	19.39
Saudi A.	23.93	24.02	15.89
U.A.E.	17.44	17.83	12.25

Table 3: Standard deviation of the domestic currency's real value of oil revenues (1979-1987), %

Appendix VI.B

A Note on the Calculation of Some Exchange Rates

Since the dollar is assumed to be the numeraire, certain adjustments were taken into consideration when calculating variability between the numeraire and the other currencies of the industrial countries.

Since variability between the dollar and any of these currencies has already been included in converting oil revenues from dollars, into the other five currencies, then the following variance

$$\sigma^2_{i/us}$$

(i = franc, mark, lira, yen, and pound)
drops out if any share of oil revenues is expressed in these five currencies, and the combination of the invoicing and pegging schemes requires finding the above variance as one of its components. For example, if oil is invoiced in an import-weighted basket, whilst the domestic currency is pegged to a single currency, say the franc, then the variance of the domestic currency's real value of oil revenues will be defined so that, when measuring how the basket behaves vis-á-vis the franc, the variance of the exchange rate between the franc and the dollar, which is a member of the basket, is left out.

However, when a basket peg and invoicing is adopted as an alternative scheme, the following adjustment has been applied to the measurement of variability of exchange rates.

If the domestic currency is pegged to a basket, whilst oil is invoiced in an alternative (another basket), then assuming the required calculations involve finding the $\sigma^2_{e_b/ff}$, where b is the basket to which h is pegged, and ff is a member currency of the basket in which oil is invoiced (ff can be a member of b, however, the variance would be zero), then

$$\sigma^2_{e_{ff/e}} = \beta^2_{dm}\sigma^2_{e_{dm/ff}} + \beta^2_{ll}\sigma^2_{e_{ll/ff}} + \beta^2_{yy}\sigma^2_{e_{yy/ff}} + \beta^2_{uk}\sigma^2_{e_{uk/ff}} - [(1-\beta^2_{us})\sigma^2_{e_{us/ff}}]$$

where

dm = mark

ll = lira

yy = yen

uk = pound

us = dollar

β_i= basket weight of currency i

i = the trading partners.

The objective of this adjustment is to isolate some of the variability associated with using the dollar as the numeraire, when it is also included in the basket to which the currency is pegged. The last term in the above expression would remove the variability of the dollar/franc exchange rate, adding only the weighted variability of this exchange rate, as would be implied by a peg to a basket in which the domestic currency behaves against the franc by β_{us} of the behavior of the dollar vis-á-vis the franc.

This procedure was applied to all similar variances, i.e. those involving the mark, lira, yen and the pound.

VII. Conclusions and Recommendations

Throughout the historical development of the international monetary system, countries in the world have failed to insulate themselves from potential shocks, whether these are political or economic in nature. Consequently, the various attempts to manage the world monetary arena, one may argue, were primarily designed to minimize rather than eliminate such shocks. The vulnerability of any economy to these disturbances depends on several factors; the size of the economy is, however, prominent. It is because of this feature that the potential impacts of external shocks are likely to be felt more in developing than developed countries.

In an attempt to minimize the impact of exchange rate fluctuations on their domestic economies, most developing countries have adopted a pegged exchange rate regime. This type of policy has the drawback of eliminating an instrument which may be needed by the authorities to influence the domestic economy. However, some countries have adhered to a selected peg (which may be a single currency, or, alternatively, a basket of currencies), thus fixing the relative value of their currencies to other currency(s). Although this would eliminate the variability of their currencies with respect to the currency(s) of the peg, fluctuations may manifest themselves in other variables. One possible channel for these fluctuations is the foreign price level. Changes in this price level can affect the cost of imports (both goods and inputs), thus contributing to the domestic rate of inflation. The impact of instability in the foreign price level is seen to be greater when the currency of a developing country is pegged to a single currency and there is a diversified pattern of imports. To rectify the drawback of a single currency peg, an alternative peg, to a trade-weighted basket of currencies, has been suggested. Although the latter regime has been shown to be superior, most peggers have not been persuaded by it.

In addition to its influence on the prices of imports, a peg may have consequences for the value of revenues from exports. One may argue that, as long as exports are denominated in a currency which differs from that used for imports, potential impacts of exchange rate fluctuations on the domestic economies of developing countries cannot be eliminated by choosing a peg. The experience of the member states of the Gulf Cooperation Council exemplifies this. The Gulf Cooperation Council was established in 1980 with six members including: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

These countries are small and open, and revenues from oil exports constitute the bulk of their foreign exchange earnings. Although their currencies are effectively pegged to the dollar (only the Kuwaiti dinar is not totally pegged to the dollar), their imports are not totally invoiced in terms of the dollar. As a result, the value of oil revenues in the domestic currency is insulated from exchange rate fluctuations; however, the purchasing power of these revenues is not. This is because the imports of the GCC member states are invoiced in a variety of currencies, whereas their domestic currencies are pegged to the dollar. To sum up, their income is in dollars, while their expenditures are not. For the authorities, this has posed a dilemma which is more persistent during periods in which the dollar is depreciating relative to the currencies of the countries from which the GCC member states import.

Thus, it has been the purpose of this thesis to analyze the alternative possibilities for choosing the optimal currency or currencies for invoicing oil, recognizing the fact that the GCC member states prefer a pegged exchange rate regime. This has led to exploration of the optimality of choice of a peg, and to testing empirically the optimality of this peg as an invoicing scheme for oil compared to other alternatives. This has been done according to the contribution of an invoicing scheme to the stability of the real value of oil revenues, expressed in terms of the domestic currencies of the GCC member states.

A. Summary and Conclusions

After introducing the problem and its significance in Chapter I, the remaining body of the thesis was divided as follows. Chapter II examined the historical development of the international monetary system. It included a review of the operation of the exchange rates under the Gold Standard, which was characterized by relative stability. Although adherence to this regime collapsed in the early 1930's, an attempt was made in the Bretton Woods agreement to reinforce the newly emerging exchange rate regime by incorporating an anchor, for which gold was reinstated. Due to the increasing complexities of the world economic environment, and the ability of some members to shift burdens of the system to others, the Bretton Woods agreement collapsed in the early 1970's, paving the way for other minor attempts to restore confidence in an international monetary system. However none has succeeded.

As a consequence of the feature of interdependence associated with the adjustable par value system of Bretton Woods, many authors have revived the discussion of flexible exchange rate systems, arguing that they eliminate the interdependence amongst the world economies. In this respect, exchange rates would respond to balance of payments disequilibria, hence diminishing the need for the authorities to intervene in the foreign exchange market. The advantages and disadvantages of flexible versus fixed exchange rate regimes were also discussed.

Other economists have considered the case when a particular number of countries join in a currency area with the purpose of establishing an optimum currency area between them. This area is characterized by fixed exchange rate between the currencies of the member countries, while they would float jointly vis-á-vis the other currencies in the world. A survey of current exchange rate regimes leads us to conclude that only the European Monetary System could qualify as a candidate for this exchange rate practice, leaving most of the developing countries as peggers.

A theoretical review of literature relating to the optimum currency peg was presented in Chapter III. It identified several welfare functions upon which a peg may be based. The review included discussions of alternative models, and their recommended pegs. It was found that there is neither a universal currency peg capable of yielding an optimal solution under the alternative proposed welfare functions, nor a common objective to be fulfilled by a peg. Rather a peg was likely to be chosen independently by individual countries, while its outcome was found to be influenced to a large extent by trade shares, stability of monetary policy in trading partners and fluctuations amongst the currencies of the trading partners.

Chapter IV examined the literature on currency invoicing of international trade. The main objective of this was to become acquainted with the potential impact of the practice of currency invoicing of contracts on the domestic economy, and to identify the determinants of the choice of currency invoicing of a trade contract. It was concluded that, exchange risk is an essential component of risk which the chosen invoicing schemes attempt to avoid. However, the potential impact of this risk on the volume of trade was neither accepted by all researchers (in the light of their findings), nor was it easily distinguished from other types of risk. Although the forward market provides a possible means of covering exchange risk, it by no means eliminates all types of risk involved in international trade. Thus, as it was reported, the use of forward covering was limited in international trade.

The analytical framework was presented in Chapter V. In order to understand the motives behind the current pegging schemes and their relationship to the issue of invoicing oil in the GCC member states, field work was conducted in the Gulf. Interviews and questionnaires have contributed positively to the building of the model. A distinctive feature of the model is its integrative approach to the issue. Since the problem simultaneously involves the choice of the currency peg and the choice of currency invoicing for oil, the model was designed to take account of this. The presentation of the methodology examined alternative possibilities for invoicing oil, ranging from a single currency to weighted baskets of currencies. Alternative schemes of pegging the domestic currencies of the countries of the GCC were examined. Since these countries rely heavily on oil revenues, it was proposed that a stabilization of the real value of oil revenues could serve as a welfare function. The percentage change in the real value of oil revenues was defined as a weighted sum of the percentage change in the nominal value of oil revenues expressed in terms of a particular currency(s), deflated by an import-weighted price index. It was argued that this would determine the purchasing power of oil revenues.

