CURRENCY DEVALUATIONS AND IMPLICATIONS OF THE CORRESPONDENCE PRINCIPLE

CURRENCY DEVALUATIONS AND IMPLICATIONS OF THE CORRESPONDENCE PRINCIPLE

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ABSTRACT

Are devaluations contractionary? Do devaluations ensure improvement in the balance of payments? These questions have attracted much attention in recent years, since during that time, macro-economists have developed models involving intermediate imports. In such a framework, the exchange rate has both expansionary demand-side and contractionary supply-side effects.

A number of studies, both theoretical and empirical, have explored the relative size of the competing effects that follow from devaluations. However, most of the studies involve very limited or specialized models. For example, most studies deal with a specific form of the production function, and dynamic analysis of exchange rate devaluation is almost always absent. As a result, very few studies shed any light on the relationship between stability of the model and the likelihood of contractionary devaluation. Furthermore, except for one, none of the studies has examined devaluation's effects under different tax system.

In this thesis, we extend those models which have imposed the bare minimum of restrictions on the production relationship, and which pay explicit attention to dynamics. The whole thesis can be viewed as two main essays. In the first main essay (Chapters 3 and 4) we focus on the likelihood of contractionary devaluation in a model with a general production function involving imported inputs. In this essay the inconsistencies in Buffie (International Economic Review 1986) are corrected. Furthermore, some sensitivity tests are also performed in this essay. These stem from the alternative specifications of wage flexibility, inflationary expectations, the definition of the money demand function, and alternative degrees of capital mobility. In the second main essay (Chapter 5) a sensitivity analysis of an improved version of the Lai and Chang model (Journal of Macroeconomics 1989) is presented. In this essay we have investigated how the supply-side effects of taxes and exchange rates interact (when the tax systems is not fully indexed) to complicate the effects of devaluation.

In our first essay we noticed that regardless of alternative specifications of wage flexibility and of inflationary expectations the strong Buffie's results do not hold in general. Buffie derived the result that if the system is locally stable then devaluation cannot both contract employment and worsen the balance of payments of the country. Furthermore, if labour and the imported inputs are gross substitutes then devaluation both increases employment and improves the balance of payments (given stability). However, when we assume that the aggregate demand function for goods is negatively sloped in the price/output plane then it is seen that in stable economies all the results derived by Buffie hold true.

In this same essay we found that in case of perfect capital mobility the employment effect of devaluation largely depends upon the alternative specifications of the wage flexibility and of inflationary expectations. It is seen that if workers have perfect foresight then devaluation has an ambiguous effect on employment, expansionary when workers have static expectations, and neutral when the real wage is sticky at each point in time.

As far as our second essay is concerned, we have studied the effects of devaluations when the supply-side effects of exchange rates are studied through the labour market. We have developed a model which contains the Lai and Chang model as a special case. For convenience, however, we have solved the model for two cases, one which addresses taxation issues and one which deals with Laursen-Metzler effects. The models in both taxation issues and Laursen and Metzler cases are solved for zero and perfect capital mobility.

For zero capital mobility and with plausible parameter values, we found that the strong Lai and Chang result holds true. Lai and Chang derived the result that if workers are free of any money illusion then regardless of the nature of the tax system (*proportional versus progressive*) devaluation necessarily contracts output. When we permitted some money illusion it is seen that the output effect of devaluation cannot be determined conclusively. However, with perfect capital mobility, or with government policy that fixes the domestic rate of interest, (and assuming plausible parameters values) it is seen that if workers are not suffering from any money illusion, then devaluation is neutral for proportional taxation, contractionary for progressive taxation, and expansionary for regressive taxation. On the other hand, when we permitted some money illusion it is seen that the output will increase with devaluation both for proportional and regressive taxation. While in the case of progressive taxation, the output effect of devaluation largely depends upon the output elasticity of the tax system and of the degree of money illusion.

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Chapter 1

GENERAL INTRODUCTION TO THE THESIS

1.1 OVERVIEW

The effects of devaluations on the economy have caused a great deal of concern in recent years. Whether devaluations are contractionary, or if they decrease the balance of payments deficit are the issues currently under investigation. These questions in particular were raised in the 1970s when the world experienced the first oil price shock. This oil, shock re-vitalized economists' interest in the aggregate supply side of the economy. In particular, the supply-side effects of the exchange rate became under increased scrutiny. As many countries use oil as an intermediate import, the conventional wisdom that devaluation of the domestic currency improves the payments balance and increases employment is threatened. The reason is that in the presence of imported inputs such as oil the exchange rate has both expansionary demand-side and contractionary supply-side effects. The net effect of a devaluation policy on real variables of the economy depends upon these competing demand and supply side effects of the exchange rate. This gives rise to the need of developing economic models which can be used to explore the relative size of the competing effects that follow from devaluations. Since the major portion of this thesis involves the effects of devaluations on demand and supply sides of the economy, caused by the exchange rate, it is important that these concepts are well understood.

In simple terms **devaluation** means a reduction in the official value of domestic currency. It occurs when a unit of a nation's currency can buy fewer units of foreign currency. In this case the exchange rate is treated as an exogenous variable, where its value is predetermined. Its counterpart, the depreciation of the domestic currency means that the value of the exchange rate is continuously changing due to changes in the demand for and the supply of foreign currency. Due to excess supply of domestic currency, the value of the exchange rate decreases. Hence the exchange rate is treated as an endogenous variable. Except for expectations effects, the impact exerted on economic variables by depreciation of the domestic currency is the same as that exerted by devaluation of the domestic currency. For the purpose of this thesis, the exchange rate is assumed to be an exogenous variable and considered as a key policy option for the authorities.

How does the exchange rate effect the demand and supply of the domestic good? A simple example related to imports and exports of a country can illustrate these concepts. If the devaluing country imports finished goods only, then following the familiar supply/demand principles, devaluation of her currency will be expected to result in an increase in the demand for its exports and a decrease in the demand for its imports. Consequently, due to substitution effects the net demand for the home goods will be increased. This is known as the positive demand-side effect of the exchange rate. Its opposite, a negative demand-side effect of the exchange rate occurs when for some reason, such as low export and import demand price elasticities, the demand for home goods falls as a result of devaluation.

The concept of supply-side effects of the exchange rate is similar to that of demand side. When a country importing intermediary inputs for production purposes devalues her currency then due to the increase in the price of imported inputs the production costs for a specific level of output will increase. This exerts a negative impact upon output and is thus called a negative supply-side effect of the exchange rate.

Apart from imported inputs the supply-side effects of the exchange rate can be examined either through the labour market clearing condition or through the cost of working capital. Some economists have assumed that labour supply depends on the real wage rate--the wage deflated by the consumer price index (CPI). The CPI is a weighted average of the prices of domestically produced goods and finished imported goods[1]. While other economists have assumed that the rate of interest is a part of direct business costs, since firms must hold working capital[2]. As a result of devaluation both the CPI and the rate of interest increase, exerting a negative impact upon output by increasing the

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[1]See, for example, Lai and Chang (1989) and Salop (1974).

[2]See, for example, Calvo (1983).

cost of producing a given level of output. In the analysis presented in this thesis, the supply-side effects of the exchange rate are examined both through the labour market clearing condition and imported inputs.

The supply-side effects of the exchange rate were ignored in the more conventional economic literature. Earlier analysis of devaluation were centred around the familiar Marshall-Lerner Condition[3] (MLC). A conventional Keynesian economist such as Meade (1951) concludes in his work that due to widespread unemployment and imperfect competition, the prices of many home goods are sticky. If a country's currency devalues, then in the presence of MLC, the aggregate demand function shifts outwards. This, together with the horizontal aggregate supply function, stimulates domestic output and improves the balance of payments. Other economists such as Diaz-Alejandro (1963) hold the opinion that devaluation can be contractionary in the short-run even without the presence of a negative supply-side effects of the exchange rate. He challenges Meade's (1951) claim with the argument that devaluation will reduce the aggregate demand for the domestic good by changing the income distribution in favour of capitalists or profit makers who have a low marginal propensity to consume (MPC) and against labourers who have a high MPC. Thus, even if output is demand-determined, (that is the aggregate supply function is horizontal and not a function of exchange rate), devaluation would be contractionary. Furthermore, Robinson (1947) and Hirschman (1949) have shown that

[3]The satisfaction of the traditional Marshall Lerner condition implies that the sum of import and export price elasticities exceeds unity. This in turn implies that the foreign exchange market is stable (see Chapter 2 below for more details).

despite the satisfaction or violation of MLC, if initially the trade balance is in deficit, then it is quite likely that devaluation improves the trade balance expressed in foreign currency and deteriorates its counterpart in domestic currency.

Broadly speaking, the economists who challenge the proposition that short-run devaluation is expansionary can be divided into three groups.

The first group (including Larrian and Sachs (1986), and Buffie (1986b)) has challenged expansionary devaluation policy on the grounds of negative supply-side effects of the exchange rate. As noted above, these stem from the inclusion of intermediate imported inputs, and working capital considerations in the specification of the labour market. This group has concluded that in the presence of both a positive demand-side and a negative supply-side effects of the exchange rate, the net effect of devaluation on gross output depends upon the elasticity of substitution between imported inputs and domestic labour. A high (low) elasticity of substitution between imported inputs and domestic labour increases (decreases) the likelihood of expansionary devaluation.

The second group, which is known to be pessimistic about the import and export price elasticities, includes Cooper (1971a,1971b), Krugman and Taylor (1978) and others. They have the opinion that devaluation could be contractionary in semi-industrialized countries because their trade flows are relatively insensitive to price and exchange rate changes. Other economists such as Dornbusch (1980) and Schmid (1982) claim that due to sufficiently low import and export elasticities in oil importing countries, devaluation could have negative real effects.

The third group, monetarists (consisting of Hume (1752) Han (1959) and Dornbusch (1974) and many others) have concluded that due to real balance effects, devaluation can influence economic activities only in the short-run. However, in the long-run when all variables adjust to their new sustainable levels, then devaluation will certainly be neutral. More precisely, in the impact period devaluation, which is a nominal disturbance, can change economic activity by reducing domestic absorption, since some prices are sticky in the short-run. But in the long-run, as domestic wages and prices adjust, devaluation fails to reduce the domestic absorption, so currency depreciation cannot change real variables.

1.2 IMPLICATIONS OF THE CORRESPONDENCE PRINCIPLE

Does stability preclude the possibility of contractionary devaluation? Economists such as Calvo (1983), and Larrian and Sachs (1986) have derived the result that devaluation will exert contractionary effects only if the local equilibrium is unstable. Basically they have made use of Samuelson's (1947) correspondence principle to resolve the sign ambiguity of certain expressions which appear in the short and long-run devaluation multipliers. The correspondence principle, which is based on the presumption of stability, gives the conditions under which the system converges to full equilibrium.

Buffie (1986b) has also attempted to establish a correspondence between stability of the system and the impact effects of devaluation upon labour employment, the demand for and the price of the home good, and the balance of payments. He concluded that for a general technology, there exists no definite correspondence between stability and the impact effects of devaluation upon employment and balance of payments. However, in his model, devaluations cannot both contract employment and reduce the payments balance. This is because either contraction in employment or reduction in payments balance is incompatible with stability. Furthermore, if the production function is separable between primary factors and the imported input then stability guarantees that devaluation both increases employment and improves the balance of payments. This is also true if the labour and the imported inputs are gross substitutes.

More recently, Lai and Chang (1989) have emphasized the importance of the relationship between stability, the degree of money illusion, and the nature of the tax system in determining the output effects of devaluation. In particular, by assuming Walrasian stability[4], they have derived the following three results:

(a) regardless of whether the income tax is progressive or proportional, currency devaluation has a negative impact on output if the workers are free from money illusion.

(b) When workers suffer from money illusion, the supply-side tax effects may result in a contractionary devaluation.

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[4]The system is stable in the Walrasian sense if the price level increases when the good market is in excess demand.

(c) When the income tax rate is proportional, whether the currency devaluation is expansionary or contractionary has nothing to do with the tax induced aggregate supply-side effects.

In a comprehensive literature survey Lizondo and Montiel (1989 p. 221) have discussed the issue of correspondence between stability of the system and the potential effects of devaluation and conclude that 'the relevance of the correspondence principle is inescapably model specific. A presumption of stability does not in general rule out the possibility that devaluation could be contractionary on impact'.

1.3 EMPIRICAL EVIDENCE

A number of empirical studies have also been done to study the effects of devaluations. Cooper (1971a) found that in LDCs although devaluation contracts output, it improves the current account and the balance of payments. Sheehy (1986) who has covered 16 Latin American countries concluded that devaluation is highly contractionary in these countries. Edwards (1986), on the other hand, has covered 12 less developed countries (LDC's) and found that devaluations are contractionary in the impact period while in the long-run they all become neutral. Ahluwallia and Lysy (1981) have done a case study for Malaysia and found that devaluation will be contractionary when the export elasticity is less than 0.5. Gylfson and Risager (1984) have covered 8 LDCs and 7 developed countries and realized that while devaluation is expansionary in developed countries and contractionary in LDCs, devaluation improves the current account in both kinds of countries. Hamilton (1987) who has done a study for Australia found a very different result. Hamilton concluded that is devaluation is expansionary in the short-run but contractionary in the long-run. Finally, Hamarios (1989) has used the data for the periods 1953-73 and 1975-84 and has covered twenty seven countries and six devaluation episodes to study the effects of devaluations upon prices and the trade balance. He found that nominal devaluations result in significant real devaluations that last for three years. In addition, it is seen that in over 80 percent of cases, devaluation causes a net improvement in the trade balance both in the impact period and in the middle period. The study concluded that the effects of devaluation upon the trade balance last for two to three years.

1.4 THESIS MOTIVATION

In doing the literature summary, a number of theoretical and empirical studies were examined which explored the relative size of competing effects of the demand-side and the supply-side effects that follow from devaluation of the domestic currency. Some common problems were observed in most of the works which can be placed into four categories:

(a) In most of the models, author(s) dealt with a specific form of the production function. For example, Krugman and Taylor (1978) have used a fixed coefficient technology of production; and Gylfson and Schmid (1983) and Islam (1984) have used a Cobb-Douglas production function. Therefore, the results of these studies may be limited by these specific forms of the production function.

(b) Only a few studies have performed a dynamic analysis of the devaluation. Calvo (1983), Larrain and Sachs (1986), Lizondo and Montiel (1990), and Buffie (1986b) are the few examples on this subject. As a result, an explicit relationship between stability and the likelihood of contractionary devaluation is derived in only a few cases. Furthermore, due to the static nature of the models, the time of the variable in question in the event of devaluation cannot be studied.

(c) Except for Lai and Chang (1989), none of the studies have examined devaluation effects under different tax regimes. Lai and Chang have shown that the nature of the tax system (proportional versus progressive) plays a crucial role in determining the effects of devaluations.

In this thesis an attempt is made to improve the devaluation literature, in the light some of the issues just summarized. The models that impose the bare minimum restriction on the production relationship and pay explicit attention to dynamics have been extended. We demonstrate the inconsistencies which exist in the work of Buffie(1986b) and then derive results, both for two corrected versions of the model and for various extensions of it (for example, we allow for various degrees of capital mobility). We establish the relationship between the stability condition(s) of the model and the effects of devaluation on employment and the balance of payments. In the later chapter by correcting and extending the Lai and Chang (1989) model, we have investigated how the supply-side effects of taxes and the exchange rate interact (when the tax system is not fully indexed) to complicate the effects of devaluation.

1.5 THESIS ORGANIZATION

This thesis is divided into six chapters. Following this introduction, in the second chapter, a brief survey of the devaluation literature is presented. Due to the nature of this thesis only some of those studies in which the exchange rate is used as a policy instrument variable are reviewed. We focus on four kinds of studies. First, we discuss those studies which deal only with the demand-side effects of the exchange rate such as Meade (1951), Diaz-Alejandro (1963) and many others. Secondly, we consider studies which deal with the supply-side effects of the exchange rate such as Salop (1974) and Lai and Chang (1989). Thirdly, we review those studies which involve intermediary inputs such as Gylfason and Schmid (1983), Krugman and Taylor (1978) and others. Finally, we focus on the studies of Calvo (1983), Larrian and Sachs (1986), and Buffie (1986b) which explicitly address the connection between the stability and effects of devaluation.

In the first main chapter, Chapter 3, we point out and remove the inconsistencies which exist in the work of Buffie (1986b). In the corrected version of Buffie's model it is seen that Buffie's strong results do not hold in general. Buffie had shown that if the system is stable then devaluation cannot both contract employment and worsen the payments balance at the same time. In the corrected version of the Buffie model, we have found that both "perverse" results are possible, even if stability obtains. However, in addition to assuming stability of the model, when we assumed that the aggregate demand function for goods is negatively sloped in the price/output plane, we found that Buffie's theorem holds true.

Chapter 4 includes some analytical sensitivity tests performed in the corrected version of Buffie's model. These tests relate to the alternative specifications of wage flexibility, inflationary expectations, the definition of the money demand function, and alternative degrees of capital mobility. It is found that the stability conditions and the comparative static results are sensitive to the alternative specifications of wage flexibility and to the assumption of perfect capital mobility. In the zero capital mobility regime it is seen that in general, regardless of which specification of wage flexibility is used, Buffie's results do not hold. However, if we assume that the aggregate demand function for goods is negatively sloped and if labour and the imported input are gross substitutes, then stability of the model guarantees that devaluation certainly increases employment and improves the balance of payments. For perfect capital mobility, on the other hand, it is seen that the alternative specifications of wage flexibility and of inflationary expectations play a crucial role in determining the effects of devaluation on employment. We found that devaluation has an ambiguous effect on employment when workers have perfect foresight, an expansionary effect when workers have static expectations, and is neutral when the real wage is sticky at each point in time.

Chapter 5 is based on some extensions of the Lai and Chang (1989) (henceforth L-C) study. We have developed a model that contains the L-C model as a special case.

For convenience, however, we have solved the model for two cases, one which addresses taxation issue (TI) and the other deals with the Laursen-Metzler effects (L-M). The models in both TI and L-M cases are solved for zero and perfect capital mobility.

As far as comparative static results are concerned we found that under plausible set of parameter values and for zero capital mobility the strong L-C result that currency devaluation has a negative impact on output if workers are free of money illusion, whether the income tax is progressive or proportional, holds true. With perfect capital mobility, or with government policy that fixes the domestic rate of interest, and with workers free from any money illusion, then the tax system plays a crucial role in determining the output effect of devaluation. It is seen that devaluation is neutral for proportional taxation, contractionary for progressive taxation, and expansionary for regressive taxation. Similarly, when we allow some degree of money illusion, it is seen that in the TI case output will increase with devaluation both for proportional and regressive taxation. While in the case of progressive taxation, the output effect of devaluation largely depends upon the tax elasticity and of the degree of money illusion. Under a plausible set of parameter values the same result holds in the L-M case.

In the final chapter, Chapter 6 a brief summary of findings of the thesis is presented. In particular, also as a vehicle for integrating the several issues posed by the sensitivity tests performed in this thesis, we have proposed a model which can be used for dynamic simulations.

Chapter 2

SURVEY OF THE LITERATURE

2.1 INTRODUCTION

In this chapter a brief survey of the devaluation literature is presented. Due to the nature of this thesis however, only some of those studies in which the exchange rate is used as a policy instrument variable are reviewed.

A number of authors have done both partial and general equilibrium analyses of devaluations policy. Due to nature of the thesis however, we focus on only those studies in which devaluation effects are studied in a general equilibrium framework.

The results derived by different authors can broadly be placed into three categories:

(i) Expansionary/contractionary devaluation effects depend upon the demand-side effects of the exchange rate.

(ii) Expansionary/contractionary devaluation effects depend upon the competing demand and supply-side effects that follow from the exchange rate.

(iii) Expansionary/contractionary devaluation effects depend upon the stability of the model.

In order to structure our survey and to compare several different results, frequent use of the following model is made in this chapter.

THE MODEL

Aggregate Demand

The demand side of the model is explained by the following equations:

<2.1> $$Q = C(Q^d) + I(r) + G + X(\frac{ep^x}{p}) - \frac{ep^m}{p}IM(Q^d,\frac{ep^m}{p})$$

<2.2> $$Q^d = (1-t)Q - \frac{ep^n}{p}IN$$

<2.3> $$\frac{M}{p} = L(Q,(1-t)r)$$

Aggregate Supply

The supply side of the model is explained by the following equations:

<2.4> $$Q = Q(\bar{K},N,IN)$$

<2.5> $$\frac{w}{p} = Q_N(\bar{K},N,IN)$$

<2.6> $$h(N,g) = (1-t)w$$

<2.7> $$g = \alpha ep^f + (1-\alpha)p$$

<2.8> $$ep^n = pQ_{IN}(\bar{K},N,IN)$$

Dynamics

The dynamics of the model is explained by the following balance of payments equation:

$$\dot{M} = p\left[X(\frac{ep^x}{p}) - \frac{ep^m}{p}IM(Q^d,\frac{ep^m}{p}) - \frac{ep^n}{p}IN(w,p,e,p^n)\right] + H(r-r^f) \tag{<2.9>}$$

The notation is defined as follows:

Q	gross output
Q^d	disposable income
Y^f	foreign income
t	income tax rate
C	consumption made by private agents
I	investment demand by the domestic residents
G	government expenditure
g	consumer price index
α	proportion of expenditure on foreign good
X	exports of the good Q
IM	imports of the final good
IN	imports of intermediate inputs
M	level of nominal money stock
r	rate of interest
r^f	foreign rate of interest
$\dot{M}$	balance of payments surplus
p	price of the domestic good Q
p^x	export price of good X
p^m	import price of the final good import
p^n	import price of intermediate inputs
e	exchange rate; domestic price of the foreign currency
w	nominal wage rate

N level of employment or number of hours worked
$h(..)$ inverse labour supply function
$Q(..)$ production function
Q_N marginal productivity of labour
Q_{IN} marginal productivity of imported inputs
$\bar{K}$ fixed capital
H net capital inflow

The dot indicates a time derivative. All expectations are static, so there is no difference between nominal and real interest rates.

Before starting the discussion about currency devaluation it is important to give a brief interpretation of equations <2.1> through <2.9>. Equation <2.1> shows the equality between supply and demand for the domestically produced good, Q, whose price is, p. Demand is the sum of spending by domestic households, firms and the government, plus net exports, $X(ep^x/p)-(ep^m/p)IM(Q^d, ep^m/p)$. As usual, private consumption and investment are specified as functions of disposable income and rate of interest. It is also assumed that along with the terms of trade, ep^f/p, the demand for imports depends on the disposable income. While the demand for exports is defined as a function of terms of trade and the foreign income, Y^f. For simplicity, we assume that the foreign income is fixed and is therefore omitted. Equation <2.2> measures the disposable income of the private agents. This measures the income which agents retain after paying both taxes, tQ, and total payments to foreigners for the intermediate input, ep^n. Equation <2.3> is the standard LM equation. It stipulates equilibrium in the money market. It is assumed that the demand for money is negatively related to interest rate, r, and positively related to output.

As far as the supply side of the model is concerned equation <2.4> shows that output is produced by combining labour, the imported input, and fixed capital. Equation <2.5> and <2.6> represent the demand for and the supply of labour respectively. Equation <2.8> represents the demand for the imported input, which is supplied perfectly elastically by the rest of world. The demand for labour and the imported input are obtained by solving the firms' profit maximization problem. The supply of labour is obtained by maximizing the household's utility function, defined with after tax real income and leisure as arguments, subject to the time constraint. The labour demand and imported demand functions show that, for a price-taker firm, profit will be maximized if the value of labour's marginal product, pQ_N, and the value of imported input's marginal product, pQ_{IN}, are equal to the nominal wage rate, w, and nominal price of imported input, ep^n, respectively. It should be noted that contrary to labour demand, the supply function of labour is specified as a function of after tax wage rate and of the consumer price index, which is defined as the weighted average of all the domestic and imported foreign consumer goods. To allow for various specifications concerning money illusion among labour supplies, we leave the inclusion of the price index, g, quite general at this point. We have assumed that all labourers and all firms are homogeneous. This assumption enables us to defend the aggregate demand and supply functions of labour by making reference to these individual optimization problems.

Equation <2.7> defines the consumer price index (CPI). For convenience it is assumed that the CPI is the weighted average of the price of the domestic and the foreign goods. This assumption however, is not arbitrary. Samuelson and Swamy (1974) have shown that <2.7> represents a true cost of living if the domestic residents' utility function, defined with domestic goods and imports as arguments, is Cobb-Douglas.

The last equation <2.9> introduces some intrinsic dynamics into the system. It measures the balance of payments which is defined as the sum of current account and the capital account. It also shows the sources and uses of foreign exchange. $X(ep^x, p)-(ep^m/p)IM(Q^d, ep^m/p)-(ep^n/p)IN(w, p, e, p^n)$, which is known as the trade balance or current account (as long as we ignore the debt service account). This aggregate measures the net earnings of foreign exchange which stems from exports of domestic goods and imports of both final goods and of intermediate inputs. If the money value of exports exceeds (falls short) the money value of imports then it is said that the trade balance is in surplus (deficit) or the current account is positive (negative). $H(r-r^f)$, on the other hand, measures the net inflow of the foreign exchange which stem from the net purchase of domestic financial instruments by foreigners. The yield on the domestic bond, is measured by the domestic rate of interest, r, and the expected yield on the foreign bond is measured by r^f. Since it is assumed that the exchange rate is an exogenous variable and that the devaluations considered in this thesis were not expected by the agents being modelled we omit any expected exchange rate terms[1].

Although it creates a stock-flow mis-specification problem, for reasons of simplicity, we ignore both wealth effects and the debt service account. Finally, we are assuming that the price of both the final imported good, p^m, and of the intermediary input, p^n, are exogenous and equal to unity.

This completes the basic introduction of the model. In the impact period there are nine endogenous variables Q, Q^d, p, r, N, IN, w, g, and $\dot{M}$, while, M and G are exogenous variables. The endogenous variables can be assigned values by solving equations <2.1> through <2.9> simultaneously.

After this brief introduction of the model we now move to the next section of this chapter where the conventional wisdom of a devaluation policy is discussed.

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[1]See Turnovsky (1981) for implications of expected capital gain in determining the output effects of devaluation.

2.2 DEVALUATION IN THE ABSENCE OF SUPPLY-SIDE EFFECTS OF THE EXCHANGE RATES

2.2.1 The Elasticity Approach to Balance of Payments

This approach is associated with Robinson (1937). It involves the explicit use of the Marshallian partial equilibrium analysis for export and import markets of goods separately. Capital flows are assumed to be absent. In addition, it is assumed that both exports of domestic goods and imports of foreign goods depend upon relative prices only. Moreover, the country in question is importing only final goods for consumption purposes. In these circumstances the balance of payments equation <2.9> is written as:

<2.10> $$B = X(\frac{ep^x}{p}) - \frac{ep^m}{p}IM(\frac{ep^m}{p})$$

It is assumed that the economy is operating at less than full employment and that labour is the only variable factor of production. Furthermore, the domestic price of the domestic good is taken as predetermined at a given point in time. In this situation, from <2.10> it is evident that if trade is balanced initially, then devaluation improves the payments balance if and only if

<2.11> $$\frac{dB}{de} = \bar{X}(\eta_x + \delta_e - 1) > 0$$

where

$\bar{X}$: *initial value of exports*

η_x: *export price elasticity*

δ_e: *price elasticity of imported final consumption good*

which implies that the balance of payments will improve upon devaluation if the Marshall-Lerner Condition is satisfied i.e., the sum of export elasticity and price elasticity of imported final consumption goods must exceed unity ($\eta_x + \delta_e - 1 > 0$).

2.2.2 The Keynesian Multiplier Approach

The Keynesian multiplier approach which is developed by Harberger (1950), Laursen and Metzler (1950), and many others is considered an improvement over the elasticity approach. Contrary to the elasticity approach, the Keynesian multiplier approach involves a general equilibrium analysis of the balance of payments. In this approach it is assumed that imports of final goods depend not only on the relative prices of imports but, also depend upon gross income.

The basic structure of the Keynesian model is the same as shown by our model. However, Keynesian economists assumed that due to widespread unemployment the labour supply function is perfectly elastic. In other words, for a given money wage rate a firm can hire an infinite amount of labour. In addition, the price of the domestic good is also assumed to be predetermined at given point in time. Assuming zero capital mobility, no tax on income, and that output variations are accomplished by varying labour only (that is, assuming no intermediate imports), after doing some manipulations we can write our model in the following matrix form,

<2.12>
$$\begin{pmatrix} 1-c+m^d & -I_r & 0 \\ L_Q & L_r & 0 \\ m^d & 0 & 1 \end{pmatrix} \begin{pmatrix} dQ \\ dr \\ d\dot{M} \end{pmatrix} = \begin{bmatrix} \bar{X}(\eta_x+\delta_e-1) & 0 \\ 0 & 1 \\ \bar{X}(\eta_x+\delta_e-1) & 0 \end{bmatrix} \begin{pmatrix} de \\ \\ dM \end{pmatrix}$$

As usual we are assuming that,

$$I_r = \frac{dI}{dr} < 0, \quad L_Q = \frac{dL}{dQ} > 0, \quad L_r = \frac{dL}{dr} < 0$$

$$0 < m^d = \frac{dIM}{dQ^d} < c = \frac{dC(Q^d)}{dQ^d} < 1$$

c : ***marginal propensity to consume***

Applying Cramer's rule to <2.12> and after doing some manipulations we have:

<2.13>
$$\frac{dQ}{de} = \frac{\bar{X}L_r(\eta_x+\delta_e-1)}{\Delta}$$

<2.14>
$$\frac{d\dot{M}}{de} = \frac{\bar{X}L_r(1-c+\frac{I_rL_Q}{L_r})(\eta_x+\delta_e-1)}{\Delta}$$

where

$$\Delta = L_r(1-c+m^d)+I_rL_Q<0$$

Since $0<m^d<c<1$, $I_r, L_r<0$,, and $L_Q>0$, Δ must take a negative value. In these circumstances Multipliers <2.13> and <2.14> show that in a conventional Keynesian model, if the devaluation is demand expansionary, $\eta_x+\delta_e-1>0$, then it both increases gross output and improves the payments balance. This is the same result which is derived by Meade (1951) and Tsiang (1961).

2.2.3 The Structuralist Approach to Balance of Payments

Diaz-Alejandro (1963) has criticized the results derived by conventional Keynesian economists by arguing that due to the redistribution effect of income from workers to capital owners, devaluation could contract output while improving the payments balance. In order to understand his point of view we assume that the total income of the economy is distributed among two classes of people; workers and profit owners: $Q = Q_w + Q_k$ where Q_w is the total income owned by workers and Q_k is the total amount of the income owned by profit receivers. Let c_w and c_k be the marginal propensity to consume of workers and of profit owners out of their own income respectively. Further assume that the total consumption C in <2.1> can be written as $C_w + C_k$. Where C_w and C_k represent the total consumption made by workers and profit receivers respectively. For simplicity we assume that the investment is fixed in the impact period. In these circumstances we derive the following impact devaluation multiplier:

<2.15>
$$\frac{dQ}{de} = \left(\frac{1}{1+m^d}\right)\left(c_w\frac{dQ_w}{de} + c_k\frac{dQ_k}{de} + \bar{X}(\eta_x+\delta_e-1)\right)$$

Diaz-Alejandro contended that for a given level of home output and of net exports the increase in the price of foreign currency will increase the real income of profit earners ($dQ_k/de>0$) while reducing the real income of wage earners ($dQ_w/de<0$). In addition, since it is generally true that the marginal propensity to consume of the labour class is greater than that of the profit earners ($c_w>c_k$), it is possible that:

<2.16> $$\left|c_w\frac{dQ_w}{de}\right| > c_k\frac{dQ_k}{de} + \bar{X}(\eta_x+\delta_e-1)$$

which implies that devaluation will exert a negative impact on output. As far as the effects of devaluation on the balance of payments is concerned, by using equation <2.3> and assuming that there is a zero capital mobility we can obtain:

<2.17> $$\frac{d\dot{M}}{de} = \bar{X}(\eta_x+\delta_e-1) - m^d\frac{dQ}{de}$$

From <2.17> it is evident that if condition <2.16> is satisfied then despite the fall in output devaluation certainly improves the balance of payments of the country.

In the devaluation literature Diaz-Alejandro and the related studies are typically known as the *structuralist approach* to balance of payments.

2.2.4 Initial Trade Balance and Devaluation

The results indicated by <2.11>, <2.13>, <2.14>, and <2.17> above are centred around the satisfaction of the traditional Marshall (1923)-Lerner condition ($\eta_x + \delta_e - 1 > 0$) (henceforth MLC). Brown (1942) extended the MLC by taking into account several other aspects of the economy such as the elasticities of supply, and the marginal propensities to import. However, both Marshall and Brown have derived their condition(s) by assuming an initial trade balance. Robinson (1947) was the first to criticize both Marshall and Brown on this point. She has derived a correct formula for the effect of devaluation on the trade balance which is not in equilibrium initially. But, she has derived the result for the case when the trade balance is measured only in terms of the domestic currency. Hirschman (1949), on the other hand, derived some interesting formulae for the effect of devaluation on the trade balance when it is measured in both possible currencies. He showed that if initially imports are not equal to exports then MLC is not sufficient for the payments balance to improve upon devaluation. However, if initially imports are equal to exports then only in this case does the satisfaction of the MLC become both necessary and sufficient for the payments balance, measured in either currency, to improve with devaluation. Hirschman also proved that if the payments balance is measured in domestic currency units, then devaluation might entail quite misleading results. Furthermore, in the event of devaluation an initial import surplus enhances the likelihood of improvement in the payments balance.