The estimation of the model and the analysis of findings were presented in Chapter VI. The analysis began by presenting several important economic variables in the GCC economies and examined their development over the sampled periods, which extended from 1971 until 1987. Examination of the relationship between oil revenues and government expenditures revealed a close and a positive correlation. This may be explained by government ownership of the oil sector, and the consequent reliance on oil revenues as the major source of government financing of the public sector. However, this ownership has resulted in the public sector playing a fundamental and a dominant role in the economy, where the impact of instability in the oil sector filters easily through to the economy.

On the empirical front, several estimations were conducted. However, all were centered around the hypothesis of testing the relationship between the alternative schemes of pegging the domestic currencies of the GCC countries and the choice of the optimal currency invoicing for oil. Stated differently, given that the GCC countries peg their currencies to a single currency or alternative baskets of currencies, would the same choice or an alternative scheme prove optimal for invoicing oil. The analysis examined annual data from 1971 to 1987, and tested the following schemes: 1) Pegging the domestic currencies to a single currency, whilst oil is invoiced in the same currency. 2) Pegging the domestic currencies to a single currency, with oil assumed to be invoiced in another currency. 3) Pegging the domestic currencies to a weighted-basket of currencies (which included import-weighted, total trade-weighted, SDR-weighted, and ECU-weighted baskets), while oil is invoiced in a single currency. 4) Pegging the currencies of the GCC countries to a single currency, whilst oil is invoiced in a weighted basket of currencies (same possibilities as above). 5) Pegging the currencies of the GCC member states to the same weighted basket in which oil is invoiced. 6) The domestic currencies are pegged to one basket, whilst oil is assumed to be invoiced in another.

As it can be inferred from the various alternatives, several possibilities exist within any of these schemes. This was considered in the same chapter and a summary of the findings may be presented accordingly.

1) When oil was assumed to be invoiced in the same currency to which the domestic currencies were pegged, the evidence favors the dollar for Bahrain, Oman, Qatar and the United Arab Emirates, whereas the pound fulfilled the optimality condition for Kuwait and Saudi Arabia.

2) When oil was assumed to be invoiced in one currency, while the domestic currencies were pegged to another, a peg to the dollar combined with an invoice of oil in the pound has proved to be optimal for all members of the GCC.

3) Considering a peg to a basket of currencies, while oil was assumed to be invoiced in a single currency, mixed results were obtained, depending on whether the ECU basket was considered or not. If the ECU was excluded (due to the shorter observation points) and estimation was conducted over the period 1971-1987, an invoice to the dollar combined with a peg to the SDR, was found to be optimal for Bahrain, Oman, and Qatar. Moreover, a dollar invoicing scheme fulfilled the optimality criterion when it was combined with a peg to an import-weighted basket, for the U.A.E. For Saudi Arabia, the same pegging scheme would have to be complemented with a pound invoicing policy.

4) If oil was assumed to be invoiced in a basket of currencies, while the choice of the currency peg was limited to a single currency, variability in the domestic currency's real value of oil revenues would have been minimized if oil was invoiced in an import-weighted basket, while a peg to the dollar was adopted by Bahrain, Kuwait, and Saudi Arabia. For Qatar, an import-weighted basket would provide an optimal solution if it was supplemented by a peg to the franc. For Oman, an SDR invoicing scheme would have to be combined with a peg to the franc to yield optimal results, whereas it would have to be combined with the dollar for the U.A.E.

5) Considering the whole data range, there was conclusive evidence for an import-weighted basket as the optimal choice, if the invoicing basket was the same as the pegging basket. A minor gain in terms of stability was found for Oman if the SDR basket was adopted. However, when estimation was conducted over

the period 1979-1987, the case for the import-weighted basket was strengthened further, yielding overwhelmingly optimal results for all GCC countries.

6) An invoicing basket scheme for oil which differed from that adopted for the purpose of pegging the domestic currencies indicated the superiority of an import-weighted basket for invoicing, combined with a peg to a total trade-weighted basket. Indeed, this has proven to be the optimal policy whether the estimation covered the full data range or that from 1979 to 1987. Moreover, as trade shares were adjusted according to the percentage of trade invoiced in a particular currency rather than the direction of trade, the above choice continued to fulfill the optimality condition.

Stability in the real value of oil revenues in terms of the domestic currencies of the GCC countries was found to be influenced by several factors, such as trade shares, deviations from purchasing power parity and inflation rates in the countries of the trading partners. However, a prominent role was played by the degree and magnitude of covariations between the nominal value of oil revenues, defined in terms of the numeraire currency and the exchange rate(s) between the candidate currency(s) and the numeraire. Large and negative covariances increased the attractiveness of one currency over another. They also affected the optimality of one basket compared with another. For a basket scheme, these covariations were basically transmitted via basket weights and via the differences between basket weights and trade shares.

Although the findings have revealed varying levels of instability whenever alternative schemes were implemented, statistical evidence does not provide support to favor one choice over another. When the hypothesis of equality of variances was examined at a 5 percent level of confidence, there was no basis for rejecting this hypothesis for any set of variances.

B. Recommendations

At present, the member states of the Gulf Cooperation Council practically peg their currencies to the dollar, with the exception of Kuwait, which pegs to a total trade and investment-weighted basket of currencies. However the dollar retains the largest weight. Judging the findings of the present thesis in terms of the contribution of each alternative peg to the total instability of the weighted imported rate of inflation, one may find evidence to support alternative arrangements. Single currency pegs did not minimize the imported weighted rate of inflation, an outcome which may be explained by the diversified patterns of imports of the GCC member states. Alternative basket pegs which are defined in terms of trade weights have minimized the weighted imported inflation rates, relative to those that would have been experienced had a single currency peg been adopted. The empirical findings of this thesis found an import-weighted basket to yield superior results, compared to other baskets.

This conclusion supports that hypothesized in the literature, for example Crockett and Nsouli (1977). Justification for this rests on the characteristics of an import-weighted basket, which results in the domestic countries importing an average rate of instability of the inflation rates existing in the trading partners, whereas deviations from purchasing power parities amongst their currencies are eliminated.

A total trade-weighted basket would have resulted in a greater instability in the domestic rates of inflation, an outcome which may be attributed to the level of instability in the rates of inflation in the countries with whom total trade shares were large.

Moreover, the optimality of the SDR and the ECU baskets was questioned as a result of their inability to insulate the domestic economies of the GCC member states from deviations from purchasing power parity.

However, does this imply that the case for abandoning a dollar peg is worth pursuing ? We would be in a better position to answer this question when the choice of currency invoicing for oil has been examined. This matter is now discussed.

As a matter of tradition or of leadership, oil has been invoiced in dollars, a situation that has found little support in the present analysis. As has already been mentioned, a peg to a total trade-weighted basket, combined with an invoicing scheme for oil which is based on import shares, would have minimized the instability in the real value of oil revenues expressed in terms of individual currencies of the GCC member states. Consequently, adopting this alternative is recommended. However, once the results were subjected to statistical testing, one scheme could not be preferred to another. Based on the statistical evidence, it may be argued, therefore, that there is no justification for adopting an alternative invoicing scheme for oil, as well as an alternative choice of pegging. But if the levels of instability as measured by the standard deviation of the real value of oil emerging under the various alternatives considered in the present research are compared, there would be incentives to replace the current arrangements. For example, while the optimal choice of invoicing and pegging yielded almost half the standard deviation implied by other combinations, statistical testing showed no significant differences. Whether one should or should not rely on statistical methods in assessing the findings is an open question.

Nonetheless, even if the authorities were to engage in a policy shift of pegging and invoicing, several points are worth considering. Firstly, would any country be willing to allow its currency to play such a major role in international trade as that currently played by the dollar ? Secondly, are the GCC countries in a position that allows their decisions to be honored in the international market ? Above all they are small, but have a huge oil reserves. Thirdly, what would be the consequences of a shift in policy on the confidence in the domestic currencies, as the peg scheme is altered, and on the world demand for oil as the currency of invoicing is changed ? One may expect the latter to be a function of the world elasticity of demand for oil. Fourthly, a departure from the current invoicing-pegging policy into an alternative scheme which assigns weights to the pegging choice which differ from that assigned to the invoicing of oil, can disrupt the financial balance existing between oil revenues and government's planned expenditures. To elaborate further, currently oil is invoiced in dollars and all GCC countries peg to the dollar. This has been viewed as a means of minimizing uncertainty about the nominal value of oil revenues in terms of the domestic currencies. The current policy may also be justified on financial grounds. A peg to the dollar is seen to minimize the need for the authorities to alter policies so frequently, since they would have to replicate the behavior of variables via which demand for the dollar is affected. For example, following the interest rate of the U.S. may be easier or more efficient than following the behavior of several interest rates, which would have to occur if a basket peg was adopted. Moreover, the U.S. economy is considered to be the largest in the world, and the financial market for the dollar is widely available. Thus, if oil revenues are received in dollars, and the dollar is used as a common anchor for most international trade (the trade which is not denominated in dollars), it may be wise to keep oil invoiced in dollars.

A basket invoicing scheme would result in most countries defining oil in terms of various compositions of currencies, for which a common anchor would be difficult to define in a dynamic setting. Moreover, since oil is considered to be a homogenous commodity under a nonunique basket, there would be no assurances that importers would be paying the same price. This problem may be more complicated once the variation of trade shares across time is allowed for.

The evidence provided by the present work would have to be supplemented by further research and analysis of this issue itself, as well as of related matters. In particular, several points are worth noting. Firstly, the forecasting ability of the model. Secondly, the reaction of oil importers had oil been invoiced in alternative schemes. Thirdly, the impact of alternative invoicing policies on governments' revenues in the GCC. Fourthly, what would be the impact of invoicing oil in nonunique baskets on the monopolistic behavior of a group of exporters, such as a cartel ? Fifthly, the applicability of the model to other countries or other commodities would either enhance its importance, or would call for an improvement in its structure; nonetheless, either is equally an integral part of the learning process of the profession.

These questions are beyond the scope of the present thesis. However, within the terms of the model examined here, it is clear that there is a case for the adoption of a peg to a total trade-weighted basket, combined with an invoicing scheme for oil which is based on import shares; while it has been found that a total trade-weighted basket may import greater inflationary impulses than an import based one, the welfare approach here focuses upon stability in the real value of oil revenues and for this to be achieved the total trade-weighted/import-weighted combination of a peg and invoice seems best.

Appendix 1

This appendix includes the descriptive data and the data used in the estimation of the model. The sources of the data are either cited at the end of the tables, or referred to in the references listed below. Data reported are for: exchange rates, adjusted trade shares, differences between trade shares and the SDR and the ECU, deviations from PPP, weights of the currencies included in the SDR and the ECU, money supply, consumer price index, real growth rates, variances of various exchange rates, oil revenues, percentage change in oil revenues and total government revenues, are included.

Sources of data (All data are annual)

A) Consumer Price Index, line 64 of the International Financial Statistics (IFS), Yearbook 1988. For each country the data were derived from country page.

B) Money supply, line 35I (Money plus Quasi-Money), IFS, Yearbook 1988. Country page data were used for each country. For Luxembourg line 35I is not available, therefore the sum of lines 24 and 25 was used.

C) Trade shares, derived from country page of the IFS, Directions of Trade Statistics Yearbook 1988. The world total used was that of line 001 (DOTS world total).

D) Exchange rates data were obtained from IFS Yearbook 1988 for each country, with the following observed:

First: GCC member states.

1) Bahrain, BD/SDR, line ac
2) Bahrain, BD/dollar, line ag
3) Kuwait, KD/SDR, line ac
4) Kuwait, KD/dollar, line ag
5) Oman, RO/SDR, line aa
6) Oman, RO/dollar, line ae
7) Qatar, QR/SDR, line ac
8) Qatar, QR/dollar, line ag

9) Saudi Arabia, SR/SDR, line aa

10) Saudi Arabia, SR/dollar, line ae

11) U.A.E., Dh/SDR, line aa

12) U.A.E., Dh/dollar, line ae

Second: Industrial countries.

1) Belgium, franc/dollar, line ae

2) Denmark, krone/dollar, line ae

3) France, franc/SDR, line aa

4) France, franc/dollar, line ae

5) Germany, mark/SDR, line aa

6) Germany, mark/dollar, line ae

7) Ireland, pound/dollar, line ag

8) Italy, lira/SDR, line aa

9) Italy, lira/dollar, line ae

10) Luxembourg, franc/dollar, line ae

11) Netherlands, guilder/dollar, line ae

12) U.K., pound/SDR, line ac

13) U.K., pound/dollar, line ag

14) U.S., dollar/SDR, line sa

15) U.S., dollar/ECU, line ea

E) Reference to sources for other data are cited at the bottom of tables.

Notes on the calulations procedure

i) In general, the dollar has been used as the numeraire currency due to the role of the dollar in the international financial sector and its use in denomination of trade flows. Thus, it was used to determine the cross exchange rates between the various currencies.

ii) The percentage change in a variable was found according to the following log approximation method:
Percentage change in X = $100. * [\ln(X_t/X_{t-1})]$
where
X = variable which may represnt a series of data.

iii) Most figures were quoted to two decimal places, thus numbers may not round to a specific total and squaring a number may not result in the exact squared number reported.

Year	BD/$	KD/$	RO/$	QR/$	SR/$	Dh/$
1971	0.3751	0.3289	0.3838	4.3860	4.1500	4.3860
1972	0.3751	0.3289	0.3838	4.3860	4.1500	4.3860
1973	0.3974	0.2967	0.3454	3.9474	4.5500	4.0075
1974	0.3947	0.2896	0.3454	3.9474	4.5500	3.9805
1975	0.3955	0.2942	0.3454	3.9874	3.5500	3.9970
1976	0.3956	0.2870	0.3454	3.9584	3.5300	3.9970
1977	0.3956	0.2801	0.3454	3.9598	3.5050	3.8980
1978	0.3838	0.2718	0.3454	3.8385	3.3150	3.8380
1979	0.3770	0.2731	0.3454	3.7049	3.3650	3.7660
1980	0.3760	0.2713	0.3454	3.6399	3.3250	3.6710
1981	0.3760	0.2814	0.3454	3.6399	3.4150	3.6710
1982	0.3760	0.2887	0.3454	3.6399	3.4350	3.6710
1983	0.3760	0.2926	0.3454	3.6399	3.4950	3.6710
1984	0.3760	0.3045	0.3454	3.6399	3.5750	3.6710
1985	0.3760	0.2890	0.3454	3.6399	3.6450	3.6710
1986	0.3760	0.2923	0.3854	3.6399	3.7450	3.6710
1987	0.3760	0.2699	0.3854	3.6399	3.7450	3.6710
Average change	-0.962	-1.236	0.0113	-1.165	-0.641	-1.112
S.D.	2.691	3.954	3.882	2.782	7.100	2.325

BD: Bahraini dinar; KD: Kuwaiti dinar; RO: riyal Omani
QR: Qatari riyal; SR: Saudi riyal; Dh: U.A.E. Dirham
S.D.: Standard deviation.

Table 1: Exchange rates of the dollar in terms of the GCC currencies (1971-1987)

Year	BD/sdr	KD/sdr	RO/sdr	QR/sdr	SR/sdr	Dh/sdr
1971	0.4762	0.3571	0.4167	4.7619	4.5057	4.7619
1972	0.4762	0.3558	0.4167	4.7619	4.5057	4.7619
1973	0.4762	0.3579	0.4167	4.7619	4.2825	4.8344
1974	0.4833	0.3546	0.4229	4.8330	4.3464	4.8735
1975	0.4630	0.3444	0.4043	4.6679	4.1324	4.6791
1976	0.4597	0.3334	0.4013	4.5990	4.1013	4.6206
1977	0.4806	0.3402	0.4196	4.8100	4.2576	4.7349
1978	0.5001	0.3541	0.4500	5.0008	4.3187	5.0001
1979	0.4966	0.3598	0.4550	4.8807	4.4328	4.9611
1980	0.4795	0.3460	0.4405	4.6425	4.2407	4.6820
1981	0.4376	0.3276	0.4020	4.2367	3.9749	4.2729
1982	0.4148	0.3185	0.3810	4.0153	3.7892	4.0495
1983	0.3937	0.3063	0.3616	3.8108	3.6591	3.8434
1984	0.3686	0.2984	0.3386	3.5680	3.5043	3.5984
1985	0.4130	0.3175	0.3794	3.9982	4.0037	4.0323
1986	0.4599	0.3576	0.4703	4.4524	4.5808	4.4903
1987	0.5334	0.3829	0.5455	5.1640	5.3129	5.2079
Average change	0.709	0.435	1.683	0.506	1.029	0.559
S.D.	6.878	4.773	8.373	6.961	7.089	6.995

BD: Bahraini dinar; KD: Kuwaiti dinar; RO: riyal Omani
QR: Qatari riyal; SR: Saudi riyal; Dh: U.A.E. Dirham
S.D.: Standard deviation.

Table 2: Exchange rates of the SDR in terms of the GCC currencies (1971-1987)

Year	FF/$	DM/$	LL/$	YY/$	U.K./$
1971	5.2245	3.2685	594.00	314.80	0.3918
1972	5.1210	3.2015	282.50	302.00	0.4259
1973	4.7085	2.7030	607.90	280.00	0.4304
1974	4.4445	2.4095	649.40	300.95	0.4258
1975	4.4855	2.6223	683.60	305.15	0.4942
1976	4.9698	2.3625	875.00	292.80	0.5874
1977	4.7050	2.1050	871.60	240.00	0.5247
1978	4.1800	1.8280	892.80	194.60	0.4915
1979	4.0200	1.7315	804.00	239.70	0.4496
1980	4.5160	1.9590	930.50	203.00	0.4193
1981	5.7480	2.2548	1200.00	219.90	0.5241
1982	6.7250	2.3765	1370.00	235.00	0.6194
1983	8.3475	2.7238	1659.50	232.20	0.6894
1984	9.5920	3.1480	1936.90	251.10	0.8647
1985	7.5610	2.4610	1678.50	200.00	0.6923
1986	6.4550	1.9408	1358.10	159.10	0.6782
1987	5.3400	1.5815	1169.30	123.50	0.5343
Average change	0.136	-4.53	4.23	-5.84	0.479
S.D.	14.60	14.13	14.06	14.13	14.83

FF: French franc; DM: German mark; LL: Italian lira
YY: Japanese yen; U.K.: U.K. pound.
S.D.: Standard deviation.