The intuition behind the above results runs as follows: Devaluation could possibly have two kinds of effects: (1) a valuation effect on the initial values of import and export quantities at the new value of the exchange rate, and (2) a quantity effect, determined by the export and import elasticities at the original exchange rate. If initially trade is balanced then the loss in revenues incurred due to the higher cost of imports are exactly offset by the additional export revenues. In this case devaluation involves only the quantity effect. On the other hand, if initially the trade balance is in deficit then the valuation effect of devaluation leads to a deterioration of the domestic trade balance, measured in domestic currency terms.

The reader could note that since in our model (both in this chapter and in the subsequent chapters) we are assuming throughout that in the steady state the country in question has a balance of payments equal to zero, the measurement of the balance of payments in either domestic currency or the foreign currency does not have any direct bearing on our results. Why are we not considering $\dot{M}<0$ initially? For policy purposes, it would clearly be preferable to consider initial conditions involving a balance of payments deficit, but, given our emphasis on the correspondence principle, we must derive local stability conditions by conventional methods, that is by considering small deviations from a full equilibrium.

2.2.5 Domestic Absorption Approach

Meade (1951) argued that in the full equilibrium devaluation will increase prices by the full amount of the exchange rate and leave the payments balance unchanged. The reason behind this outcome can best be explained in terms of Alexander's (1952) *domestic absorption* theory. According to this theory a reduction in domestic absorption is a necessary condition for devaluation to improve the payments balance of the country[2]. In Meade's model the full equilibrium involves an exogenous value for both the level of output and the interest rate. The former implies constant consumption and the latter implies constant investment. Consequently, in Meade's full employment model, devaluation fails to reduce the domestic absorbtion and as a result the payments balance remains unaffected. In addition, prices are increased exactly by the amount of the exchange rate which in turn eliminates the excess demand for the domestic good which is initiated because of devaluation.

If we eliminate the intermediate inputs from our prototype model above, we see that it can be used to confirm the above result. From equation <2.1> by holding output constant at the full employment level, $\bar{Q}$, and assuming fixed investment $\bar{I}$ and also treating both price $\boldsymbol{p}$ and the nominal money supply $\boldsymbol{M}$ as endogenous variables we get:

<2.18> $$\frac{dp}{de} = 1$$

[2]The domestic absorption theory states that deficits/surpluses in the balance of payments occur due to abnormal saving and spending. A deficit will occur if at a given exchange rate there exists an excess spending, while a surplus will exist if there is excess savings in the country.

Similarly, from <2.9> we get:

<2.19> $$\frac{d\dot{M}}{de} = \bar{X}(\eta_x + \delta_e - 1)(1 - \frac{dp}{de})$$

Equations <2.18> and <2.19> imply that devaluation is in effective in changing the payments balance which confirms the Meade and Alexander's results.

Tsiang (1961) has used the work of Meade and Alexander and derived the result that if instead of keeping constant interest rates, the monetary authority fixes the money supply then even at full employment level devaluation could reduce the domestic absorption and improves the balance of payments. The reason behind this outcome runs as follows: The increase in the price level reduces the real supply of money, which in turn raises the interest rate. Consequently, investment will fall from its pre-devaluation level. However, investment in the export sector will be increased. Since the demand for the foreign finished good will fall, the payments balance will certainly be improved upon devaluation. An important point, however, to note here is that the demand for finished foreign goods will fall if and only if the price of the domestic good does not increase by the full amount of the exchange rate. On the other hand, if the domestic good price is increased by more than the amount of exchange rate then devaluation deteriorates the balance of payments. This result can be confirmed with the help of our prototype model above for no imported input case as follows:

Given that p, r, Q^d are the endogenous variables, holding money stock, M, output Q constant, $t=0$, and assuming zero capital mobility from equation <2.1> through <2.3> we get:

$$\text{<2.20>} \qquad 1-\frac{dp}{de} = \frac{-I_r\bar{M}}{\bar{X}(\eta_x+\delta_e-1)L_r} < 0$$

From <2.19> and <2.20> it is evident that devaluation worsens the payments balance.

2.2.6 The Monetarist Approach to Balance of Payments

Another approach which some economists have adopted to study the effects of devaluation on prices, output, and the balance of payments is known as the 'Monetarist approach to balance of payments' (see Dornbusch (1980), Hahn (1959), Jones (1971), Johnson (1977b)). Monetarists hold the view that exchange rates are determined by the stock of assets among trading countries. Thus, Monetarists believe that a deficit in the payments balance stems from excess money supply while, surplus occurs due to a shortfall of money supply. Furthermore, contrary to Keynesian analysis where spending is defined as the function of income, the Monetarists have defined spending as a function of real balances. The Monetarist believed that households and firms always attempt to maintain a certain level of real money balances. The amount of real balances which agents try to hold is related to wealth, through portfolio decisions, or to income, through the demand for money. Agents always adjust their behaviour due to changes in prices and on the nominal money supply. A careful reader can note here that in the event of devaluation the price of domestic good and of foreign good will increase, this reduces the real money balances. For a given level of money supply, agents will cut down their spending to maintain their desired real balances. This exerts a negative impact on output. Many Monetarists argued that the best policy is that the central bank should maintain the money supply according to domestic criteria and let economic forces determine the exchange rate and balance of payments endogenously.

Due to the nature of this thesis we are not discussing this approach in detail. However, in order to appreciate this approach a brief review of Dornbusch's (1973) study whose demand side is quite similar to the models which we have used in Chapters 3 and 4 below is presented here:

Dornbusch's model involves the assumption that two countries are trading goods for money only; in both countries the supply of real output is taken as fixed, and in both countries the demand for real balances is defined by the following Cambridge form of the money demand function:

$$\langle 2.21\rangle \qquad L = kp\bar{Q} \ ; \quad L^* = k^*p^*\bar{Q}^*$$

where

An asterisk denotes the foreign country

k, k^* the desired ratios of money to income

$\bar{Q}$, $\bar{Q}^*$ A fixed real output

p, p^* the money price of goods in terms of domestic and foreign currency

It is further assumed that the domestic price of the good in the trading countries are related through purchasing power parity:

<2.22> $$p = ep^*$$

Furthermore, the inflow of money in one country is assumed to be equal to the outflow of money from the other country:

<2.23> $$\dot{M} = B = -e\dot{M}^*$$

Finally, by following the monetarist approach, in each country the desired nominal expenditure, Z, is defined as the difference between the nominal income and the hoarding of money, H. The hoarding of money is defined as the difference between the desired money balance, L, and the actual money balances, M:

<2.24> $$Z = p\bar{Q} - H$$

<2.25> $$Z^* = p^*\bar{Q}^* - H^*$$

<2.26> $$H = \pi(L - M)$$

<2.27> $$H^* = \pi^*(L^* - M^*)$$

where

$$0 < \pi , \pi^* < 1$$

Using equation <2.21> through <2.27> it is shown that the worlds' good's market will be in equilibrium if and only if the home country's rate of hoarding equals the foreign country's rate of dis-hoarding:

<2.28> $$\pi(kp\bar{Q} - M) + e\pi^*(k^*p\bar{Q}^*/e - M^*) = 0$$

Using equation <2.28> and assuming that the world money supply is equal to the sum of the money stocks in each country it is shown that home country's balance of payments certainly can be improved upon devaluation. Following devaluation, the domestic price of the good is either increased or will stay at the pre-devaluation level, and the price in the foreign country is either decreased or will stay at the pre-devaluation level.

In a two-commodity model, on the other hand, it is assumed that in each country there exist two goods. One is a traded good while the other is a nontraded good. By taking the traded good as numeraire it is assumed that consumption of each good depends upon the relative price and real expenditure. Real expenditure is defined as real income (which is defined as the sum of the real value of traded and non traded good) less real hoarding.

The comparative static analysis of the model shows that devaluation of the domestic currency certainly both improves the payments balance and the price of the traded good of the devaluing country. In addition, devaluation lowers the relative price of the non-traded good in the devaluing country while increases the price in the foreign country.

The study concluded that devaluation is in fact a monetary phenomena and it effects the payments balance in the short-run if and only if it successfully reduces real money balances.

2.3 DEVALUATION AND THE SUPPLY-SIDE EFFECTS OF THE EXCHANGE RATES

2.3.1 Labour Supply and Devaluations

The basic weakness of the studies reported above is that the authors have assumed that labour supply is perfectly elastic. This implies that if the economy is operating at other than the full employment level, then wage adjustments have no effect on the efficacy of devaluation. Salop (1974) has attempted to enrich the devaluation debate on this point. For this purpose he extended the Meade-Tsiang analysis by assuming that labour supply is positively related to real wages (see equation <2.6>)

By assuming that output is produced by involving labour and some fixed factor $Q=Q(\bar{K},N)$, Salop has derived the aggregate supply function which in our notation could be written as:

<2.29> $$Q = \phi(e,p)$$

where

$$Q_N = \frac{\partial Q(\bar{K},N)}{\partial N} : \textit{ marginal productivity of labour}$$

$$Q_{NN} = \frac{\partial Q_N(N,\bar{K})}{\partial N} < 0$$

$$\phi_p = \frac{-\ Q_N^2\alpha}{Q_{NN} - Q_N} > 0$$

$$\phi_e = \frac{Q_N^2\alpha}{Q_{NN} - Q_N} < 0$$

In addition, Salop has defined the following LM curve and the import demand function:

<2.30> $$\frac{M}{g} = L(\frac{pQ}{g}, r)$$

<2.31> $$IM = IM(\frac{pQ}{g}, \frac{ep^m}{p})$$

In these circumstances the reader can readily confirm the following differences between the Meade-Tsiang and the Salop models. First, even in the short-run in the Salop model, both the nominal wage and the price of the domestic good are endogenous variables. Secondly, in the Salop model, if the income elasticity of money demand is not equal to unity then the exchange rate becomes a direct shift variable for the LM curve. Thus, in the Salop model, exchange rates have supply-side effects. Finally, contrary to

Meade-Tsiang, in the Salop model labour market always clears, and this implies that the economy is always operating at the full employment level.

Salop has derived the result that if the monetary authority fixes the money supply then devaluation certainly reduces output and improves the payments balance at the same time. This is the same result which is derived by Diaz-Alejandro (1963) discussed above.

More recently, Lai and Chang (1989) have developed a model whose demand side is almost the same as that given by our prototype model above. As far as the supply side of the model is concerned it is very similar to the one which is defined by Salop (1974). The following two differences, however, could be noted here. First, L-C have defined labour supply as the function of real wage and of the tax rate. Secondly, they have derived the aggregate supply function of goods for varying degrees of money illusion.

L-C have pointed out the importance of the degree of money illusion and of the nature of the tax system (*proportional vs. progressive*) in determining the impact effect of devaluation upon gross output, as we discussed in the introduction. A detailed description and extension of the L-C analysis is given in Chapter 5 below[3].

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[3]Turnovsky (1981) has developed a stochastic model to analyze the short-run and long-run effects of changes in the exchange rate on prices and output. The most distinguishing characteristic of the model is that it assumes that agents form expectations about possible changes in the exchange rate and the foreign price level. The comparative static results of the model reveal that if agents under-predict changes in the exchange rate then price of the domestic good will increase by less than the amount of the exchange rate and gross output will increase with devaluation. On the other hand, if agents over-predict changes in the exchange rate then price will increase by more than the amount of the exchange rate and output will reduce with devaluation. Finally, if agents correctly predict changes in the exchange rate then the price of the domestic good will increase exactly by the amount of the exchange rate and output level will stay at its pre-devaluation level. The detailed description of this paper however, is beyond the scope of this thesis.

2.3.2 Intermediate Inputs And Devaluations

In the studies summarized above it is assumed that the country in question imports only final consumption goods. Recently, many papers have been written in which devaluation effects are studied in the presence of imported intermediate inputs. For simplicity, let us now assume that the home country imports only intermediary inputs. In addition, let us assume that the domestic output is produced by combining the imported input and the domestic value added, Y, in a fixed proportion:

<2.32> $$Q = \min(\gamma_1 Y, \gamma_2 IN)$$

where

$$\gamma_1, \gamma_2 > 0$$

By assuming that the domestic value added Y is produced with the help of labour and some fixed factor the reader can readily derive the following labour demand function:

<2.33> $$w = (p - ep^n(\gamma_1/\gamma_2))Q_N(N)$$

Assuming $e=p=p^n=p^m=1$ initially and solving <2.6>, <2.32> and <2.33> simultaneously we can derive the following aggregate supply function for the home good:

<2.34> $$Q = \phi(p, ep^n)$$

where

$$\delta = \frac{\partial h(N,g)/\partial g}{h(N,g)}$$

$$h_N = \frac{\partial h(N,g)}{\partial N} > 0$$

$$J = (p - ep^n \frac{\gamma_1}{\gamma_2})Q_{NN} - \frac{h_N}{h} < 0$$

$$\phi_p = -\frac{Q_N(Q_N - \delta)}{J} \gtrless 0$$

$$\phi_e = \phi_{p^n} = \frac{Q_N^2(\gamma_1/\gamma_2)}{J} < 0$$

The parameter δ measures the degree of money illusion. $\delta=1$ implies that workers have no money illusion, while $\delta=0$ means that workers are suffering from full money illusion.

By assuming zero capital mobility, no taxes on income, and following the above procedure the reader can readily derive the following solution to the model which is written in the multiplier form,

$$\langle 2.35\rangle \qquad \begin{pmatrix} 1 & -\alpha_2 & 0 \\ 1 & -\phi_p & 0 \\ 0 & -F_1 & \frac{1}{\bar{M}} \end{pmatrix} \begin{pmatrix} dQ \\ dp \\ d\dot{M} \end{pmatrix} = \begin{pmatrix} \alpha_1 & \alpha_3 \\ 0 & \phi_e \\ 0 & F_2 \end{pmatrix} \begin{pmatrix} dM \\ de \end{pmatrix}$$

where

$\bar{Q}$ *initial value of output*

$\bar{M}$: *initial level of money supply*

$$\alpha_0 = 1 - c(1 - \frac{\gamma_1}{\gamma_2}) + \frac{I_r L_Y}{L_r} > 0$$

$$\alpha_1 = \frac{I_r}{\alpha_0 L_r} > 0$$

$$\alpha_2 = \frac{1}{\alpha_0}\left[\frac{c\gamma_1\bar{Q}}{\gamma_2} - \bar{X}\eta_X - \frac{I_r\bar{M}}{L_r}\right] \gtrless 0$$

$$\alpha_3 = \frac{1}{\alpha_0}\left[\bar{X}\eta_x - \frac{c\gamma_1\bar{Q}}{\gamma_2}\right] \gtrless 0$$

$$F_1 = \bar{X}(1 - \eta_x) - \frac{\gamma_1\phi_p}{\gamma_2} \gtrless 0$$

$$F_2 = -\frac{\gamma_1\phi_e}{\gamma_2} > 0$$

Applying Cramer's rule to <2.35> it can easily be shown that the system will be stable if and only if

<2.36> $$\frac{d\dot{M}}{dM} = \frac{\alpha_1[(\bar{X}(\eta_x - 1) + \phi_p(\gamma_1/\gamma_2)]}{\Delta_1} < 0$$

where

$$\Delta_1 = \frac{\alpha_2 - \phi_p}{\bar{M}} \gtrless 0$$

If we assume that the aggregate supply function for goods is positively sloped in the p/Q plane ($\phi_p>0$) and the price elasticity of exports is greater than one ($\eta_x>0$) then the inequality <2.36> will be satisfied if and only if $\Delta_1 < 0$. With this information in hand we now study the impact effect of devaluation on output.

Applying Cramer's rule to <2.35> and after doing some manipulations we get:

<2.37>
$$\frac{dQ}{de} = \frac{Q_N}{J\alpha_0\bar{M}\Delta_1}\left[-\bar{X}\left(\eta_x - \frac{c\bar{Q}\gamma_1}{\bar{X}\gamma_2}\right)\left(\delta - \frac{Q_N(\gamma_2-\gamma_1)}{\gamma_2}\right) - \frac{\gamma_1 I_r \bar{M} Q_N}{\gamma_2 L_r}\right] \gtrless 0$$

From <2.37> it is evident that devaluation can contract gross output, even if the system is stable. For example, if we assume that the aggregate supply function is positively sloped ($\phi_p > 0$), devaluation is demand expansionary ($\eta_x - (c\bar{Q}\gamma_1)/(\bar{X}\gamma_2) > 0$), and that production is domestic value added intensive ($\gamma_1 > \gamma_2$), then using <2.37> it can be seen that devaluation reduces gross output.