Table 3: Exchange rates of the dollar in terms of the currencies of the industrial countries (1971-1987)

Year	SDR/$	ECU/$
1971	0.9211	n.a
1972	0.9211	n.a
1973	0.8289	n.a.
1974	0.8168	n.a.
1975	0.8542	n.a.
1976	0.8607	n.a.
1977	0.8232	n.a.
1978	0.7676	n.a.
1979	0.7591	0.6935
1980	0.7841	0.7636
1981	0.8591	0.9215
1982	0.9065	1.0334
1983	0.9552	1.2086
1984	1.0202	1.4106
1985	0.9104	1.1263
1986	0.8175	0.9342
1987	0.7049	0.7672
Average change	-1.671	1.262
Standard deviation	7.384	18.098

SDR: Special Drawing Rights.
ECU: European Currency Unit.

Table 4: Exchange rates of the dollar in terms of the SDR and the ECU (1971-1987)

	U.S.	Japan	France	Germany	Italy	U.K.	Total
Total Trade							
Actual	292.8	400.2	53.90	173.5	69.30	237.0	1,226.7
Actual shares	5.99	8.18	1.10	3.55	1.42	4.85	25.09
Adjusted shares	23.87	32.63	4.39	14.14	5.65	19.32	100.00
Imports							
Actual	213.7	133.8	37.50	145.0	62.8	210.3	803.10
Actual shares	8.94	5.60	1.57	6.07	2.63	8.80	33.61
Adjusted shares	26.61	16.66	4.67	18.06	7.82	26.19	100.00

Shares are in percentage, while others are in millions dollars.
Actual total trade with all countries in the world was $ 4,891 (millions) and total imports was $2,390 (millions).
Explanations: Actual shares of total trade may be found by dividing actual total trade of each country by total trade with all countries in the world. The same applies to imports. However, adjusted shares were found by dividing the actual trade by the corresponding sum of that column.

Table 5: Bahrain's trade with the industrial countries (1986)

	U.S.	Japan	France	Germany	Italy	U.K.	Total
Total Trade							
Actual	1,002	2,418	460.0	681.0	1,110	567.0	6,238.0
Actual shares	7.51	18.12	3.45	5.10	8.32	4.25	46.75
Adjusted shares	16.06	38.76	7.37	10.92	17.80	9.09	100.00
Imports							
Actual	723.0	1,354	321.0	527.0	369.0	483.0	3,777
Actual shares	12.83	24.03	5.70	9.35	6.55	8.57	67.03
Adjusted shares	19.14	35.92	8.50	13.95	9.77	12.79	100.00

Shares are in percentage, while others are in millions dollars.
Actual total trade with all countries in the world was \$ 13,341 (millions) and total imports was \$5,634 (millions).
Explanations: Actual shares of total trade may be found by dividing actual total trade of each country by total trade with all countries in the world. The same applies to imports. However, adjusted shares were found by dividing the actual trade by the corresponding sum of that column.

Table 6: Kuwait's trade with the industrial countries (1986)

	U.S.	Japan	France	Germany	Italy	U.K.	Total
Total Trade							
Actual	214.2	1,805	106.7	191.4	89.0	764.5	3,171.7
Actual shares	3.95	33.27	1.97	3.53	1.64	14.08	58.44
Adjusted shares	6.75	56.94	3.36	6.03	2.81	24.10	100.00
Imports							
Actual	175.6	319.9	98.0	185.1	78.10	645.8	1,502.5
Actual shares	6.41	11.67	3.58	6.75	2.85	23.56	54.82
Adjusted shares	11.69	21.29	6.52	12.32	5.20	42.98	100.00

Shares are in percentage, while others are in millions dollars.
Actual total trade with all countries in the world was $ 5,428 (millions) and total imports was $2,740 (millions).
Explanations: Actual shares of total trade may be found by dividing actual total trade of each country by total trade with all countries in the world. The same applies to imports. However, adjusted shares were found by dividing the actual trade by the corresponding sum of that column.

Table 7: Oman's trade with the industrial countries (1986)

	U.S.	Japan	France	Germany	Italy	U.K.	Total
Total Trade							
Actual	132.9	1,203.5	244.3	97.2	111.7	220.4	2,010
Actual shares	4.15	37.60	7.63	3.04	3.49	6.89	62.80
Adjusted shares	6.61	59.88	12.15	4.84	5.56	10.97	100.00
Imports							
Actual	68.50	164.0	85.5	95.40	59.40	180.6	653.40
Actual shares	6.25	14.97	7.81	6.14	5.42	16.49	57.00
Adjusted shares	10.48	25.10	13.09	14.60	9.09	27.64	100.00

Shares are in percentage, while others are in millions dollars.
Actual total trade with all countries in the world was $ 3,201 (millions) and total imports was $ 1,095.4 (millions).
Explanations: Actual shares of total trade may be found by dividing actual total trade of each country by total trade with all countries in the world. The same applies to imports. However, adjusted shares were found by dividing the actual trade by the corresponding sum of that column.

Table 8: Qatar's trade with the industrial countries (1986)

	U.S.	Japan	France	Germany	Italy	U.K.	Total
Total Trade							
Actual	7,480	7,864	3,234	2,496	3,298	3,013	27,385
Actual shares	15.95	16.77	6.90	5.32	7.03	6.43	58.40
Adjusted shares	27.31	28.72	11.81	9.112	12.04	11.0	100.00
Imports							
Actual	3,794	3,065	1,317	1,706	1,602	2,438	13,922
Actual shares	17.16	13.86	5.96	7.71	7.24	11.02	62.95
Adjusted shares	27.25	22.02	9.46	12.25	11.51	17.51	100.00

Shares are in percentage, while others are in millions dollars.
Actual total trade with all countries in the world was \$ 46,890 (millions) and total imports was \$ 22,114 (millions).
Explanations: Actual shares of total trade may be found by dividing actual total trade of each country by total trade with all countries in the world. The same applies to imports. However, adjusted shares were found by dividing the actual trade by the corresponding sum of that column.

Table 9: Saudi Arabia's trade with the industrial countries (1986)

	U.S.	Japan	France	Germany	Italy	U.K.	Total
Total Trade							
Actual	898.0	6,621	495.0	578.0	511.0	1,040	10,143
Actual shares	4.49	36.49	2.73	3.19	2.82	5.73	55.45
Adjusted shares	8.85	65.28	4.88	5.70	5.04	10.25	100.00
Imports							
Actual	543.0	1,147	346.0	537.0	407.0	942.0	3,922
Actual shares	8.04	16.99	5.13	7.96	6.03	13.96	58.11
Adjusted shares	13.84	29.25	8.82	13.69	10.38	24.02	100.00

Shares are in percentage, while others are in millions dollars.
Actual total trade with all countries in the world was $ 18,147 (millions) and total imports was $ 6,750 (millions).
Explanations: Actual shares of total trade may be found by dividing actual total trade of each country by total trade with all countries in the world. The same applies to imports. However, adjusted shares were found by dividing the actual trade by the corresponding sum of that column.

Table 10: U.A.E.'s trade with the industrial countries (1986)

	FF	DM	LL	YY	U.K.	U.S.
$\xi_{ff/i}$	n.a.	-0.21	0.16	-4.12	0.36	2.03
	n.a.	(6.75)	(11.12)	(12.20)	(9.22)	(13.59)
$\xi_{dm/i}$	0.021	n.a.	0.18	-4.10	0.34	2.05
	(6.75)	n.a.	(13.06)	(13.39)	(12.69)	(14.61)
$\xi_{ll/i}$	-0.16	-0.18	n.a.	-4.28	0.16	1.86
	(11.12)	(13.06)	n.a.	(15.15)	(11.76)	(15.16)
$\xi_{yy/i}$	4.12	4.10	4.28	n.a.	4.45	6.15
	(12.20)	(13.39)	(15.15)	n.a.	(13.42)	(14.88)
$\xi_{uk/i}$	-0.32	-0.34	-0.16	-4.45	n.a.	1.76
	(9.22)	(12.69)	(11.76)	(13.42)	n.a.	(14.55)
$\xi_{us/i}$	-2.03	-2.05	-1.86	-6.15	-1.70	n.a.
	(13.59)	(14.61)	(15.16)	(14.88)	(14.55)	n.a.

Standard deviations in parenthesis.
Positive value of $\xi_{j/i}$ implies that currency j has appreciated relative to currency i.

Table 11: Average and standard deviation in exchange rates from PPP (1971-1987), %

	U.S. β_{us} =0.42	Japan β_{yy} =0.15	France β_{ff} =0.12	Germany β_{dm} =0.19	U.K. β_{uk} =0.12	Italy β_{ll} =0.00
Bahrain	0.1539	-0.0166	0.0733	0.0092	-0.1419	0.0782
Kuwait	0.2286	-0.2092	0.0350	0.0505	-0.0079	0.0977
Oman	0.3031	-0.629	0.0548	0.0668	-0.3098	0.0520
Qatar	0.3152	-0.1010	-0.0109	0.0440	-0.1564	0.0909
Saudi A.	0.1475	-0.0702	0.0254	0.0675	0.0551	0.1151
U.A.E.	0.2816	-0.1425	0.0318	0.0531	-0.1202	0.1038

β_i = SDR weight.

Table 12: The differences between SDR weight and import shares

	U.S. $\beta_{us}=0.42$	Japan $\beta_{yy}=0.15$	France $\beta_{ff}=0.12$	Germany $\beta_{dm}=0.19$	U.K. $\beta_{uk}=0.12$	Italy $\beta_{ll}=0.00$
Bahrain	0.1813	-0.1763	0.0761	0.0486	-0.0732	0.0565
Kuwait	0.2594	-0.2376	0.0463	0.0808	0.0291	0.1780
Oman	0.3525	-0.4194	0.0864	0.1297	-0.1210	0.0281
Qatar	0.3539	-0.4488	-0.0015	0.1416	0.0103	0.0556
Saudi A.	0.1469	-0.1372	0.0019	0.0989	0.0100	0.1204
U.A.E.	0.3315	-0.5028	0.0712	0.1330	0.0175	0.0504

β_i = SDR weight.

Table 13: The differences between SDR weight and total trade shares

Currency	SDR weight (%)	ECU weight (%)
U.S. dollar	42.0	0.00
Japanese yen	15.0	0.00
Pound sterling	12.0	13.3
Deutsche mark	19.0	33.0
French franc	12.0	19.8
Belgian franc	0.00	9.3
Danish krone	0.00	3.1
Irish pound	0.00	1.1
Italian lira	0.00	9.5
Luxembourg franc	0.00	0.4
Netherlands guilder	0.00	10.5
Total weight	100.0	100.0

ECU weights as of September 16,1984, i.e. before the inclusion of the Greek drachma.

Table 14: Weights of the SDR and the ECU used in the estimation

Year	BD/ECU	KD/ECU	RO/ECU	QR/ECU	SR/ECU	Dh/ECU
1979	0.5436	0.3938	0.4980	5.3421	4.8519	5.2932
1980	0.4924	0.3552	0.4523	4.7668	4.3544	4.8075
1981	0.4080	0.3053	0.3748	3.9500	3.7059	3.9837
1982	0.3638	0.2793	0.3342	3.5223	3.3240	3.5524
1983	0.3110	0.2420	0.2857	3.0116	2.8917	3.0373
1984	0.2665	0.2158	0.2448	2.5803	2.5343	2.6023
1985	0.3338	0.2566	0.3066	3.2319	3.2364	3.2594
1986	0.4024	0.3129	0.4115	3.8961	4.0086	3.9294
1987	0.4900	0.3517	0.5011	4.7442	4.8812	4.7847

Table 15: Exchange rates of the ECU in terms of the GCC currencies (1979-1987)

Year	Bahrain	Kuwait	Oman	Qatar	Saudi A.	U.A.E.
1971	73.140	418.800	n.a.	462.900	3.590	n.a.
1972	87.880	493.600	44.80	664.100	5.040	n.a.
1973	99.640	536.300	46.60	777.000	6.810	2,257
1974	145.83	684.60	85.20	1,048.8	9.780	6,036
1975	184.22	891.10	118.00	1,748.8	17.780	8,820
1976	303.83	1,220.1	164.60	2,705.1	29.610	16,754
1977	355.50	1,568.7	206.60	3,567.0	45.560	15,540
1978	402.35	1,950.4	230.60	4,115.5	58.030	17,576
1979	411.87	2,262.7	246.20	4,511.4	65.980	18,222
1980	524.06	2,875.6	325.00	5,277.1	77.440	23,527
1981	730.54	3,866.0	450.70	7,475.1	102.99	29,094
1982	780.21	4,182.7	562.60	8,567.0	123.79	33,646
1983	843.11	4,367.8	672.30	8,487.7	137.08	36,342
1984	827.76	4,475.8	774.00	10,354	145.34	46,870
1985	903.31	4,435.3	894.40	11,305.4	147.01	49,887
1986	885.17	4,546.9	829.00	12,568.9	160.61	52,076
1987	968.45	4,762.0	882.00	13,649.9	168.40	54,940

All figures are in millions of domestic currencies except for Saudi Arabia, they are in billions of SR.

Table 16: Money plus Quasi-money in the GCC countries (1971-1987)

Year	Bahrain	Kuwait	Qatar	Saudi Arabia
1971	32.50	n.a.	n.a.	33.00
1972	34.10	52.40	n.a.	34.50
1973	39.00	56.80	n.a.	40.20
1974	48.50	64.10	n.a.	48.80
1975	56.40	69.50	n.a.	65.60
1976	69.10	73.10	n.a.	86.40
1977	81.40	80.40	n.a.	96.20
1978	94.20	87.40	n.a.	94.70
1979	96.30	93.50	93.50	96.40
1980	100.0	100.0	100.0	100.0
1981	111.3	107.4	108.5	102.7
1982	121.2	115.7	114.7	102.1
1983	124.8	121.2	117.9	101.5
1984	125.2	122.6	119.2	100.3
1985	121.9	124.4	121.4	97.00
1986	119.1	125.6	123.4	94.10
1987	117.0	126.4	n.a.	93.20

n.a.: Not available.
For the U.A.E. and Oman no comprehensive CPI is published
1980=100.

Table 17: Consumer Price Index in the GCC countries (1971-1987)

Year	U.S.	Japan	France	Germany	Italy	U.K.
1971	714.200	67,398	408.00	376.90	55,802	20.320
1972	806.500	84,040	484.00	429.80	65,808	25.980
1973	859.300	98,188	555.00	467.60	81,240	33.14
1974	905.500	109,494	654.00	501.40	94,020	37.43
1975	1,020.4	125,331	757.00	558.80	117,011	40.10
1976	1,159.9	142,249	850.00	601.00	141,599	44.74
1977	1,282.5	158,032	1,054	663.20	173,059	48.99
1978	1,381.3	178,720	1,173	731.20	212,943	56.12
1979	1,467.0	193,720	1,325	768.90	251,008	63.13
1980	1,570.5	206,987	1,428	803.90	285.247	74.79
1981	1,643.7	229,207	1,578	833.50	314,305	95.55
1982	1,787.1	246,584	1,746	890.90	369.724	106.41
1983	2,078.3	263,585	1,937	941.70	420,358	120.04
1984	2,266.6	281,809	2,096	994.50	465,668	134.93
1985	2,483.4	306,804	2,226	1,074.4	514,188	150.17
1986	2,706.8	335,307	2,365	1,144.4	556,058	184.00
1987	2,807.4	372,695	2,731	1,212.8	593,281	222.60

All figures are in billions of domestic currencies.

Table 18: Money plus Quasi-money in the industrial countries (1971-1987)

Year	U.S.	Japan	France	Germany	Italy	U.K.
1971	49.10	39.10	42.10	64.10	28.70	30.30
1972	50.80	41.00	44.70	67.70	30.40	32.50
1973	53.90	45.80	47.90	72.40	33.70	35.50
1974	59.80	56.40	54.50	77.40	40.10	41.10
1975	65.30	72.60	60.90	82.00	46.90	51.10
1976	69.10	79.40	66.80	85.60	54.80	59.60
1977	73.60	85.90	73.00	88.70	64.10	69.00
1978	79.20	89.50	79.70	91.10	71.10	74.70
1979	88.10	92.80	88.20	94.90	82.50	84.80
1980	100.0	100.0	100.0	100.0	100.0	100.0
1981	110.4	104.9	113.4	106.3	117.8	111.9
1982	117.1	107.8	126.8	111.9	137.2	121.5
1983	120.9	109.9	139.0	115.6	157.3	127.1
1984	126.1	112.3	149.3	118.4	174.3	133.4
1985	130.5	114.6	157.9	121.0	190.3	141.5
1986	131.1	115.3	161.9	120.7	204.3	146.4
1987	137.9	115.4	167.3	121.0	214.0	152.5

1980=100.

Table 19: Consumer Price Index in the industrial countries (1971-1987)

Country	1979	1980	1981	1982	1983	1984	1985	1986	1987
Belgium	93.80	100.0	107.6	117.0	126.0	134.0	140.5	142.3	144.5
Denmark	89.00	100.0	111.7	123.0	131.5	139.8	146.4	151.7	157.8
France	88.20	100.0	113.4	126.8	139.0	149.3	157.9	161.9	167.3
Germany	94.90	100.0	106.3	111.9	115.6	118.4	121.0	120.7	121.0
Ireland	84.60	100.0	120.4	141.0	155.8	169.2	178.4	185.2	191.0
Italy	82.60	100.0	119.5	139.2	159.5	176.8	193.0	204.3	214.0
Luxem-bourg	94.10	100.0	108.1	118.2	128.4	135.7	141.2	141.6	141.5
Nether-lands	93.90	100.0	106.7	113.0	116.2	120.0	122.7	122.0	122.3
U.K.	84.80	100.0	111.9	121.5	127.1	133.5	141.6	146.4	152.5

1980=100.

Table 20: Consumer Price Index in the ECU-member countries (1979-1987)

Year	Belgium	Denmark	France	Germany	Ireland
1979	1,527.0	150.38	1,325	768.9	3,878
1980	1,577.5	167.99	1,427	803.9	4,679
1981	1,677.3	186.21	1,577	833.5	5,183
1982	1,797.4	206.83	1,747	890.9	5,534
1983	1,946.7	247.57	1,937	941.7	5,903
1984	2,034.7	309.79	2,096	994.5	6,433
1985	2,142.3	366.67	2,226	1,074.4	6,753
1986	2,366.0	401.19	2,365	1,144.4	7,841
1987	2,580.6	417.79	2,730	1,212.8	8,532

All figures are in billions of the domestic currencies.