Now we review some of the papers which assume that the country in question is importing both intermediate inputs and the final consumption goods. Since in this thesis we focus only on those models which assume that the devaluing country is importing either the intermediate inputs or the final consumption goods, the reader may skip this section and move to section 2.4 where we discuss the implications of the correspondence principle.

Shea (1976) has derived the condition(s) under which devaluation could worsen or improve the trade balance. Shea's model assumes the country in question imports both consumer goods and intermediary inputs. Shea's model is based upon assumptions such as: output is produced with Cobb-Douglas production function with constant return to scale, the nominal wage is fixed, there exists zero capital mobility, and investment demand is fixed at each point in time. To make the expressions simpler he derived the theoretical relationships between the price elasticities of the demand for imported final goods and of intermediate imported inputs. In addition, the relationships between the income elasticities of the demand for total imports and of intermediate imported inputs are also derived. With the help of these relationships Shea has concluded that the satisfaction of the MLC continues to imply that the balance of payments will improve upon devaluation, even if intermediate inputs are included in the model.

Nielsen (1987) has also derived condition(s) under which the balance of payments will improve upon devaluation when the country is importing intermediate inputs. Contrary to Shea, Nielsen has assumed that output is produced with a production function which is weakly separable between domestic primary factors and imported inputs. Also, unlike Shea, Nielsen assumes the country imports both intermediate inputs and final consumer goods. Nielsen concluded that the satisfaction of MLC is not sufficient for the payments balance to improve with devaluation. He showed that along with export and final good import elasticities, some other factors such as the relative values of finished good and exports to the gross home good, the elasticity of substitution between primary inputs and imported intermediate goods, and the share of foreign intermediate input in domestic production play a crucial role in determining the balance of payments effects of devaluation.

Krugman and Taylor (1978) have pointed out various new elements which causes a reduction in output in the event of devaluation and which did not get much importance in the orthodox literature. The Krugman and Taylor model is based upon the following assumptions: (1) like Diaz-Alejandro (1963) the population is divided into two classes; the wage earners and the profit or rent receivers respectively; (2) the country is divided into two sectors, one sector is producing a traded good while the other sector is producing a nontraded good; (3) due to the small country assumption export and import prices are taken as fixed in foreign currency; (4) the price of the home good or the nontraded good is determined by a mark up on the direct cost of labour and imported inputs; (5) nominal wages are taken as fixed in domestic currency; (6) the traded good is produced with domestic resources while the nontraded good is produced by labour and the imported input through fixed coefficient technology; (7) all imports are intermediate; (8) country have a fixed supply of the traded good; (9) in the short-run the substitution responses of both exports and imports to price changes are negligible, and (10) the rate of interest is taken as fixed by government choice.

By assuming in addition the same marginal propensity to consume for workers and profit receivers Krugman and Taylor have derived the result that the output effect of devaluation merely depends upon the pre-devaluation level of the trade balance. If the trade balance is zero then devaluation will be neutral, if the trade balance is in deficit then devaluation will contract output, and if the trade balance is in surplus then devaluation increases output. After obtaining this result Krugman and Taylor have relaxed the assumption of equal marginal propensity to consume among the two classes. By assuming an initial trade balance Krugman and Taylor have derived the result that devaluation stimulates (contracts) output if the marginal propensity to consume of wage earners is less (greater) than that of profit/rent receivers.

The third theoretical result which Krugman and Taylor have derived stems from the government budget constraint. If before devaluation both the government budget and trade balance are in equilibrium then (under certain additional assumptions such as both labour and capital have the same marginal propensity to consume, and imported inputs are not subject to any tariff) devaluation must contract output as long as there exists some tariff on exports.

Krugman and Taylor have also relaxed the fixed rate of interest assumption. In this case they have derived the result that if the demand for money is a linear function of gross output then devaluation contracts output.

Hanson (1983) has extended the Krugman and Taylor model by assuming that the devaluing country is importing both final goods and the intermediate inputs. In addition, he has assumed that instead of fixed coefficient technology the home good is produced by a CES production function involving labour and imported inputs. Similarly, contrary to Krugman and Taylor, Hanson assumes that agents are homogeneous. Like Krugman and Taylor however, he assumes that through government policy the interest rate is pegged.

By assuming nominal wage rigidity, Hanson has derived that devaluation will always improve the balance of payments measured in the foreign currency, even if the quantity of exports is fixed in the short-run. Contrary to Krugman and Taylor, Hanson concluded that the effect of devaluation on output depends not only on the initial trade deficit but, also upon some other factors such as the weighted sum of demand elasticities for imported inputs and consumer goods, and the elasticity of substitution between consumer goods and final imported goods. Hanson argued that due to the possibility of substitution in production and consumption (which is absent in the Krugman and Taylor model) the likelihood of contractionary devaluation is smaller.

Hanson also considered flexible wages. He showed that if either the real wage is fixed through wage indexation or labour supply is specified a function of the real wage, where the money wage is deflated by the CPI, then devaluation is certain to be neutral in respect to both output and foreign payments balance. The reason behind this result is the same which is given by Alexander (1959) i.e in this special case devaluation is neutral since it fails to reduce the domestic absorption.

Gylfason and Schmid (1983) is also one of the studies which analyze the effects of devaluation in the presence of intermediate inputs. The demand and supply side of the Gylfason and Schmid model is very similar to our prototype model above. However, Gylfason and Schmid have defined the input output relation as a linear homogeneous production function.

As far as comparative static results are concerned, Gylfason and Schmid have shown that for given values of export and import elasticities, the share of factors in the total production, and the share of final good imports in the national income devaluation increases the output if it does not change the real money balances significantly. One interesting result which they have derived is that if the elasticity of substitution between the imported input and domestic labour is less than one then devaluation will increase output more (or lower it less) than real income. Gylfason and Schmid have also derived the result that if real wages and the real money supply are assumed to be constant through time then in this special case devaluation leaves the real income and gross output unaffected. On the other hand, if only the real wage is assumed to be constant then devaluation contracts the real income. As far as the impact effect of devaluation upon balance of payments is concerned Gylfason and Schmid have shown that balance of payments will improve with devaluation as long as devaluation exerts a positive impact on the real income.

Economists such as Islam (1984), Buffie (1984b, 1989) and other have developed two sector models to study the effect of devaluation on output, prices, and balance of payments. Contrary to most of the studies which we have discussed above, the two sector model assumes that one sector is producing a traded good while the other sector is producing a non-traded good. The distinguishing feature of these models is that each sector is producing goods independently. The net effect of devaluation on overall employment must be derived by combining the effects of devaluation on each sector of the economy. The detailed discussion of these studies however, is beyond the scope of this thesis.

2.4 DEVALUATION AND THE CORRESPONDENCE PRINCIPLE

Recently some economists such as Larrian and Sachs (1987), Buffie (1986b), and Calvo (1983) have made use of the Samuelson's (1947) correspondence principle to establish the relationship between the stability of the system and the effects of devaluations. Calvo and Larrian and Sachs have derived the result that devaluation will contract output if and only if the system is locally unstable.

For nominal wage rigidity and in the absence of intermediate inputs our prototype model above, predicts the same result which is derived by Calvo and Larrain and Sachs. Applying Cramer's rule to <2.12> the reader can readily confirm that the system is necessarily stable ($d\dot{M}/dM<0$). From <2.13> and <2.14> it is evident that if the MLC is satisfied then devaluation certainly increases gross output and improves the payments balance. However, in case of intermediate inputs it is seen above that devaluation can contract output, even if the system is locally stable (see equations <2.37> above).

Buffie (1986b) has also attempted to establish a correspondence between the model's stability condition(s) and the impact effects of devaluation on labour employment, demand for and the price of the home good, and the balance of payments. He concluded that for a general technology, there exists no definite correspondence between stability and the impact effects of devaluation upon employment and balance of payments. However, in his model devaluation cannot both contract employment and reduce the payments balance. This is because either contraction in employment or reduction in payments balance is incompatible with stability. Furthermore, if the production function is separable between primary factors and the imported input then stability guarantees that devaluation both increases employment and improves the balance of payments. This is also true if labour and imported inputs are gross substitutes. The detailed description and criticism on the Buffie analysis is given in Chapter 3 below.

Does stability preclude contractionary devaluation? The investigations of Calvo (1983), Lai and Chang (1989), Buffie (1986b), and our prototype model above, reveal that the correspondence between stability and the effects of devaluation very much depends upon the specification of the model. This is the same conclusion which is reached by Lizondo and Montiel (1989 p. 221) in a comprehensive survey of the devaluation literature, 'the relevance of the correspondence principle is inescapably model specific. A presumption of stability does not in general rule out the possibility that devaluation could be contractionary on impact'.

2.5 CONCLUSION

In this literature survey a number of theoretical and empirical studies were examined which explore the relative size of competing effects of the demand-side and the supply-side effects that follow from devaluation of the domestic currency. Four kinds of studies were reviewed here. First, only those studies are reported which deal with the demand-side effects of the exchange rates such as Meade (1951), Diaz-Alejandro (1963) and many others. Secondly, those studies which deal with both demand and the supply-side effects of the exchange rates such as Salop (1974) and Lai and Chang (1989) are included. Thirdly, we review studies which have incorporated intermediate inputs such as Gylfason and Schmid (1983), Krugman and Taylor (1978). Finally, the studies of Calvo (1983), Larrian and Sachs (1986), Lizondo and Montiel (1989), and Buffie (1986b) which explicitly address the issue of stability and devaluation effects are discussed as well.

Throughout the survey it is generally observed that definite effects of devaluation on different economic variables do not often emerge. Conventional economists such as Robinson (1947) and Meade (1951) hold the view that due to high unemployment and also due to the absence of any supply-side effects of the exchange rates, devaluation will improve the payments balance and increase employment if it increases the demand for home good. A number of papers are written which seriously challenge this result on number of grounds. For example, Diaz-Alejandro (1963) argued that devaluation could change the distribution of income in favour of capitalists who have a low marginal propensity to consume and against labourers who have high marginal propensity to consume. Consequently, devaluation could contract output, even though exchange rates have no supply-side effects. On the other hand, economists such as Krugman and Taylor (1978), Gylfason and Schmid (1983) and many others challenge the expansionary devaluation prediction omit "on the grounds" by citing the negative supply-side effects of the exchange rates. However, economists like Calvo (1983), Larrian and Sachs (1986) supported this standard result by arguing that stability of the system is sufficient to rule out perverse outcomes of devaluation. Finally, the monetarists such as Johnson (1976) and Dornbusch (1973) and many others argued that the effects of devaluation could be realized only in the short-run. In the long-run when all the variables adjust to their new sustainable levels, then devaluation will become neutral.

Our survey reveals that results derived by different authors largely depend upon the underlying assumptions of the model(s) which they have used for analysis. It is cumbersome to point out the limitations of each of the studies reported above separately. However, the reader could note that in most of the studies the authors have used a specific form of the production function. For example, Krugman and Taylor (1978) have used a fixed co-efficient technology of production; and Gylfason and Schmid (1983) and Shea (1976) have a used Cobb-Douglas production function. The results of these studies may be limited by specific forms of the production function. Similarly, we noticed that a very few studies (except Calvo (1983), Larrain and Sachs (1986), and Buffie (1986b)) have checked the correspondence between stability of the model and the likelihood of contractionary devaluation. Furthermore, due to the static nature of the models none of the studies has done a dynamic theoretical analysis of the devaluation policy. Finally, we have seen that except Lai and Chang (1989), none of the studies have examined devaluation effects under different tax system (proportional vs. progressive).

Considering these limitations, we have decided to perform sensitivity tests in this thesis, by extending the studies not limited to a specific form of the production function. In particular, we have chosen those studies in which the relationship between stability of the model and effects of devaluation is explored. For this reason, we have extended the work of Buffie (1986b) and Lai and Chang (1989). By correcting and extending the Buffie model in Chapters 3 and 4, we have examined the effects of devaluation on employment and the balance of payments of the country. Similarly, by improving the work of Lai and Chang in Chapter 5, we have shown how the output effects of devaluation are complicated when the supply-side effects of both taxes and exchange rates interact.

Chapter 3

STABILITY, IMPORTED INPUTS, AND DEVALUATIONS: IMPLICATIONS OF THE CORRESPONDENCE PRINCIPLE

3.1 INTRODUCTION

In this chapter we attempt to point out and remove the inconsistencies that exist in the work of Buffie (1986b). In one of his papers, Buffie has studied the effects of devaluation of the domestic currency on the demand for goods, price, employment, and the balance of payments in a hypothetical economy which imports goods from rest of the world merely for production purposes. The detailed description of the model is given in section 3.2 below. Buffie finds that although devaluation will certainly increase the cost of imported inputs, it does not necessarily imply that the contractionary effects of devaluation definitely offset the expansionary demand-side effects of the exchange rate. He showed that the impact effects of devaluation depend upon the stability of the model.

Buffie concludes that if the model is locally stable then in the impact period devaluation certainly increases the demand for and the price of goods. But, it may or may not improve employment and the payments balance. If labour and imported input are gross substitutes then devaluation definitely improves labour employment and the payments balance. In addition, Buffie has derived an interesting result by assuming the separability of the production function between primary factors and the imported input. In this special case, he found that the stability of the system guarantees that devaluation both improves labour employment and the payments balance. In addition, for a very general specification of technology, he finds that devaluation cannot both contract employment and worsen the payments balance, since this joint outcome is incompatible with the local stability of the system.

Although, the Buffie model is very interesting and it is one of the few studies, (along with Calvo (1983) and Larrian and Sachs (1986)) that relates the stability of the model to the impact effects of devaluation, there exist some inconsistencies in his model. Throughout the comparative static analysis Buffie assumed that the nominal wage is fixed in the short-run, while the price of the domestic good adjusts continuously to clear the goods market. These assumptions imply that the real wage must also be adjusting continuously. But, Buffie's dynamic analysis assumes that the real wage is adjusting **sluggishly** over a period of time as the rate of unemployment exceeds or falls short of the natural rate of unemployment. That is, at a point in time the real wage is predetermined. The comparative static and dynamic stability sections of Buffie's analysis are inconsistent. Since Buffie has attempted to establish a correspondence between the stability conditions and the impact effects of devaluation this internal inconsistency is central.

There is another inconsistency in the Buffie analysis. In order to derive the stability conditions, Buffie solved the two differential equations of the model (as we explain more fully below) simultaneously. This is a correct way of deriving the stability conditions in his model. But, a problem emerges when he justifies the sign of a particular expression by referring to the "**Walrasian Stability**" condition. According to this condition the equilibrium should be stable if the demand for goods is negatively sloped and the supply function is positively sloped in the price/output plane. If, on the other hand, the demand and supply functions are both positively sloped, then equilibrium will be stable if the slope of the demand function is steeper than the slope of the supply function. In the present context, this appeal to Walrasian stability is unsatisfactory for the following reason.

In the Buffie model the dynamics of the system are explained through the wage adjustment and balance of payments equations (as we explain more fully below). Thus, the time paths of variables must be determined by involving these equations. This requires that any conditions regarding the slope of aggregate demand and the aggregate supply function of good, **must** derive from these dynamic equations and should not be justified by making use of some other notion of stability which is not the part of the model. The equation of Walrasian stability condition cannot also be part of the model. Furthermore, the Walrasian stability condition is based on the assumption that the goods price adjusts **sluggishly** to restore equilibrium in the goods market. This, in fact, contradicts Buffie's assumption that the goods price adjusts continuously to clear the market[2].

There are however, at least two ways of solving the Buffie model correctly. They both involve using Phillips curve

<3.1> $$\dot{w} = \beta[\mu - \bar{\mu}] + \dot{p}, \qquad \beta < 0$$

where

- w *nominal wage rate*
- $\dot{w}$ *rate of change of nominal wage*
- p *price of the domestically produced good*
- $\dot{p}$ *time derivate of price level*
- μ *actual rate of unemployment*
- $\bar{\mu}$ *natural rate of unemployment*
- β *speed of adjustment of nominal wage rate*

but they differ according to what specification they make concerning money wages. In the first specification it is the level of the nominal wage that is fixed at each point in time. $\dot{p}$ can be calculated by taking the time derivative of the variables in the goods market equilibrium condition (as we explain more fully below). This assumption involves

[2]See Buffie (1986b) page 126.

agents having perfect foresight. We can call this special case as: "Sluggish Money Wages with Perfect Foresight". An alternative is to assume that agents have static expectations, this would involve simply dropping the $\dot{p}$ term. We can call this special case as: "Sluggish Money Wages with Static Expectations".