Table 21: Money supply (M2) in five member countries of the ECU (1979-1987)

Year	Italy	Luxembourg	Netherlands	U.K.
1979	251,008	138.9	223.61	63.13
1980	285,247	204.0	236.24	74.79
1981	314.305	225.6	254.52	95.55
1982	369,724	330.2	268.13	106.41
1983	420,358	316.4	281.31	120.04
1984	465,668	330.9	299.71	134.93
1985	514,188	409.1	320.11	150.17
1986	556,058	579.7	337.20	184.00
1987	593,281	588.6	343.48	222.60

All figures are in billions of the domestic currencies.

Table 22: Money supply (M2) in four member countries of the ECU (1979-1987)

Currency	β_i = ECU weight	$(\beta_i - \alpha_i)$ α_i = import share	$(\beta_i - \alpha_i)$ α_i = total trade share
U.S. dollar	0.00	-26.60	-23.87
Japanese yen	0.00	-16.60	-32.63
Pound sterling	13.3	-12.89	-6.02
Deutsche mark	33.0	14.94	18.86
French franc	19.8	15.13	15.41
Belgian franc	9.30	9.30	9.30
Danish krone	3.10	3.10	3.10
Irish pound	1.10	1.10	1.10
Italian lira	9.50	1.68	3.85
Luxembourg franc	0.40	0.40	0.40
Netherlands guilder	10.5	10.5	10.5

Table 23: Differences between ECU weights and trade shares (Bahrain)

Currency	β_i = ECU weight	$(\beta_i - \alpha_i)$ α_i = import share	$(\beta_i - \alpha_i)$ α_i = total trade share
U.S. dollar	0.00	-19.14	-16.06
Japanese yen	0.00	-35.92	-38.76
Pound sterling	13.3	0.510	4.21
Deutsche mark	33.0	19.05	22.08
French franc	19.8	11.30	12.43
Belgian franc	9.30	9.30	9.30
Danish krone	3.10	3.10	3.10
Irish pound	1.10	1.10	1.10
Italian lira	9.50	-0.27	-8.30
Luxembourg franc	0.40	0.40	0.40
Netherlands guilder	10.5	10.5	10.5

Table 24: Differences between ECU weights and trade shares (Kuwait)

Currency	β_i = ECU weight	$(\beta_i - \alpha_i)$ α_i = import share	$(\beta_i - \alpha_i)$ α_i = total trade share
U.S. dollar	0.00	-11.69	-6.75
Japanese yen	0.00	-21.29	-56.94
Pound sterling	13.3	-29.68	-10.80
Deutsche mark	33.0	19.68	26.97
French franc	19.8	13.28	16.44
Belgian franc	9.30	9.30	9.30
Danish krone	3.10	3.10	3.10
Irish pound	1.10	1.10	1.10
Italian lira	9.50	4.30	6.69
Luxembourg franc	0.40	0.40	0.40
Netherlands guilder	10.5	10.5	10.5

Table 25: Differences between ECU weights and trade shares (Oman)

Currency	β_i = ECU weight	$(\beta_i - \alpha_i)$ α_i = import share	$(\beta_i - \alpha_i)$ α_i = total trade share
U.S. dollar	0.00	-10.48	-6.61
Japanese yen	0.00	-25.10	-59.88
Pound sterling	13.3	-14.34	2.33
Deutsche mark	33.0	18.40	28.16
French franc	19.8	6.71	7.65
Belgian franc	9.30	9.30	9.30
Danish krone	3.10	3.10	3.10
Irish pound	1.10	1.10	1.10
Italian lira	9.50	0.41	3.94
Luxembourg franc	0.40	0.40	0.40
Netherlands guilder	10.5	10.5	10.5

Table 26: Differences between ECU weights and trade shares (Qatar)

Currency	β_i = ECU weight	$(\beta_i - \alpha_i)$ α_i = import share	$(\beta_i - \alpha_i)$ α_i = total trade share
U.S. dollar	0.00	-27.25	-27.31
Japanese yen	0.00	-22.02	-28.72
Pound sterling	13.3	-4.21	2.30
Deutsche mark	33.0	20.75	23.89
French franc	19.8	10.34	7.99
Belgian franc	9.30	9.30	9.30
Danish krone	3.10	3.10	3.10
Irish pound	1.10	1.10	1.10
Italian lira	9.50	-2.01	-2.54
Luxembourg franc	0.40	0.40	0.40
Netherlands guilder	10.5	10.5	10.5

Table 27: Differences between ECU weights and trade shares (Saudi Arabia)

Currency	β_i = ECU weight	$(\beta_i - \alpha_i)$ α_i = import share	$(\beta_i - \alpha_i)$ α_i = total trade share
U.S. dollar	0.00	-13.84	-8.85
Japanese yen	0.00	-29.25	-65.28
Pound sterling	13.3	-10.72	3.05
Deutsche mark	33.0	19.31	27.30
French franc	19.8	10.98	14.92
Belgian franc	9.30	9.30	9.30
Danish krone	3.10	3.10	3.10
Irish pound	1.10	1.10	1.10
Italian lira	9.50	-0.88	4.46
Luxembourg franc	0.40	0.40	0.40
Netherlands guilder	10.5	10.5	10.5

Table 28: Differences between ECU weights and trade shares (U.A.E.)

Currency	$E_{i/us}$	$\xi_{us/i}$
Japanese yen	2.15 (15.02)	0.421 (15.39)
Pound sterling	2.15 (18.33)	0.421 (19.10)
Deutsche mark	-1.13 (18.33)	1.43 (18.33)
French franc	3.54 (19.63)	1.14 (18.32)
Belgian franc	2.09 (19.72)	2.28 (19.64)
Danish krone	1.59 (18.45)	0.039 (18.06)
Irish pound	3.08 (17.52)	-1.49 (14.76)
Italian lira	4.68 (18.29)	-1.63 (15.99)
Luxembourg franc	2.09 (19.72)	2.59 (18.98)
Netherlands guilder	-0.86 (18.63)	1.42 (18.77)

ECU weights are as of September 16,1984.
$E_{i/us}$: Price of the dollar in terms of currency i.
$\xi_{us/i}$: Deviations from PPP.
Standard deviations in parenthesis.

Table 29: Means and standard deviations of changes in the exchange rates of the ECU-currencies and the dollar and deviations from PPP (1979-1987)

Year	U.S.	Japan	France	Germany	Italy	U.K.
1972	4.33	4.12	3.16	8.19	2.18	4.85
1973	5.29	4.57	6.79	7.59	7.62	5.06
1974	3.06	0.18	4.05	-1.42	-1.12	-0.53
1975	-0.27	-1.45	-3.70	2.64	-0.72	-1.26
1976	4.15	5.42	5.70	4.68	3.75	4.76
1977	3.16	2.61	1.88	5.19	1.01	4.56
1978	3.29	3.21	2.64	5.06	3.86	5.15
1979	3.19	3.87	4.78	5.15	2.11	2.44
1980	1.61	1.45	3.83	4.18	-2.09	-0.15
1981	1.16	0.02	1.13	3.60	-0.95	1.91
1982	2.51	-0.97	0.24	3.03	1.11	-2.58
1983	0.69	1.87	1.04	3.18	3.48	3.50
1984	1.30	3.23	3.12	4.95	2.05	6.23
1985	1.64	2.00	2.79	4.59	3.84	3.34
1986	2.06	2.42	2.88	2.45	2.89	2.85
1987	2.15	1.66	3.05	4.29	3.58	2.84

Source: IFS, Yearbook 1988, country page. For France, line 99br ; Germany, line 99ar; Italy, line 99br; Japan, line 99ar; U.K., line 99bp; U.S., line 99ar.

Table 30: Real growth rates in the industrial countries (1972-1987), %

	Franc	Mark	Lira	Yen	Pound	Dollar
Franc	0.00	41.71	111.34	166.71	84.05	213.22
Mark	41.71	0.00	157.77	165.38	125.66	199.87
Lira	111.34	157.77	0.00	231.66	144.31	255.71
Yen	166.71	165.38	231.66	0.00	155.61	199.84
Pound	84.05	125.66	144.31	155.61	0.00	220.17
Dollar	213.22	199.87	255.84	199.84	220.17	0.00

The variances are in terms of percentage.
The numbers to be read as exchange rates between the currencies on the first row and those on the first column.

Table 31: Variances of various exchange rates (1971-1987)

	Franc	Mark	Lira	Yen	Pound	Dollar
Franc	0.00	23.61	21.43	95.39	106.70	385.56
Mark	23.61	0.00	14.74	108.57	149.98	336.03
Lira	21.43	14.74	0.00	90.24	152.80	334.53
Yen	95.39	108.57	90.24	0.00	46.24	225.69
Pound	106.70	149.98	152.80	46.24	0.00	354.80
Dollar	385.56	336.03	334.53	255.69	354.80	0.00
Belgian franc	11.68	26.91	19.19	91.76	131.65	389.14
Danish krone	5.83	10.18	9.48	82.76	118.15	340.68
Luxembourg franc	11.68	26.91	19.19	91.76	131.65	389.14
Irish pound	8.97	18.51	29.97	89.54	101.76	307.26
Netherlands guilder	17.80	0.86	13.51	103.44	140.41	347.29

Notes in Table (31) apply here.