The second method of achieving internal consistency is to assume that it is the real wage, $z = w/p$, that is predetermined at a point in time. This involves the assumption that w always makes a discrete jump in response to any jump in p, and that the real wage only adjusts through time according to the Phillips curve <3.1>, which can be written by assuming $w=p=1$ initially as,

<3.2> $$\dot{z} = \beta[\mu - \bar{\mu}], \quad \beta < 0$$

where

$$\dot{z} = \dot{w} - \dot{p}$$

and we have called this special case: "A Sluggish Real Wage Phillips curve".

Now that this long critical introduction is complete, the plan of Chapter 3 is as follows: In section 3.2 we explain the corrected Buffie model, while in section 3.3 we derive the stability conditions of the model. In section 3.4 we discuss plausible parameter values of the variables and the slope expression for the aggregate demand function for goods. In section 3.5 we study the effects of devaluation on employment and the balance of payments, while in section 3.6 we study the implications of the plausible parameter values of the variables and of the slope expression. Finally, in section 3.7 we give the concluding remarks of this chapter.

3.2 A CORRECTED BUFFIE MODEL

Aggregate Supply

The Buffie model assumes that the country in question is producing a single good, Q, with a general production function involving domestic labour, N, imported input, IN, and some fixed factor say capital, K. The supply side of the economy is explained by the following equations which are derived by making use of the Hotelling lemma and by assuming that both capital and its price, r, are fixed.

<3.3> $$Q = \pi_p(w,p,e)$$

<3.4> $$N = -\pi_w(w,p,e)$$

<3.5> $$IN = -\pi_e(w,p,e)$$

The variables are defined as before. Equation <3.3> represents the aggregate supply function, and equations <3.4> and <3.5> represent the demand functions for labour and the imported input. $\pi(w,p,e)$ is the indirect variable profit function which is homogeneous of degree zero in nominal wages, w, good price, p, and the nominal exchange rate, e. $\pi_i(w,p,e)$ is the partial derivative of the indirect variable profit function with respect to the argument i $(i = w,p,e)$.

Assuming $e=p=w=1$ initially, the following local partial elasticities are defined.

<3.6>

$$\delta_e = -\frac{\pi_{ee}}{\pi_e} \qquad \delta_w = \frac{\pi_{ew}}{\pi_e} \qquad \delta_p = \frac{\pi_{ep}}{\pi_e}$$

$$\phi_p = \frac{\pi_{pp}}{\pi_p} \qquad \phi_e = \frac{\pi_{pe}}{\pi_p} \qquad \phi_w = \frac{\pi_{pw}}{\pi_p}$$

$$\varepsilon_w = -\frac{\pi_{ww}}{\pi_w} \qquad \varepsilon_e = \frac{\pi_{we}}{\pi_w} \qquad \varepsilon_p = \frac{\pi_{wp}}{\pi_w}$$

Throughout the analysis, we are assuming that all factors of production are normal. The own price elasticities are negative, and δ_w and ε_e have the same sign. If the imported input and domestic labour are gross substitutes then δ_w and ε_e are positive. On the other hand, if they are gross complements, then δ_w and ε_e are negative. These assumptions imply that $\delta_p, \delta_e, \varepsilon_w, \phi_p > 0$, $\phi_e, \phi_w < 0$, $\delta_w, \varepsilon_e \gtrless 0$.

In order to make the expressions used later simpler the following relationships between the local partial elasticities are used:

<3.7> $$\delta_e = \delta_w + \delta_p \qquad \varepsilon_w = \varepsilon_e + \varepsilon_p \qquad \phi_e + \phi_w = -\phi_p$$

<3.8> $$\phi_p = \theta_L \varepsilon_p + \theta_I \delta_p \quad \phi_w = \theta_I \delta_w - \theta_L \varepsilon_w \quad \phi_e = \theta_L \varepsilon_e - \theta_I \delta_e$$

Where θ_j $j-I,L$ represent the share of the variable inputs i.e., imported input and of labour in the total cost of production respectively. Relationships in <3.7> are obtained by exploiting the homogeneous of degree zero property of the indirect variable profit function in w, p, e, while the relationships in <3.8> are obtained by differentiation of the production function.

Aggregate Demand

Domestic consumers purchase only one domestically produced good. Part of the production of this good is exported to the rest of the world. For simplicity, it is assumed that their exists no government. To explicitly study the devaluation effects which stem from the supply-side effects of the exchange rate it is assumed that the devaluing country imports only intermediate inputs, ***IN***.

The market clearing condition for the home good is defined as:

<3.9> $$Q = C + X(\frac{ep^x}{p})$$

Where C is the total domestic consumption of good Q. p^x is the export price and $X(ep^x/p)$ is the total exports of the domestic good. As usual, it is assumed that exports of the domestic good depend upon relative prices, ep^x/p. For simplicity, we assumed that export price is exogenous and equal to unity for convenience.

Following the monetary approach to the balance of payments, domestic consumption is defined as the difference between the disposable income, Q^d, and the real hoarding of money, H/p,:

<3.10> $$C = Q^d - H/p$$

The disposable income is defined as the difference between the home good and total payments to foreigners for intermediary inputs:

<3.11> $$Q^d = Q - \frac{ep^m IN}{p}$$

Where p^m is the foreign price of the imported inputs. For simplicity, we assumed that this price is exogenous and equal to unity.

Using <3.3>, <3.5> and <3.11> above, equation <3.10> can further be written as:

<3.12> $$Q = \pi_p(w,p,e) + (e/p)\pi_e(w,p,e) - H/p$$

Real hoarding is defined as a proportion of the difference between the actual real money balances, M/p, and their desired level, M^d/p:

<3.13> $$H/P = \psi[M^d/p - M/p], \ \psi > 0$$

The demand for real money is defined as the linear function of value added:

<3.14> $$\frac{M^d}{p} = \kappa[\pi_p(w,p,e) + (e/p)\pi_e(w,p,e)]$$

By substituting <3.14> into <3.13> and then <3.13> into <3.12> the reader can readily derive the following reduced form of the aggregate demand function for good Q:

<3.15> $$sQ = (1-s)(e/p)\pi_e(w,p,e) + \psi M/p + X(e/p)$$

where $s = \kappa\psi$ *is the short-run marginalpropensity to save*

Dynamics

Besides the above seven equations <3.3>, <3.4>, <3.5>, <3.9>, <3.12>, <3.13>, and <3.14> the model also contains two differential equations, which define the dynamics of the model. One equation is the accumulation identity for the balance of payments, while the second is the Phillips curve. The balance of payment identity explains the net inflow of money over a period of time as:

<3.16> $$\dot{M} = B = pX(e/p) - eIN$$

where a dot over a variable indicates the time rate of change. Substituting equation <3.11> into <3.10> and then <3.10> into <3.9> gives:

<3.17> $$H = pX(e/p) + e\pi_e(w,p,e)$$

Finally, by substituting equation <3.14> into <3.13> and then <3.13> into <3.17> the following reduced form of the first differential equation of the model can easily be obtained:

<3.18> $$\dot{M} = B = p\psi[\kappa(\pi_p(w,p,e) + (e/p)\pi_e(w,p,e)) - M/p]$$

As far as the second differential equation of the model is concerned, we assume that the nominal wage is adjusting sluggishly over a period of time according to the following Phillips curve:

<3.19> $$\dot{w} = \beta[1 + \pi_w(w,p,e) - \bar{\mu}] + \dot{p}$$

where $\bar{\mu}$ is the natural rate of unemployment, and β is less than zero. For simplicity, we are assuming that the size of the labour force in the country is equal to unity. Therefore, $-\pi_w$ can be thought of as the fraction of the labour force demanded. The above Phillips curve explains the adjustment in the nominal wage through time, as it adjusts towards full equilibrium. Wages decrease (increases) when the actual rate of unemployment $1+\pi_w(w,p,e)$ (= 1-N) exceeds (falls short of) the natural rate of unemployment $\bar{\mu}$ or as good price decreases (increases). The speed of adjustment of the rate of nominal wages depends not only on the parameter β but it also depends on the parameters which will appear in the Phillips curve when the term $\dot{p}$ is calculated by taking the time derivative of the variable in the goods market equilibrium condition (see more detail below). We mentioned above that this interpretation of the Phillips curve <3.19> involves agents having perfect foresight. In the analysis presented below, we called this special case as: "Sluggish Money Wages with Perfect Foresight".

This completes the basic structure of the model. In the short-run there are ten endogenous variables Q, Q^d, p, C, M^d, H, N, IN, $\dot{w}$, and $\dot{M}$ which can be given values by solving the equations <3.3>, <3.4>, <3.5>, <3.9>, <3.10>, <3.11>, <3.13>, <3.14>, <3.18>, and <3.19> simultaneously. In the long-run however, if the system is stable then $\dot{w}$ and $\dot{M}$ will converge to zero and the levels of both w and M are endogenous.

3.3 STABILITY ANALYSIS

In order to derive the stability conditions, we first derive the reduced form of the two differential equations of the model defined above. For this purpose, we proceed as follows. Solving the aggregate demand <3.15> and supply <3.3> equations for the model we get:

<3.20> $$s\pi_p(w,p,e) = (1-s)(e/p)\pi_e(w,p,e) + \psi M/p + X(e/p)$$

For convenience, we rewrite equations <3.18> and <3.19> above:

<3.21> $$\dot{M} = B = p\psi[\kappa(\pi_p(w,p,e) + (e/p)\pi_e(w,p,e)) - M/p]$$

<3.22> $$\dot{w} = \beta[1 + \pi_w(w,p,e) - \bar{\mu}] + \dot{p}$$

Assuming $e=p=w=1$, $X=IM$ and hoarding $H=0$ initially[2], the total differentiation of <3.20> coupled with the use <3.6> and some manipulations gives:

<3.23> $$dp = A_1 dw + A_2 dM$$

where

$$A_1 = \frac{-s\phi_w\theta_I^{-1} - (1-s)\delta_w}{\Delta}, \quad A_2 = \frac{\psi}{\Delta X}$$

$$\Delta = \eta_x + (1-s)\delta_p - 1 + s\theta_I^{-1} + s\phi_p\theta_I^{-1} \gtrless 0$$

From <3.23> we can get:

<3.24> $$\dot{p} = A_1\dot{w} + A_2\dot{M}$$

where dot over a variable represents the time derivative. Substituting <3.21> into <3.24> and then <3.24> into <3.22> and by collecting terms we get:

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[2] If we assume hoarding is zero initially then it implies that

$$M^d/p = M/p = \kappa(\pi_p + (e/p)\pi_e)$$

which in turn implies that $\psi M/\pi_e = s(1-\theta_I^{-1})$.

<3.25>
$$\dot{w} = \frac{[\beta[1+\pi_w(w,p,e)-\bar{\mu}] + [A_2\psi p[k\pi_p(w,p,e)+e/p\pi_e(w,p,e)]-M/p}{1-A_1}$$

Holding the exchange rate, e, constant, the total differentiation of <3.25> (coupled with the use of <3.6> and that at initial equilibrium $w=p=e=1$, $X=IM$ and both $\dot{w}$ and $\dot{M}$ are equal to zero) yields:

<3.26>
$$d\dot{w} = \frac{\beta\pi_w(-\varepsilon_w dw+\varepsilon_p dp)+A_2\pi_p(s\phi_w-s\theta_I\delta_w)dw}{1-A_1} + \frac{A_2\pi_p(s\phi_p-s\theta_I\delta_p+s\theta_I+\psi M/\pi_p)dp-A_2\psi dM}{1-A_1}$$

Substituting the expression of dp from <3.23> back into <3.26> and by collecting terms we get:

<3.27>
$$d\dot{w} = adw + bdM$$

where

$$a = \frac{h_1 + A_2h_3}{1-A_1} \qquad b = \frac{h_2 + A_2h_4}{1-A_1}$$

$$h_1 = \beta\pi_w[-\varepsilon_w + \varepsilon_p A_1] \qquad h_2 = \beta\pi_w\varepsilon_p A_2$$

$$h_3 = \pi_p[z_1 + z_2A_1] \qquad h_4 = \pi_p[z_3 + z_2A_2]$$

$$z_1 = s\phi_w - s\theta_I\delta_w, \quad z_2 = s\phi_p - s\theta_I\delta_p + s\theta_I + s\frac{\psi M}{\pi_p}, \quad z_3 = -\frac{\psi}{\pi_p}$$

Similarly, holding the exchange rate, e, constant and using the assumption that at initial equilibrium $w=p=e=1$, $X=IM$, and $\dot{M}=0$, the total differentiation of <3.22> coupled with the use of <3.6> above yields:

$$\text{<3.28>} \qquad d\dot{M} = \pi_p \left[(s\phi_w - s\theta_l\delta_w)dw + (s\phi_p - s\theta_l\delta_p + s\theta_l + \frac{\psi M}{\psi_p})dP - \frac{\pi_p \psi dM}{\pi_p} \right]$$

By substituting the equation <3.23> into <3.28> and collecting terms we get:

$$\text{<3.29>} \qquad d\dot{M} = h_3 dw + h_4 dM$$

For convenience, we rewrite equations <3.27> and <3.29> into matrix form, we have the model in its final compact form, which is useful for identifying the stability conditions:

$$\text{<3.30>} \qquad \dot{Y} = AY$$

where

$$Y = \begin{pmatrix} dw \\ dM \end{pmatrix}, \quad \dot{Y} = \begin{pmatrix} d\dot{w} \\ d\dot{M} \end{pmatrix}, \quad A = \begin{pmatrix} a & b \\ h_3 & h_4 \end{pmatrix}$$

In a system where the dynamics involve adjustment in two variables that are predetermined at each point in time, stability requires that there should exist two stable roots. In this case, stability of the system requires that the determinant and the trace of the matrix A must take a positive and negative value respectively:

<3.31> $$\det(A) = ah_4 - bh_3 > 0$$

<3.32> $$Trace(A) = a + h_4 < 0$$

Substituting the values of a and b into <3.31> and rearranging the terms gives:

<3.33> $$\det(A) = \frac{(h_1 h_4 - h_2 h_3)}{(1 - A_1)} > 0$$

It is shown in the appendix to this chapter that by substituting in the values of h_1, h_2, h_3, and h_4 and doing a series of manipulations, det(A) is positive if and only if:

<3.34> $$\frac{\eta_x + \delta_e - 1 - \dfrac{\varepsilon_e \delta_w}{\varepsilon_w}}{R} > 0$$

where

$$R = \eta_x + \delta_e - 1 + s\theta_l^{-1} - s\theta_l^{-1}\theta_L \varepsilon_e \gtrless 0$$

From <3.34> it is evident that the determinant of matrix A will be positive either if

<3.35> $$\eta_x + \delta_e - 1 - \frac{\varepsilon_e \delta_w}{\varepsilon_w} > 0, \quad \textit{and}$$

$$R > 0$$

or,

<3.36> $$\eta_x + \delta_e - 1 - \frac{\varepsilon_e \delta_w}{\varepsilon_w} < 0, \quad \textit{and}$$

$$R < 0.$$

As explained above, to justify the sign of the expression in the denominator in <3.34> the notion of Walrasian stability cannot be used. The reason is that there are already equations to determine the time paths of variables. Moreover, if the equation which is used to derive the Walrasian stability condition is included into the model then the price, p, must be treated as predetermined at each point in time, and this is inconsistent with what has already been assumed.

The condition(s) which ensure that the trace of matrix A is negative can be derived as follows. After substituting the values of a and h_4 into <3.32>, and after doing a series of manipulations (again see the appendix to this chapter) it can easily be shown that the trace of the matrix A is negative if and only if the following condition holds:

<3.37>
$$\frac{-\beta\pi_w\varepsilon_w[\eta_x + \delta_\epsilon - 1 - \frac{\varepsilon_\epsilon\delta_w}{\varepsilon_w}] - \psi[\eta_x + \delta_\epsilon - 1]}{R} < 0$$

An interesting point to note here is that if the condition on the deteiminant is satisfied under restriction <3.35>, then <3.35> becomes sufficient condition for local stability of the model, since it guarantees that <3.37> holds as well. On the other hand, if the determinant is positive under condition <3.36>, then the determinant condition is not sufficient for stability of the system. The main reason for this is that $\eta_x+\delta_\epsilon-1 < \varepsilon_\epsilon\delta_w/\varepsilon_w$ does not ensure that $\eta_x+\delta_\epsilon-1 < 0$.

Another interesting point to note here is that in his (inconsistent) model Buffie has derived the same stability conditions given by <3.34> and <3.37> but, as explained above, he incorrectly made use of the Walrasian stability condition to argue for a positive sign of R.

The derivation of the local stability conditions is now complete. To summarize, the above analysis reveals that the system is locally stable under the following two set of conditions.

<3.38> $$\eta_x + \delta_\epsilon - 1 - \frac{\epsilon_\epsilon \delta_w}{\epsilon_w} > 0, \quad \textit{and}$$

$$R > 0$$

or,

<3.39> $$\eta_x + \delta_\epsilon - 1 - \frac{\epsilon_\epsilon \delta_w}{\epsilon_w} < 0, \quad \textit{and}$$

$$R < 0 \quad \textit{and}$$

$$\frac{-\beta\pi_w\epsilon_w[\eta_x + \delta_\epsilon - 1 - \frac{\epsilon_\epsilon \delta_w}{\epsilon_w}] - \psi[\eta_x + \delta_\epsilon - 1]}{R} < 0$$

where

$$R = \eta_x + \delta_\epsilon - 1 + s\theta_I^{-1} - s\theta_I^{-1}\theta_L\epsilon_\epsilon$$

3.4 PLAUSIBLE PARAMETER VALUES AND THE SLOPE CONDITIONS

Along with stability, economists have usually assumed that in the real world the Marshall-Lerner condition (MLC), defined in Chapter 2 above, is satisfied and that the aggregate demand function for goods is negatively sloped in the price/output plane. In order to remove the sign ambiguities of the multipliers below, we will make use of these common beliefs.

Using the aggregate demand function for goods <3.15> and the supply function <3.3> above, it can be shown that if the nominal wage is predetermined at a point in time and if the aggregate demand function for goods is negatively sloped, then Δ must have a positive value. While if the real wage, w/p, is sticky at each point in time and if the aggregate demand function for goods is negatively sloped, then $\boldsymbol{R}$ must has a positive value. (We consider this real wage rigidity case in the next chapter.)

With the above information in hand we now derive the comparative static results which follow from devaluation of the domestic currency. First, in section 3.5, we apply the correspondence principle to study the effects of devaluation on employment and the payments balance. Secondly, in section 3.6, to remove the sign ambiguities of the devaluation multipliers we use the presumption of stability of the model and that the aggregate demand function for goods is negatively sloped in the p/Q plane.

3.5 COMPARATIVE STATIC RESULTS

Assuming that the nominal wage and the money stock are predetermined at a point in time, that both net exports and hoarding are equal to zero initially, and that $e=p=w=1$ initially, in this section we study the effects of devaluation upon employment and the balance of payments of the country.

THE EMPLOYMENT EFFECT

For convenience, we rewrite the goods market equilibrium condition <3.20>:

<3.40> $$s\pi_p(w,p,e) = (1-s)\frac{e}{p}\pi_e(w,p,e) + \frac{\psi M}{p} + X\left(\frac{e}{p}\right)$$

Treating w and M as predetermined at a point in time the total differentiation of <3.40> coupled with the use of <3.6> gives:

<3.41> $$\frac{dp}{de} = \frac{\eta_x+(1-s)(\delta_e-1)-s\phi_e\theta_l^{-1}}{\Delta} \gtrless 0$$

where

$$\Delta = \eta_x+(1-s)(\delta_p-1)+s\theta_l^{-1}+s\phi_p\theta_l^{-1} \gtrless 0$$

Next, we rewrite equation <3.4> for convenience as:

<3.42> $$N = -\pi_w(w,p,e)$$

Treating w as predetermined at a point in time, and using <3.6> the total differentiation of equation <3.42> gives:

$$\frac{dN/N}{de} = \varepsilon_p \frac{dp}{de} + \varepsilon_e \qquad \text{<3.43>}$$

By Substituting <3.41> into <3.43>, and by doing some manipulations we get:

$$\frac{dN/N}{de} = \frac{\varepsilon_w}{\Delta}\left[\eta_x + \delta_e - 1 - \frac{\varepsilon_e \delta_w}{\varepsilon_w} + s\left(1 + \frac{\varepsilon_e}{\varepsilon_w v_x}\right)\right] \qquad \text{<3.44>}$$

where

$$\Delta = \eta_x + (1-s)\delta_p - 1 + s\theta_I^{-1} + s\phi_p\theta_I^{-1} \gtrless 0$$

From <3.44> (see appendix to Chapter 3 for the derivation of <3.44>) it is evident that due to ambiguity in the sign of the expression in the square brackets, and of Δ, the employment effect of devaluation cannot be determined conclusively. But, by applying the correspondence principle, we now try to remove the sign ambiguity of this multiplier.

If the system is stable under condition <3.38>, we know that $\eta_x + \delta_e - 1 - \varepsilon_e\delta_w/\varepsilon_w > 0$. However, since ε_e can take either sign and since we are not sure about the sign of Δ, the employment effect of devaluation cannot be determined conclusively. However, if we assume that labour and the imported input are gross substitutes $\varepsilon_e > 0$, then under condition <3.38> employment will increase (decrease) with devaluation if $\Delta > 0$ ($\Delta < 0$). The reader can easily confirm that for $\Delta > 0$ a high share of the imported input in the total cost, θ_I, increases the likelihood of employment increasing following devaluation.

If, on the other hand, stability condition <3.39> is satisfied then even if in addition Δ and ε_e take a definite sign the employment effect of devaluation cannot be determined conclusively.

The above outcome contradicts the findings of Buffie. By assuming $\Delta > 0$ (see Buffie ((1986b) p. 128) and also that the system is stable only under condition <3.38> Buffie has derived the result that if labour and the imported inputs are gross substitutes then devaluation necessarily increases labour employment.

BALANCE OF PAYMENTS EFFECT

For convenience, we rewrite equation <3.18> above:

<3.45>
$$\dot{M} = B = H = p\psi\left[k(\pi_p(w,p,e) + (e/p)\pi_e(w,p,e)) - \frac{M}{p}\right]$$

Treating w and M as predetermined at a point in time the total differentiation of <3.45> coupled with the use of <3.6> and of the envelope theorem gives (see appendix to Chapter 3 for the derivation of <3.46>):

<3.46>

$$\frac{dB}{de} = \frac{\bar{IM}s(v_x^{-1}+\theta_L\theta_I^{-1}\varepsilon_w)}{\Delta}\left[\eta_x+\delta_e-1-\frac{\varepsilon_e\delta_w}{\varepsilon_w}\right] + \frac{\varepsilon_e\delta_w}{\Delta\varepsilon_w}\left[\frac{(1-\theta_I)\theta_L^{-1}\varepsilon_w^{-1}+\theta_I\theta_L^{-1}\varepsilon_e^{-1}}{1+(1-\theta_I)\theta_L^{-1}\varepsilon_w^{-1}}\right] \gtrless 0$$

where

$$\Delta = \eta_x + (1-s)\delta_p - 1 + s\theta_I^{-1} + s\phi_p\theta_I^{-1} \gtrless 0$$

From <3.46> it is evident that ***dB/de > 0*** as

<3.47> $$\eta_x + \delta_e - 1 > \frac{\varepsilon_e\delta_w(1-\theta_I\theta_L^{-1}\varepsilon_e^{-1})}{\varepsilon_w(1+(1-\theta_I)\theta_L^{-1}\varepsilon_w^{-1}} \quad \textit{if} \quad \Delta > 0$$

<3.48> $$\eta_x + \delta_e - 1 < \frac{\varepsilon_e\delta_w(1-\theta_I\theta_L^{-1}\varepsilon_e^{-1})}{\varepsilon_w(1+(1-\theta_I)\theta_L^{-1}\varepsilon_w^{-1}} \quad \textit{if} \quad \Delta < 0$$

If stability condition <3.38> along with $\Delta>0$ is satisfied then the impact effect of devaluation on payments balance is not certain. However, the reader can readily confirm that if labour and the imported input are gross substitutes then the payments balance certainly improves upon devaluation[3]. But, if the stability <3.38> along with $\Delta<0$ is

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[3]If labour and the imported input are gross substitutes $\varepsilon_e>0$ then the necessary and sufficient condition under which ***db/de<0*** is $-\varepsilon_w\theta_I > (1-\theta_I)\varepsilon_e$. This is not possible as long (continued...)

satisfied then condition <3.48> may or may not be satisfied. However, if we assume that $\varepsilon_{\epsilon}>0$ then the stability condition <3.38> along with $\Delta<0$ ensures that the condition <3.48> must not be satisfied. The conclusion, then, is that in this special case, devaluation must worsen the payments balance.

On the other hand, if stability condition <3.39> is satisfied, then regardless of the sign of Δ, conditions <3.47> and <3.48> may or may not be satisfied. This implies that the payments balance may or may not improve upon devaluation, even if the system is locally stable.

From the above analysis it is evident that in general, the local stability of the model does not establish a definite correspondence between devaluation and the payments balance of the country. Furthermore, it is seen that Buffie's strong result that if labour and the imported input are gross substitutes then local stability of the model guarantees that the balance of payments must improve upon devaluation does not hold in this logically consistent treatment.

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[3](...continued)
as $\varepsilon_{\epsilon} > 0$. It is important to note that if labour and the imported input are weak gross substitutes $0<\varepsilon_{\epsilon}<\theta_I\theta^{-1}$ then satisfaction of the Marshall-Lerner condition becomes sufficient for the payments balance to improve upon devaluation.

CAN DEVALUATION BOTH CONTRACT EMPLOYMENT AND WORSEN THE BALANCE OF PAYMENTS?

Buffie has derived the result that if the system is locally stable then for the general production function, devaluation cannot both contract employment and worsen the payments balance. In addition, he also proved that if labour and the imported input are gross substitutes then devaluation simultaneously improves the payments balance and employment.

With the help of multipliers <3.44> and <3.46> above we can check the validity of these strong results.

IF STABILITY CONDITION <3.38> IS SATISFIED

Under stability condition <3.38> and with $\Delta > 0$ the necessary condition which makes $dN/de<0$ is:

<3.49> $\varepsilon_e < -\varepsilon_w v_x$

Since both ε_w and v_x are positive, from <3.49> it is clear that the imported input and domestic labour have to be gross complements to make $dN/de<0$. Similarly, under stability condition <3.38> and with $\Delta > 0$ the necessary condition which makes $dB/de<0$ is to be given as:

<3.50> $\varepsilon_e > -\varepsilon_w v_x$

From <3.49> and <3.50> it is evident that if the stability condition <3.38> along with $\Delta > 0$ is satisfied then devaluation cannot both worsen the balance of payments and reduce employment.

On the other hand, if the stability condition <3.38> along with $\Delta < 0$ is satisfied then the reader can confirm that if labour and the imported input are gross substitutes then devaluation both contracts employment and worsens the payments balance.

The above discussion reveals that if the stability condition <3.38> along with $\Delta > 0$ is satisfied then the results derived by Buffie hold true.

IF STABILITY CONDITION <3.39> IS SATISFIED

If the system is stable under condition <3.39> and if $\Delta > 0$[4] then the necessary and sufficient conditions under which devaluation reduces employment and worsens the payments balance are:

$$\frac{dN/N}{de} < 0 \quad \textit{if and only if}$$

<3.51>

$$\eta_x + \delta_e - 1 < \frac{\varepsilon_e \delta_w}{\varepsilon_w}\left[1 - \frac{s\varepsilon_w}{\varepsilon_e \delta_w} - \frac{s v_x^{-1}}{\delta_w}\right]$$

[4]It will happen if and only if $\delta_w < s\theta_I \theta_L^{-1} \varepsilon_w$ and $|\delta_w - s\theta_L \theta_I^{-1}| > |R|$.

$\frac{dB}{de}<0$ *if and only if*

<3.52> $$\eta_x + \delta_e - 1 < \frac{\varepsilon_e \delta_w}{\varepsilon_w}\left[\frac{1-\theta_I\theta_L\varepsilon_e^{-1}}{1+(1-\theta_I)\theta_L^{-1}\varepsilon_w^{-1}}\right]$$

From <3.51> and <3.52> it is evident that if the MLC is violated then the sufficient condition under which devaluation contracts employment is

<3.53> $$\frac{\varepsilon_e \delta_w}{\varepsilon_w} > s(1+\varepsilon_e\varepsilon_w^{-1}v_x^{-1})$$

and the sufficient condition under which devaluation worsens the balance of payments is

<3.54> $$1 - \theta_I\theta_L^{-1}\varepsilon_e^{-1} > 0$$

From <3.53> and <3.54> it is evident that if labour and the imported inputs are gross complements $\varepsilon_e<0$ and if $\varepsilon_w v_x<-\varepsilon_e$, then devaluation both contracts employment and worsens the payments balance.

The reader can readily confirm that if the stability condition <3.39> along with $\Delta>0$ is satisfied and even if the MLC is satisfied then devaluation could both contract employment and worsen the payments balance. For example, let us assume that the condition <3.51> is satisfied even if $\varepsilon_w v_x+\varepsilon_e>0$. Under these circumstances the sufficient condition under which devaluation also worsens the payments balance is:

<3.55> $\delta_w \theta_L^{-1} \theta_I - s[\varepsilon_w + (1-\theta_I)\theta_L^{-1}] < 0$

A careful reader could note here that if labour and the imported input are gross complements ($\delta_w < 0$) then condition <3.55> is necessarily satisfied. This implies that if the MLC is satisfied and if $\varepsilon_w \nu_x + \varepsilon_e > 0$, $\delta_w < 0$, and if devaluation contracts employment, then the payments balance must also deteriorate at the same time.

By following the above procedure the reader can prove another interesting result. If stability condition <3.39> along with $\Delta > 0$ is satisfied and if labour and the imported input are gross complements then devaluation cannot both improve the payments balance and increase employment. This is because, either the increase in labour employment or the improvement in the balance of payments is incompatible with stability of the model.

If stability condition <3.39> along with $\Delta < 0$ is satisfied then necessary condition which makes ***dN/de<0*** is:

<3.56> $-\varepsilon_w^{-1} \nu_x^{-1} \varepsilon_e < 1$

and necessary condition which makes ***dB/de<0*** is:

<3.57> $-\varepsilon_w \nu_x \varepsilon_e^{-1} < 1$

From <3.56> and <3.57> it is evident that if labour and the imported input are gross substitutes than devaluation could both contract employment and worsen the balance of payments. On the other hand, if labour and the imported input are gross complements then the condition <3.56> reduces to:

<3.58> $\varepsilon_e > -\nu_x \varepsilon_w$

and the condition <3.57> reduces to:

<3.59> $\varepsilon_e < -\nu_x \varepsilon_w$

From <3.58> and <3.59> it is evident that if labour and the imported input are gross complements then devaluation cannot both contract employment and worsen the payments balance.

Contrary to Buffie, the above analysis reveals that for a general specification of technology, stability of the model does not preclude the possibility that devaluation can both contract employment and worsen the payments balance.

3.6 IMPLICATIONS OF THE PLAUSIBLE PARAMETER VALUES AND THE SLOPE CONDITIONS

We mentioned above that in an economy in which the nominal wage is predetermined at a point in time and the aggregate demand function for goods is negatively sloped, then Δ must have a positive value. On the other hand, in an economy in which the real wage is sticky at each point in time and the aggregate demand function for goods is negatively sloped, then $\boldsymbol{R}$ must have a positive value. It is of interest to assume that for all kinds of economies, the aggregate demand function for goods is negatively sloped in the price/output plane. In this section of the chapter we make use of these slope conditions to remove the sign ambiguities of the multipliers discussed above.

We noticed above that if $\boldsymbol{R}$ has a positive value then system will be stable under the condition <3.38> only. Furthermore, if the system is stable under condition <3.38> and also if Δ has a positive value then all the results derived by Buffie hold true. This shows that Buffie's results hold true only for those economies which are stable and have negatively sloped aggregate demand function for goods.

3.7 CONCLUDING REMARKS

The above investigation supports the Lizondo and Montiel (1989) finding that devaluation is not necessarily expansionary, even if the system is locally stable. It is seen that in general, there does not exist a definite correspondence between the stability of the model and the effects of devaluation on labour employment and the payments balance. However, with certain additional assumptions it is observed that stability of the model managed to resolve the sign ambiguity of devaluation multipliers.

It is seen that the stability conditions discussed by Buffie represent only one of two possible sets of assumptions which can generate stability. In section 3.3 above it is shown explicitly that their exists two set of stability conditions.

The upshot of the above analysis is that Buffie's claim that if labour and imported inputs are gross substitutes, the orthodox conclusion that devaluation will be expansionary and improve the payments balance remain valid, does not hold in general. We have observed a number of cases in which for the general specification of technology devaluation simultaneously contracts employment and worsens the payments balance. This in fact contradicts Buffie's strong result that (p. 135) ***"If the initial equilibrium is locally stable, devaluation cannot both contract employment and worsen the payment balance."***

Throughout the analysis however, it is seen that under stability condition <3.38> and with $\Delta > 0$ the results derived by Buffie hold true. But, either if the stability condition <3.39> or if the stability condition <3.38> along with $\Delta < 0$, is satisfied then Buffie's results may or may not hold. At this stage a question which naturally arises is: which set of stability condition is more likely to satisfied? The answer to this question obviously depends upon the parameter values of the model. However, we noticed that if we assume, for all assumptions concerning wage flexibility, the aggregate demand function for goods has a negative slope in price/output plane, then the model will be stable under condition <3.38> and Δ has a positive value. In these circumstances we found that the results derived by Buffie can be verified in this logically consistent framework.