Table 32: Variances of various exchange rates (1979-1987)

	Belgian franc	Danish Krone	Luxembourg franc	Irish pound	Netherlands guilder
Belgian franc	0.00	6.44	0.00	24.76	22.99
Danish krone	6.44	0.00	6.44	10.40	7.83
Luxembourg franc	0.00	6.44	0.00	24.76	22.99
Irish pound	24.76	10.40	24.76	0.00	14.99
Netherlands guilder	22.99	7.83	22.99	14.99	0.00

Notes in Table (31) apply here.

Table 33: Variances of various exchange rates (1979-1987)

Currencies	1979-1987 (%)	1971-1987 (%)
Belgian franc	1,197.131	d.a.
Luxembourg franc	1,197.131	d.a.
Danish krone	1,175.212	d.a.
Netherlands guilder	1,226.666	d.a.
Irish pound	1,079.032	d.a.
U.S. dollar	541.974	1,170.49
French franc	1,184.855	1,351.20
Deutsche mark	1,243.725	1,319.67
Japanese yen	775.524	2,397.10
Italian lira	1,215.109	1,560.73
British pound	881.821	1,271.46

d.a.: Does not apply.

Table 34: Variances of Bahrain's oil revenues expressed in alternative currencies

Currencies	1979-1987 (%)	1971-1987 (%)
Belgian franc	976.60	d.a.
Luxembourg franc	976.60	d.a.
Danish krone	976.04	d.a.
Netherlands guilder	1,091.10	d.a.
Irish pound	908.23	d.a.
U.S. dollar	629.43	1,460.78
French franc	965.52	1,453.10
Deutsche mark	1,091.41	1,455.73
Japanese yen	719.52	1,981.57
Italian lira	1,046.65	1,766.12
British pound	662.23	1,372.77

d.a.: Does not apply.

Table 35: Variances of Kuwait's oil revenues expressed in alternative currencies

Currencies	1979-1987 (%)	1971-1987 (%)
Belgian franc	1,851.91	d.a.
Luxembourg franc	1,851.91	d.a.
Danish krone	1,786.40	d.a.
Netherlands guilder	1,822.43	d.a.
Irish pound	1,594.40	d.a.
U.S. dollar	1,087.36	1,458.79
French franc	1,762.20	1,686.29
Deutsche mark	1,833.08	1,727.98
Japanese yen	1,361.32	2,034.63
Italian lira	1,921.64	1,968.91
British pound	1,200.90	1,523.90

d.a.: Does not apply.

Table 36: Variances of Oman's oil revenues expressed in alternative currencies

Currencies	1979-1987 (%)	1971-1987 (%)
Belgian franc	2,308.44	d.a.
Luxembourg franc	2,308.44	d.a.
Danish krone	2,268.90	d.a.
Netherlands guilder	2,382.75	d.a.
Irish pound	2,082.31	d.a.
U.S. dollar	1,358.34	1,848.28
French franc	2,219.91	2,083.66
Deutsche mark	2,406.16	2,108.46
Japanese yen	1,835.82	2,525.15
Italian lira	2,337.21	2,493.94
British pound	1,819.11	2,026.22

d.a.: Does not apply.

Table 37: Variances of Qatar's oil revenues expressed in alternative currencies

Currencies	1979-1987 (%)	1971-1987 (%)
Belgian franc	1,748.62	d.a.
Luxembourg franc	1,784.62	d.a.
Danish krone	1,784.19	d.a.
Netherlands guilder	1,796.90	d.a.
Irish pound	1,625.43	d.a.
U.S. dollar	1,319.36	2,870.09
French franc	1,713.93	2,900.92
Deutsche mark	1,840.21	2,880.20
Japanese yen	1,260.71	3,416.37
Italian lira	1,806.18	3,175.88
British pound	1,267.07	2,805.47

d.a.: Does not apply.

Table 38: Variances of Saudi Arabia's oil revenues expressed in alternative currencies

Currencies	1979-1987 (%)	1971-1987 (%)
Belgian franc	1,140.53	d.a.
Luxembourg franc	1,140.53	d.a.
Danish krone	1,096.35	d.a.
Netherlands guilder	1,147.75	d.a.
Irish pound	970.65	d.a.
U.S. dollar	622.36	1,530.73
French franc	1,065.27	1,595.61
Deutsche mark	1,169.49	1,601.07
Japanese yen	708.62	2,039.78
Italian lira	1,156.92	1,868.89
British pound	649.19	1,537.99

d.a.: Does not apply.

Table 39: Variances of the U.A.E.'s oil revenues expressed in alternative currencies

Year	Bahrain	Kuwait	Oman	Qatar	Saudi A.	U.A.E.
1971	222.30	2,319.52	228.50	326.04	4,014.46	867.077
1972	242.82	2,378.33	229.80	381.67	5,472.29	1,035.34
1973	335.40	3,518.46	332.36	607.99	6,356.04	1,735.0
1974	1,090.08	10.519.7	1,136.07	1,979.27	35,622.5	6,272.08
1975	990.62	8,306.24	1,439.20	1,732.21	29,475.9	6,745.81
1976	1,170.74	9,122.42	1,561.96	2,139.78	38,501.40	8,291.97
1977	1,446.99	8,980.73	1,568.62	1,981.43	43,786.0	9,270.91
1978	1,525.34	9,535.01	1,502.90	2,317.33	38,343.9	8,736.06
1979	2,049.06	16,969.6	2,152.00	3,661.33	58,549.8	13,031.9
1980	3,209.87	17,612.8	3,280.83	5,412.46	101,474.0	19,582.1
1981	3,881.95	13,661.1	4,402.72	5,316.03	110,483.0	18,760.6
1982	3,145.24	8,803.25	4,099.02	4,078.64	73,117.9	15,955.6
1983	2,586.20	9,700.23	4,202.66	3,045.66	42,314.7	13,016.3
1984	2,712.26	10,443.4	3,905.91	4,322.05	33,770.6	12,037.3
1985	2,442.31	10,215.6	4,684.71	3,458.03	25,935.8	11,621.1
1986	1,970.23	6,378.05	2,469.96	1,668.98	17.793.9	7,508.85
1987	1,966.77	7,519.87	3,165.41	1,780.96	20.480.9	8,720.78

Source: IFS, Yearbook 1988, country page. However, for Oman, revenues for 1987 were derived from IFS, Yearbook 1989.
For Kuwait, Qatar, Saudi Arabia and the U.A.E., data for 1985-1987 were derived from OPEC Annual Statistical Bulletin, 1987, p. 6.

Table 40: Oil revenues of the GCC member states, 1971-1987 (millions of dollars)

Year	Bahrain	Kuwait	Oman	Qatar	Saudi A.	U.A.E.
1972	8.82	2.50	0.568	15.75	30.97	17.73
1973	32.30	39.16	36.90	46.56	14.97	51.62
1974	117.86	109.52	122.90	118.03	172.35	128.51
1975	-9.56	-23.62	23.65	-13.33	-18.94	7.28
1976	16.70	9.37	8.18	21.13	26.71	20.63
1977	21.18	-1.56	0.425	-7.68	12.86	11.15
1978	5.27	5.98	-4.28	15.65	-13.27	-5.94
1979	29.51	57.64	35.90	45.74	42.32	39.99
1980	44.88	3.72	42.17	39.08	54.99	40.72
1981	19.01	-25.40	29.41	-1.79	8.50	-4.28
1982	-21.04	-43.94	-7.14	-26.49	-41.27	-16.19
1983	-19.57	9.70	2.49	-29.20	-54.69	-20.36
1984	4.75	7.38	-7.32	35.00	-22.55	-7.81
1985	-10.48	-2.20	18.18	-22.30	-26.39	-3.51
1986	-21.47	-47.10	-64.01	-72.84	-37.67	-43.67
1987	-0.175	16.46	24.80	6.49	14.06	14.96

Source: Derived from Table (40)

Table 41: Percentage change in oil revenues of the GCC member states (1972-1987)

Year	Total revenues	% change in revenues	Total expenditures	% change in expenditures	Budget situation
1974	117.5	-	67.0	-	50.50
1975	129.0	9.33	112.3	51.64	16.70
1976	186.7	36.96	190.9	53.05	-4.20
1977	255.1	31.21	242.5	23.92	12.60
1978	274.1	7.18	285.3	16.25	-11.20
1979	304.3	10.45	254.5	-11.42	49.80
1980	445.7	38.16	317.2	22.02	128.50
1981	536.6	18.56	380.2	18.11	156.40
1982	654.2	19.81	473.2	21.98	180.50
1983	490.5	-28.79	535.1	12.18	-44.60
1984	523.0	6.41	538.6	0.65	-15.60
1985	541.4	3.45	508.5	-5.75	32.90
1986	459.8	-16.33	495.1	-2.67	-35.30
1987	414.0	-10.49	418.0	-16.92	-4.00

Source: Revenues are from lines 81 and 81z, IFS, Yearbook, 1989 (country page). Expenditures are from the same source, line 82.

Table 42: Bahraini government total revenues and expenditures in millions of dinars (1974-1987)

Year	Total revenues	% change in revenues	Total expenditures	% change in expenditures	Budget situation
1974	2,749.9	-	1,162.9	-	1,587.0
1975	3,224.4	15.91	1,337.4	13.98	1,887.0
1976	3,033.1	-6.11	1,519.3	12.75	1,513.8
1977	3,093.4	1.96	1,959.2	25.42	1,134.2
1978	3,697.7	17.84	1,943.9	-0.78	1,753.8
1979	6,968.3	63.36	2,423.7	22.05	4,544.6
1980	6,145.6	-12.56	2,957.8	19.91	3,187.8
1981	4,675.8	-27.33	3,687.8	22.05	988.0
1982	3,008.6	-44.09	3,743.6	1.50	-735.0
1983	2,602.1	-14.51	3,538.5	-5.63	-936.4
1984	3,037.0	15.45	3,710.0	4.73	-673.0
1985	2,330.8	-26.46	3,047.9	-19.65	-717.1
1986	1,675.6	-33.00	2,689.8	-12.49	-1,014.2
1987	2,517.4	40.70	2,520.1	-6.51	-2.70

Source: Quarterly Statistical Bulletin, Central Bank of Kuwait, (various issues).

Table 43: Kuwaiti government total revenues and expenditures in millions of dinars (1974-1987)

Year	Total revenues	% change in revenues	Total expenditures	% change in expenditures	Budget situation
1974	311.5	-	329.3	-	-17.80
1975	430.3	32.30	466.5	34.82	-36.20
1976	475.3	9.94	551.0	16.64	-75.70
1977	576.1	19.23	497.7	-10.17	78.40
1978	447.6	-25.23	498.7	0.20	-51.10
1979	652.5	37.69	548.8	9.57	103.70
1980	829.1	23.95	794.9	37.04	34.20
1981	1,125.9	30.59	1,028.0	25.71	97.90
1982	1,001.2	-11.73	1,176.5	13.49	-175.30
1983	1,124.4	11.60	1,308.1	10.60	-183.70
1984	1,214.4	7.70	1,501.0	13.75	-286.60
1985	1,397.6	14.05	1,731.1	14.26	-333.50
1986	895.0	-44.56	1,587.2	-8.67	-692.20
1987	1,199.4	29.27	1,330.1	-17.67	-130.70

Source: Revenues are from lines 81h and 81z, IFS, Yearbook, 1989 (country page). Expenditures are from the same source, line 82.h.

Table 44: Omani government total revenues and expenditures in millions of riyals (1974-1987)

Year	Total revenues	% change in revenues	Total expenditures	% change in expenditures	Budget situation
1974	5,497	-	1,9731	-	3,566
1975	7,135	26.08	5,302	101.0	1,833
1976	8,927	22.40	5,809	9.13	3,118
1977	8,155	-9.04	7,318	23.09	837.0
1978	8,225	0.85	6,473	-12.26	1,752
1979	12,090	38.52	8,270	24.49	3,820
1980	19,003	45.22	10,937	27.95	8,066
1981	19,243	1.25	14,743	29.86	4,500
1982	12,434	-35.93	12,619	-15.55	815.0
1983	8,911	-40.05	15,350	19.59	-6,439
1984	13,610	42,35	12,173	-23.18	1,437
1985	10,393	-26.96	10,374	-15.99	19.00
1986	5,884	-56.88	10,433	0.56	-4.549
1987	12,217	12.16	-5,572	15.78	-5,572

Source: Revenues are from lines 81, IFS, Yearbook, 1989 (country page) Expenditures are from the same source, line 82. However, data for 1983-1987 are from: The Economist Intelligence Unit, Bahrain and Qatar, Country Profile, 1986/1987 and 1989/1990 issues.

Table 45: Qatari government total revenues and expenditures in millions of riyals (1974-1987)

Year	Total revenues	% change in revenues	Total expenditures	% change in expenditures	Budget situation
1974	41,705	-	18,595	-	23,110
1975	100,103	87.55	35,039	63.35	65,064
1976	95,040	-5.19	81,783	84.76	13,257
1977	121,198	24.31	106.867	26.75	14,331
1978	120,407	-0.65	111,400	4.15	9,007
1979	211,200	56.19	188,000	52.33	23,200
1980	348,100	49.96	236,600	22.99	111,500
1981	368,000	5.55	284,700	18.50	83,300
1982	246,256	-40.17	243,796	-15.51	2,460
1983	206,418	-17.64	230,186	-5.51	-23,768
1984	171,510	-18.52	216,363	-6.19	-44,853
1985	133,565	-25.00	184,004	-16.20	-50,439
1986	76,498	-55.73	137,442	-29.17	-60,944
1987	103,811	30.53	173,526	23.31	-69,715

Source: Revenues and expenditures data from: Statistical Summary Saudi Arabia Monetary Agency (various issues). However, data for for 1982-1987 are from: The Economist Intelligence Unit, Saudi Arabia, Country Profile, 1989/1990.

Table 46: Saudi Arabian government total revenues and expenditures in millions of riyals (1974-1987)

Year	Total revenues	% change in revenues	Total expenditures	% change in expenditures	Budget situation
1974	801.00	-	734.00	-	67.00
1975	1,773	79.45	1,157	45.50	616.00
1976	3,102	55.93	2,144	61.68	958.00
1977	5,995	65.88	5,068	86.02	927.00
1978	6,984	15.26	6,815	29.61	-1,148.0
1979	8,863	23.82	8,132	17.66	731.00
1980	17,608	68.64	13,332	49.43	4,276.0
1981	22,460	24.33	18,666	33.65	3,794.0
1982	16,101	-33.28	19,980	6.80	-3,879.0
1983	13,807	-15.37	16,310	-20.29	-2,483.0
1984	12,827	-7.36	15,669	-4.00	-2,842.0
1985	15,525	19.08	15,939	1.70	-414.0
1986	12,817	-19.16	13,368	-17.59	-551.0
1987	11,274	-12.82	13,258	-0.82	-1,984.0

Source: Revenues from IFS, Yearbook 1989, country page, line 81 plus line 81z. Expenditures are from line 82.

Table 47: The U.A.E. government total revenues and expenditures in millions of dirhams (1974-1987)

Country	Actual export	Actual share (%)	Adjusted share (%)
U.S.	79.10	3.04	18.67
Japan	266.4	10.25	62.89
France	16.40	0.63	3.87
Germany	28.50	1.10	6.73
Italy	6.50	0.25	1.53
U.K.	26.70	1.03	6.30
Total	423.6	16.30	100.0

Actual total exports in 1986 was $2,599.6 (millions).

Table 48: Bahrain's export shares (1986) expressed in millions of dollars or percentage

Country	Actual export	Actual share (%)	Adjusted share (%)
U.S.	279.0	3.63	11.34
Japan	1,064	13.83	43.23
France	139.0	1.81	5.65
Germany	154.0	2.00	6.65
Italy	741.0	9.63	30.11
U.K.	84.00	1.09	3.41
Total	2,461	31.99	100.0

Actual total exports in 1986 was $7,696.0 (millions).

Table 49: Kuwait's export shares (1986) expressed in millions of dollars or percentage

Country	Actual export	Actual share (%)	Adjusted share (%)
U.S.	38.60	1.44	2.31
Japan	1,486	55.51	89.02
France	8.70	0.32	0.52
Germany	6.30	0.24	0.38
Italy	10.90	0.41	0.65
U.K.	118.7	4.43	7.11
Total	1,669.2	62.35	100.0

Actual total exports in 1986 was $2,677.1 (millions).

Table 50: Oman's export shares (1986) expressed in millions of dollars or percentage

Country	Actual export	Actual share (%)	Adjusted share (%)
U.S.	64.00	3.00	4.72
Japan	1,039.5	48.65	76.65
France	158.8	7.43	11.71
Germany	1.80	0.80	0.13
Italy	52.30	2.45	3.86
U.K.	39.80	1.86	2.93
Total	1,356.2	64.19	100.0

Actual total exports in 1986 was $2,136.8 (millions).

Table 51: Qatar's export shares (1986) expressed in millions of dollars or percentage

Country	Actual export	Actual share (%)	Adjusted share (%)
U.S.	3,686	14.93	27.38
Japan	4,799	19.44	35.65
France	1,917	7.76	14.24
Germany	790.0	3.20	5.87
Italy	1,696	6.87	12.60
U.K.	575.0	2.33	4.27
Total	13,463	54.53	100.0

Actual total exports in 1986 was $24,692 (millions).

Table 52: Saudi Arabia's export shares (1986) expressed in millions of dollars or percentage

Country	Actual export	Actual share (%)	Adjusted share (%)
U.S.	355.0	3.04	5.71
Japan	5,474	46.81	87.99
France	149.0	1.27	2.40
Germany	41.00	0.35	0.66
Italy	104.0	0.89	1.67
U.K.	98.00	0.84	1.58
Total	11,693	53.20	100.0

Actual total exports in 1986 was \$6,221 (millions).

Table 53: U.A.E.'s export shares (1986) expressed in millions of dollars or percentage

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