The main conclusion of this chapter is that once the comparative static and dynamic parts of the analysis are made consistent, presumption of stability is not enough; a limited set of additional priors, for example, that the aggregate demand function for goods is negatively sloped, was needed to be sure that devaluation cannot both contract employment and worsen the payments balance.

Appendix To Chapter 3

Derivation of Equation <3.34>

First, we rewrite equation <3.31> for convenience,

<3A.1> $$\det(A) = ah_4 - bh_3 > 0$$

Substituting the expression for ***a*** and ***b*** from <3.27> into <3A.1> and cancelling terms we get:

<3A.2> $$\det(A) = \frac{h_1 h_4 - h_2 h_3}{1-A_1} > 0$$

Substituting the values of $\boldsymbol{h}_1$, $\boldsymbol{h}_2$, $\boldsymbol{h}_3$, and $\boldsymbol{h}_4$ from <3.27> into <3A.2> and dividing both sides by $\beta\pi_w\pi_p$ we get:

<3A.3> $$\Omega = \frac{-\varepsilon_w(z_3+z_2A_2)+\varepsilon_p A_1(z_3+A_2z_2)-\varepsilon_p A_2(z_1+A_1z_2)}{1-A_1} > 0$$

Substituting the values of A_1, A_2, z_1, z_2, and z_3 from <3.27> into <3A.3> and doing some manipulations we get:

<3A.4>

$$\det(A) = \frac{\psi}{\Delta\pi_p(1-A_1)}\Bigg[\varepsilon_w\Delta+\varepsilon_p(s\theta_l^{-1}\phi_w+(1-s)\delta_w) - \varepsilon_w(s\phi_p-s\theta_l\delta_p+s\theta_I+\psi\frac{M}{\pi_p})-\varepsilon_p(s\phi_w-s\theta_L\delta_w)\Bigg] > 0$$

By substituting $\pi_p/X=\theta_I^{-1}, \psi M/\pi_\epsilon=s-s\theta_I^{-1}, \psi M/\pi_p = s-s\theta_l$ and the value of Δ from <3.23> also dividing throughout by ψ/π_p and by cancelling terms we get:

<3A.5>

$$\det(A) = \frac{\varepsilon_w}{\Delta(1-A_1)}\left[\eta_x+\delta_p-1+\frac{\varepsilon_p\delta_w}{\varepsilon_w}\right] > 0$$

Substituting $\delta_p=\delta_\epsilon-\delta_w$ *and* $\varepsilon_p=\varepsilon_w-\varepsilon_\epsilon$, dividing both sides by ε_w, and by cancelling terms we get:

<3A.6>

$$\det(A) = \frac{1}{\Delta(1-A_1)}\left[\eta_x+\delta_\epsilon-1-\frac{\varepsilon_\epsilon\delta_w}{\varepsilon_w}\right] > 0$$

The reader can readily confirm that

$$1-A_1 = \frac{[\eta_x+\delta_\epsilon-1+s\theta_I^{-1}-s\theta_I^{-1}\theta_L\varepsilon_\epsilon]}{\Delta}$$

By substituting the value of $1-A_1$ back into <3A.6> we get the equation <3.33> reported in the text.

<3A.7> $$\det(A) = \frac{\eta_x + \delta_e - 1 - \dfrac{\varepsilon_e \delta_w}{\varepsilon_w}}{\eta_x + \delta_e - 1 + s\theta_l^{-1} - s\theta_l^{-1}\theta_L \varepsilon_e} > 0$$

<u>Derivation of equation <3.37></u>

First, we rewriting equation <3.32> for convenience,

<3A.8> $$Trace(A) = a + h_4 < 0$$

Substituting the value of 'a' from <3.27> and by arranging the terms we get:

<3A.9> $$\frac{h_1 + h_4 + A_2 h_3 - h_4 A_1}{1 - A_1} < 0$$

For sake of convenience we first derive the expressions for $h_1/(1-A_1)$ and of $[(1-A_1)h_4 + A_2 h_3]/(1-A_1)$.

Using <3.27> we can have:

<3A.10> $$\frac{h_1}{(1-A_1)} = \frac{-\beta \pi_w \varepsilon_w}{1-A_1}\left[1 - \frac{\varepsilon_p A_1}{\varepsilon_w}\right]$$

Substituting the value of A_1 from <3.23> and after doing some manipulations we get:

<3A.11> $$\frac{h_1}{1-A_1} = \frac{-\beta\pi_w\varepsilon_w}{\Delta(1-A_1)}\left[\Delta + \frac{s\phi_w\theta_I^{-1}\varepsilon_p}{\varepsilon_w} + (1-s)\frac{\varepsilon_p\delta_w}{\varepsilon_w}\right]$$

Substituting the value of Δ from <3.23> and using the fact that $\phi_w=\theta_I\delta_w-\theta_L\varepsilon_w, \phi_p=\theta_L\varepsilon_p+\theta_I\delta_p$ and after cancelling terms we get:

<3A.12> $$\frac{h_1}{1-A_1} = \frac{-\beta\pi_w\varepsilon_w}{\Delta(1-A_1)}\left[\eta_x + \delta_p - 1 + s\theta_I^{-1} + \frac{\varepsilon_p\delta_w}{\varepsilon_w}\right]$$

Substituting $1-A_1 = (\eta_x+\delta_e-1+s\theta_I^{-1}-s\theta_I^{-1}\theta_L\varepsilon_e)/\Delta$ and $\delta_p=\delta_e-\delta_w, \varepsilon_p=\varepsilon_w-\varepsilon_e$ into <3A.12> and after cancelling terms we get:

<3A.13> $$\frac{h_1}{1-A_1} = \frac{-\beta\pi_w\varepsilon_w\left[\eta_x + \delta_e - 1 + s\theta_I^{-1} - \frac{\varepsilon_e\delta_w}{\varepsilon_w}\right]}{\eta_x + \delta_e - 1 + s\theta_I^{-1} - s\theta_I^{-1}\theta_L\varepsilon_e}$$

Now we derive the following expression

$$\lambda = [(1-A_1)h_4+A_2h_3]/(1-A_1)$$

By substituting the values of h_4 and h_3 from <3.27> and after doing some manipulations we have:

<3A.14> $$\lambda = \frac{\pi_p}{1-A_1}\left[(1-A_1)z_3+(z_1+z_2)A_2\right]$$

Substituting the values of z_1, z_2, z_3, and A_2 from <3.23> and <3.27> and after doing some manipulations we get:

<3A.15> $$\lambda = \frac{-\psi}{1-A_1}\left[(1-A_1) + (s\phi_e + s\theta_I\delta_e - s\theta_I - \frac{\psi M}{\pi_p})\frac{\theta_I^{-1}}{\Delta}\right]$$

Substituting the value of $1\text{-}A_1$ from above and using the fact that $\phi_e=\theta_L\varepsilon_e-\theta_I\delta_e$ and $\psi M/\pi_p=s-s\theta_I$ into <3A.15> and some re-arranging gives:

<3A.16> $$Y = \frac{-\psi[\eta_x + \delta_e - 1]}{\eta_x + \delta_e - 1 + s\theta_I^{-1} - s\theta_I^{-1}\theta_L\varepsilon_e}$$

By combining <3A.13> and <3A.16> we get the equation <3.37> reported in the text.

<3A.17> $$\frac{-\beta\pi_w\varepsilon_w[\eta_x + \delta_e - 1 - \frac{\varepsilon_e\delta_w}{\varepsilon_w}]-\psi[\eta_x+\delta_e-1]}{R} < 0$$

where

$$R = \eta_x + \delta_e - 1 + s\theta_I^{-1} - s\theta_I^{-1}\theta_L\varepsilon_e$$

Derivation of Equation <3.44>

Rewriting equation <3.41> by replacing ϕ_e by the expressions given in <3.8> above, we have:

$$\text{<3A.18>} \qquad \frac{dp}{de} = \frac{\eta_x + \delta_e - 1 + s(1 - \theta_L\varepsilon_e\theta_I^{-1})}{\Delta}$$

From <3A.18> we can derive:

$$\text{<3A.19>} \qquad 1 - \frac{dp}{de} = \frac{sv_x^{-1} + s\theta_L\varepsilon_w\theta_I^{-1} - \delta_w}{\Delta}$$

Using $\varepsilon_e = \varepsilon_w - \varepsilon_p$ the equation <3.43> can be written as:

$$\text{<3A.20>} \qquad \frac{dN/N}{de} = \varepsilon_w\frac{dp}{de} + \varepsilon_e(1 - \frac{dp}{de})$$

Substituting <3A.18> and <3A.19> into <3A.20> and after doing some manipulations we get:

<3A.21>

$$\frac{dN/N}{de} = \frac{\varepsilon_w}{\Delta}\left[\eta_x + \delta_e - 1 - \frac{\varepsilon_e \delta_w}{\varepsilon_w} + s(1 - \theta_L \varepsilon_e \theta_I^{-1}) + \frac{s\varepsilon_e}{\varepsilon_w}(v_x^{-1} + \theta_L \varepsilon_w \theta_I^{-1})\right]$$

By cancelling terms $s\theta_L\theta_I^{-1}\varepsilon_e$ and after doing little manipulations we get the equation <3.44> reported in the text:

<3A.22>

$$\frac{dN/N}{de} = \frac{\varepsilon_w}{\Delta}\left[\eta_x + \delta_e - 1 - \frac{\varepsilon_e \delta_w}{\varepsilon_e} + s(1 + \frac{\varepsilon_e}{\varepsilon_w v_x})\right]$$

Derivation of Equation <3.46>

The balance of payments equation could be written as:

<3A.23>

$$B = pX(e/p) + e\pi_e(w,p,e)$$

Assuming that trade is balanced initially, the total differentiation of <3A.23> coupled with the use of <3.6> yields:

<3A.24>

$$\frac{dB}{de} = \bar{IM}\left[(\eta_x + \delta_e - 1)(1 - \frac{dp}{de}) + \delta_w \frac{dp}{de}\right]$$

Substituting <3A.18> and <3A.19> into <3A.24> and after cancelling terms we get:

<3A.25> $$\frac{dB}{de} = \frac{I\bar{M}}{\Delta}\Big[(\eta_x + \delta_e - 1)(sv_x^{-1} + s\theta_L\varepsilon_w\theta_I^{-1}) + s(1 - \theta_L\theta_I^{-1}\varepsilon_e)\delta_w\Big]$$

Multiplying and dividing the right hand side of <3A.25> by $v_x^{-1} + \theta_L\varepsilon_w\theta_I^{-1}$ we get:

<3A.26> $$\frac{dB}{de} = \frac{sI\bar{M}(v_x^{-1} + \theta_L\varepsilon_w\theta_I^{-1})}{\Delta}\left[\eta_x + \delta_e - 1 + \frac{(1 - \theta_L\theta_I^{-1}\varepsilon_e)\delta_w}{(v_x^{-1} + \theta_L\theta_I^{-1}\varepsilon_w)}\right]$$

The reader can readily confirm that:

<3A.27> $$\frac{(1 - \theta_L\theta_I^{-1}\varepsilon_e)\delta_w}{(v_x^{-1} + \theta_L\theta_I^{-1}\varepsilon_w)} = \frac{-\varepsilon_e\delta_w}{\varepsilon_w}\left[\frac{1 - \theta_I\theta_L^{-1}\varepsilon_e^{-1}}{1 + (1 - \theta_I)\theta_L^{-1}\varepsilon_w^{-1}}\right]$$

By substituting <3A.27> back into <3A.26> we get the equation <3.46> reported in the text:

$$\frac{dB}{de} = \frac{I\bar{M}s(v_x^{-1} + \theta_L\theta_I^{-1}\varepsilon_w)}{\Delta}\left[\eta_x + \delta_e - 1 - \frac{\varepsilon_e\delta_w}{\varepsilon_w}\right] +$$

<3A.28> $$\frac{\varepsilon_e\delta_w}{\Delta\varepsilon_w}\left[\frac{(1-\theta_I)\theta_L^{-1}\varepsilon_w^{-1} + \theta_I\theta_L^{-1}\varepsilon_e^{-1}}{1 + (1-\theta_I)\theta_L^{-1}\varepsilon_w^{-1}}\right]$$

Chapter 4

STABILITY, IMPORTED INPUTS, AND DEVALUATIONS: A SENSITIVITY ANALYSIS

4.1 INTRODUCTION

In this chapter we explore the sensitivity of the results derived in Chapter 3 to the alternative specifications of the money wage flexibility and of inflationary expectations, and the definition of money demand function. Further, we solve the model for perfect capital mobility, a case which is not considered by Buffie.

First we solve the Buffie model under the assumption that the real wage is predetermined at each point in time. Secondly, we solve the model under the assumption that nominal wage is predetermined at a point in time and that inflation has no direct bearing on the speed of adjustment of nominal wage towards its long-run sustainable level. Thirdly, we rework all versions of our corrected model under the assumption that the demand for money depends upon gross output instead of net income. Finally, we solve all versions of the model for the case of perfect capital mobility. Since these sensitivity tests are done on the corrected Buffie model, the notation is same as that used in the last chapter.

In our corrected version of Buffie's model, developed in the last chapter, we assumed that the nominal wage is predetermined at a point in time, while the adjustment in the nominal wage to the full equilibrium level is explained by the Phillips curve,

$$\dot{w} = \beta[1 + \pi_w(w,p,e) - \bar{\mu}] + \dot{p} \tag{4.1}$$

This Phillips curve assumes that agents have perfect foresight and that the nominal wage which is predetermined at a point in time will increase (decrease) sluggishly over a period of time as the actual rate of unemployment, $1+\pi_w(w,p,e)$, falls short of (exceeds) the natural rate of unemployment $\bar{\mu}$ or as the goods price, p, decreases (increases) over a period of time. The rate of change of the nominal wage depends not only on the parameter β but it also depends upon the parameter which appears in the above Phillips curve when the term $\dot{p}$ is calculated by taking the time derivative of the variables in the goods market equilibrium condition. As we mentioned in the last chapter that we can call this special case: "Sluggish Money Wages with Perfect Foresight".

The sensitivity of results derived in the last chapter to the nature of adjustment in nominal wages can be analyzed by examining the model developed there with the following two alternate interpretations of the Phillips curve <4.1>.

(1) The one interpretation of the Phillips curve <4.1> is that instead of assuming the nominal wage is predetermined at a point in time, we can assume that real wage is adjusting sluggishly over a period of time as the actual rate of unemployment, $1+\pi_e(w,p,e)$, exceeds or falls short of the natural rate of unemployment, $\bar{\mu}$. In this case, to maintain internal consistency we assume that the real wage is predetermined at each point in time. As a result, both $\boldsymbol{w}$ and $\boldsymbol{p}$ become endogenous variables. $\boldsymbol{w}$ always makes discrete jumps in response to discrete changes the price level. In these circumstances by assuming $\boldsymbol{w=p=1}$ initially, the Phillips curve <4.1> can be written as:

$$\langle 4.3 \rangle \qquad \dot{z} = \beta[1 + \pi_w(w,p,e) - \bar{\mu}], \quad \beta<0$$

$$\textit{where} \quad \dot{z} = \dot{w} - \dot{p}$$

In the analysis presented below, we call this special case: "A Sluggish Real Wage Phillips Curve".

(2) The other interpretation of the Phillips curve <4.1> is that the nominal wage which is predetermined at a point in time, increases (decreases) sluggishly over a period of time as the actual rate of unemployment exceeds (falls short of) the natural rate of unemployment. As far as changes in goods prices are concerned it can be assumed that this does not have any direct bearing on the rate of change of the nominal wage. In other words, we are assuming that agents have static expectations about prices. In these circumstances the Phillips curve <4.1> can be written as:

<4.2> $$\dot{w} = \beta[1 + \pi_w(w,p,e) - \bar{\mu}], \quad \beta<0$$

In the analysis presented below, we called this special case: "Sluggish Money Wages with Static Expectations".

In the Buffie model it is assumed that the demand for money depends upon domestic value added or GNP. This assumption is somewhat restrictive. The demand for money may also be specified as a function of gross output or GDP,

<4.4> $$M^d/p = k\pi_p(w,p,e), \quad 0<k\leq 1$$

and it has been shown that this change in the specification of the money demand function can make a dramatic difference to the results in open economy models (for example, see Miller (1976) and Scarth (1979)).

The money demand function <4.4> states that demand for money depends upon gross output. A simple implication of this money demand function is that for a given level of prices and wages, devaluation definitely reduces the demand for money[1]. This in turn increases the likelihood of positive demand-side effects of the exchange rate.

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[1]holding 'p' and 'w' constant differentiation of <4.4> coupled with the use of <3.6> gives us:

$$\left.\frac{dM^d}{de}\right|_{\substack{\bar{w}\\ \bar{p}}} = k\pi_p\phi<0$$

whereas, from equation <3.14> we have the ambiguous result.

$$\left.\frac{dM^d}{de}\right|_{\substack{\bar{w}\\ \bar{p}}} = k[\theta_L\varepsilon_e-\theta_I]\gtrless 0$$

However, we found that in the Buffie model, for money demand function <4.4> our results do not change qualitatively. This is surprising given the pre-existing sensitivity tests in this area that were cited in the previous paragraph. Nevertheless for reasons of brevity we have decided not to report these results.

In this Chapter 4, we have also attempted to extend our model to the case of perfect capital mobility, a case not considered by Buffie. Contrary to the case of zero capital mobility, perfect capital mobility involves the stock of money adjusting instantaneously to clear the money market. As a result, hoarding of money is always equal to zero. In addition, since the stock of money always makes a discrete jump to clear the money market, the flow of money, $\dot{M}$, cannot be defined. Consequently, the equation <3.18> is not part of the model.

This special case can be solved by using two different methods. The first method is to solve the model as it is solved for zero capital mobility above and then to interpret the stability conditions and devaluation multipliers by letting $\psi \to \infty$. The second and the easier method is to assume perfect capital mobility from the outset, and to drop equation <3.18> from the model. In this circumstance the dynamics of the model involves adjustment only in the nominal wage, and the stability of the model requires only that the nominal wage should adjust through time in such a way that in the long-run the actual rate of unemployment coincides with the natural rate of unemployment. This will be the case if and only if

<4.5> $$\frac{d\dot{w}}{dw} < 0$$

If the model is solved according to the second method then equation <3.18> reduces to:

<4.6> $$M/p = M^d/p = k[\pi_p(w,p,e) + (e/p)\pi_e(w,p,e)]$$

Substituting equation <4.6> back into the goods market equilibrium condition <3.20> and after some manipulation we get:

<4.7> $$X(e/p) + (e/p)\pi_e(w,p,e) = 0$$

Equation <4.7> in fact depicts the fact that in this perfect capital mobility case net exports are always equal to zero.

In the short-run there are eight endogenous variables Q, Q^d, IN, C, $M^d - M$, p, N, and $\dot{w}$ to which we can assign values by solving the equations <3.3>, <3.4>, <3.5>, <3.10>, <3.11>, <4.6>, <4.7>, and <4.1> simultaneously.

The plan of this chapter is as follows. In section 4.2 we report the stability conditions of the models involving the different interpretations of the Phillips curve <4.1> discussed above both for zero and perfect capital mobility cases. In section 4.3 we discuss the slope conditions of the aggregate demand function for goods. In section 4.4 we study the effects of devaluations on employment and the balance of payments. In particular, like Chapter 3 we study the joint outcome of devaluation on employment and the balance of payments. Finally, in section 4.5 we give some concluding remarks.

4.2 STABILITY ANALYSIS

By following the procedure given in Chapter 3 the reader can readily derive the following stability conditions for the alternative interpretations of the Phillips curve <4.1> discussed above, for zero and perfect capital mobility cases (see next page.)

STABILITY CONDITIONS

THE SLUGGISH REAL WAGE PHILLIPS CURVE:

THE ZERO CAPITAL MOBILITY CASE

<4.8> $$\eta_x + \delta_e - 1 > \frac{\varepsilon_e \delta_w}{\varepsilon_w}, \text{ and}$$

$$R > 0$$

or,

<4.9> $$\eta_x + \delta_e - 1 < \frac{\varepsilon_e \delta_w}{\varepsilon_w}, \text{ and}$$

$$R < 0, \text{ and}$$

$$-\beta \pi_w \varepsilon_w [\eta_x + \delta_e - 1 + s\theta_I^{-1} - \frac{\varepsilon_e \delta_w}{\varepsilon_w}] - \psi[\eta_x + \delta_e - 1] > 0$$

where

$$R = \eta_x + \delta_e - 1 + s\theta_I^{-1}(1 - \theta_L \varepsilon_e)$$

STABILITY CONDITIONS

SLUGGISH MONEY WAGES WITH STATIC EXPECTATIONS: THE ZERO CAPITAL MOBILITY CASE

<4.10> $$\eta_x+\delta_e-1 > \frac{\varepsilon_e\delta_w}{\varepsilon_w}, \quad \textit{and}$$

$$\Delta = \eta_x+(1-s)(\delta_p-1)+sv_x^{-1}+s\theta_l^{-1}\phi_p > 0, \quad \textit{and}$$

$$-\beta\pi_w\varepsilon_w[\eta_x+\delta_e-1-\frac{\varepsilon_e\delta_w}{\varepsilon_w}] - \psi[\eta_x+\delta_e-1-\delta_w] < 0$$

or,

<4.11> $$\eta_x+\delta_e-1 < \frac{\varepsilon_e\delta_w}{\varepsilon_w}, \quad \textit{and}$$

$$\Delta = \eta_x+(1-s)(\delta_p-1)+sv_x^{-1}+s\theta_l^{-1}\phi_p < 0, \quad \textit{and}$$

$$-\beta\pi_w\varepsilon_w[\eta_x+\delta_e-1-\frac{\varepsilon_e\delta_w}{\varepsilon_w}] - \psi[\eta_x+\delta_e-1-\delta_w] > 0$$

STABILITY CONDITIONS

SLUGGISH MONEY WAGES WITH PERFECT FORESIGHT:

THE PERFECT CAPITAL MOBILITY CASE

<4.12> $$\eta_x + \delta_e - 1 > \frac{\varepsilon_e \delta_w}{\varepsilon_w}$$

or,

<4.13> $$R_1 = \eta_x + \delta_e - 1 < 0$$

STABILITY CONDITIONS

THE SLUGGISH REAL WAGE PHILLIPS CURVE:

THE PERFECT CAPITAL MOBILITY CASE

<4.14> $$\eta_x + \delta_e + 1 - \varepsilon_e \delta_w / \varepsilon_w > 0$$

or,

<4.15> $$\eta_x + \delta_e - 1 < 0$$

STABILITY CONDITIONS

SLUGGISH MONEY WAGES WITH STATIC EXPECTATIONS: THE PERFECT CAPITAL MOBILITY CASE

<4.16>

$$\eta_x + \delta_e - 1 > \frac{\varepsilon_e \delta_w}{\varepsilon_w}, \quad \textit{and}$$

$$\Delta_1 = \eta_x + \delta_p - 1 > 0$$

or,

<4.17>

$$\eta_x + \delta_e - 1 < \frac{\varepsilon_e \delta_w}{\varepsilon_w}, \quad \textit{and}$$

$$\Delta_1 = \eta_x + \delta_p - 1 < 0$$

See the appendix to Chapter 4 for the derivation of the conditions <4.10>, <4.11>, <4.12>, and <4.13>. Before starting our discussion about the comparative static results a brief comment on the above stability conditions must be made.

Surprisingly, the stability conditions <4.8> and <4.9> are exactly the same as those which are derived in Chapter 3 where we assumed that workers have perfect foresight. However, contrary to the perfect foresight case it can be seen that stability of the model resolves the sign ambiguity of the denominators in the devaluation multipliers discussed below.

Similarly, contrary to the perfect foresight case, from <4.10> and <4.11> it is evident that when labour market participants have static expectations, the condition on Δ which appears in the devaluation multipliers and whose positive value is assumed by Buffie <u>is</u> now determined by the local stability of the model.

As far as the stability conditions for the perfect capital mobility cases are concerned, the stability conditions <4.12> and <4.13> show that when workers have perfect foresight then satisfaction of the Marshall-Lerner condition (MLC) is not sufficient for stability of the model, while the violation of the MLC is sufficient for stability (see equation <4.13>). Further, these stability conditions are exactly the same as those which we have derived by assuming that real wages are sticky at each point in time (see equations <4.14> and <4.15>). However, when we assume that workers have static expectations, it can be seen that (compared to the perfect foresight case or to the case when the real wages are sticky at each point in time), the stability of the model is more restricted in the sense that for stability more conditions must be satisfied. For example, in <4.12> above it is noticed that $\eta_x+\delta_e-1>\varepsilon_e\delta_w/\varepsilon_w$ is sufficient for the stability. On the other hand, in <4.16> not only is $\eta_x+\delta_e-1>\varepsilon_e\delta_w/\varepsilon_w$ needed for the stability but also, a restriction on Δ_I is required. Similarly, in <4.17> the reader can note that if $\delta_w>0$ then violation of the Marshall-Lerner condition (MLC) is sufficient to achieve the stability. While in case of sluggish money wages with perfect foresight, it is seen that regardless of the sign of δ_w the violation of the MLC is sufficient for stability of the system (see condition <4.13>).

The above analysis reveals that for both zero and perfect capital mobility, the stability of the model, at least to some extent, is sensitive to the alternative specifications of money wage flexibility and of inflationary expectations.

4.3 PLAUSIBLE PARAMETER VALUES AND THE SLOPE CONDITIONS

As in Chapter 3, we make use of two stylized facts (that the MLC is satisfied and that the aggregate demand function for goods is negatively sloped in the price/output plane) to remove the sign ambiguities of the multipliers. As we pointed out in the last chapter, if the nominal wage is predetermined at a point in time and if the aggregate demand function for goods is negatively sloped, then Δ must have a positive value. On the other hand, if the real wage is predetermined at a point in time and the aggregate demand function for goods is negatively sloped, then $\boldsymbol{R}$ must have a positive value.

As far as the expressions for Δ_I and $\boldsymbol{R}_I$ are concerned, they have different interpretations than those given for Δ and $\boldsymbol{R}$. It can be shown that for perfect capital mobility the aggregate demand function for goods has a zero slope in the price/output space. In these circumstances the sign of Δ_I and $\boldsymbol{R}_I$ does not impose any restriction on the slopes of the aggregate demand and supply functions.

With the above information in hand we now derive the comparative static results which follow from devaluation of the domestic currency.

4.4 SHORT-RUN COMPARATIVE STATIC RESULTS

In this sub-section of the chapter we discuss the sensitivity of the results reported in Chapter 3, to the alternative specification of the money wage flexibility and of inflationary expectations, and of perfect capital mobility. Like Chapter 3, we check the Buffie's result that for stable economies devaluations cannot both contract employment and worsen the payments balance. First, we will investigate the correspondence between the stability of the model and the impact effects of devaluations. Secondly, in addition to stability of the model we will use the slope conditions (discussed above) to remove the sign ambiguity of the multipliers.

For zero capital mobility and static expectations, the mathematical expressions which we have derived in Chapter 3 remain intact. However, these expressions now must be interpreted in the light of stability conditions <4.10> and <4.11> above. On the other hand, when the real wage is sticky at each point in time, the reader can readily derive the following impact multipliers:

<4.18> $$\frac{dN/N}{de} = \frac{\varepsilon_e s v_x^{-1}}{R}$$

<4.19> $$\frac{dB}{de} = \frac{s v_x^{-1} X[\eta_x + \delta_e - 1]}{R}$$

where

$\bar{X}$: *initial value of exports*

In the case of perfect capital mobility, either for static expectations or for perfect foresight cases, the reader can readily confirm (or see appendix to Chapter 4 for the derivation) the following multiplier:

<4.20> $$\frac{dN/N}{de} = \frac{\varepsilon_w}{\Delta_1}[\eta_x + \delta_e - 1 - \frac{\varepsilon_e \delta_w}{\varepsilon_w}]$$

where

$$\Delta_1 = \eta_x + \delta_p - 1$$

When the real wage is predetermined at each point in time it can be shown that devaluation is neutral with respect to employment.

For convenience, with the help of table 4.1 on the next page, we first give the summary of the findings and then we proceed to our discussion of the results.

TABLE 4.1

THE IMPACT EFFECTS OF DEVALUATION WHEN THE SYSTEM IS LOCALLY STABLE

	ZERO CAPITAL MOBILITY		
	Sticky Money Wages		Sticky Real Wages
	Perfect Foresight	Static Expectations	
dN/de	?	?	?
dB/de	?	?	+
can both dN/de and dB/de be negative?	YES	YES	YES
	PERFECT CAPITAL MOBILITY		
	Sticky Money Wages		Sticky Real Wages
	Perfect Foresight	Static Expectations	
dN/de	?	+	0

From table 4.1 it is evident that in the zero capital mobility case, despite the presumption of stability, devaluation of the domestic currency has an ambiguous effects on both employment and the balance of payments. This ambiguity remains for all specifications of wage flexibility and of inflationary expectations. While for perfect capital mobility, the employment effect of devaluation is ambiguous when workers have perfect foresight, expansionary when workers have static expectations, and is neutral when the real wage is sticky at each point in time. These results show that in stable economies where there exist perfect capital mobility, the employment effect of devaluation is quite sensitive to the alternative specifications of the money wage flexibility and of inflationary expectations.

CAN DEVALUATION BOTH CONTRACT EMPLOYMENT AND WORSEN THE BALANCE OF PAYMENTS?

(i) A SLUGGISH REAL WAGE PHILLIPS CURVE

For the zero capital mobility case, if we assume that the real wage is sticky at each point in time and the model is stable under stability condition <4.8>, then using <4.18> and <4.19> it can be shown that:

<4.25> $$\frac{dN/N}{de} \gtrless 0 \ as \ \varepsilon_e \gtrless 0$$

<4.26> $$\frac{dB}{de} > 0.$$

On the other hand, if the system is stable under stability condition <4.9> then:

<4.27> $$\frac{dN/N}{de} \gtrless 0 \ as \ \varepsilon_e \lesseqgtr 0$$

<4.28> $$\frac{dB}{de} \gtrless 0 \quad as \quad \eta_x+\delta_e-1 \lesseqgtr 0.$$

From <4.26> it is evident that if the stability condition <4.8> is satisfied then devaluation definitely improves the payments balance. Thus, the possibility that devaluation both contracts employment and worsens the payments balance does not arise in this special case.

From <4.27> and <4.28>, however, it can be seen that if the stability condition <4.9> is satisfied and if $\varepsilon_e>0$ and if the MLC $(\eta_x+\delta_e-1>0)$ is satisfied then devaluation both contracts employment and worsens the payments balance. The reader can note an interesting result that if the system is stable under stability condition <4.9> and if devaluation increases employment then the payments balance will be improved at the same time but the converse may not be true[2].

[2]From <4.27> it is evident that if the stability condition <4.9> is satisfied then devaluation increases employment if and only if labour and the imported inputs are gross complements ($\varepsilon_e < 0$). Under condition <4.9> devaluation worsens the payments balance if and only if the MLC is satisfied. It can be seen easily that if $\varepsilon_e < 0$ and if the MLC is satisfied then R cannot take a

(continued...)

These results are different from those which we obtain when workers have perfect foresight (see Chapter 3). In Chapter 3 we noticed that under each set of stability conditions, devaluation can both contract employment and worsen the balance of payments. This highlights the sensitivity of the results to the alternative specifications of wage flexibility and of inflationary expectations.

(ii) SLUGGISH MONEY WAGES WITH STATIC EXPECTATIONS

Following the procedure given in Chapter 3, it can be shown that for the zero capital mobility case, if workers have static expectations and the system is stable under stability condition <4.10>, then the necessary condition under which devaluation could reduce employment is

<4.21> $$\varepsilon_e < -\varepsilon_w v_x$$

Since ε_w and v_x are both positive, it is evident from <4.21> that labour and imported inputs must be gross complements **($\varepsilon_e<0$)** to make ***dN/de<0***. Similarly, under stability condition <4.10> the necessary condition which is required to make ***dB/de<0*** is

<4.22> $$\varepsilon_e > -\varepsilon_w v_x$$

---

[2](...continued)
negative value. This violates the stability condition <4.9>. This implies that if under stability condition <4.9> devaluation increases employment then it will also improve the payments balance at the same time.

From <4.21> and <4.22> it is evident that if stability condition <4.10> is satisfied then devaluation cannot both contract employment and worsen the payments balance.

On the other hand, if the stability condition <4.11> is satisfied then the necessary condition which makes ***dN/de<0*** is

<4.23> $$-v_x^{-1}\varepsilon_w^{-1}\varepsilon_e < 1$$

Similarly, the necessary condition which makes ***dB/de<0*** is

<4.24> $$-v_x\varepsilon_w\varepsilon_e^{-1} < 1$$

Using <4.23> and <4.24> the reader can readily confirm that if labour and the imported input are gross substitutes ($\varepsilon_e>0$) then devaluation could both contract employment and worsen the balance of payments.

Contrary to these findings, in the case of sluggish money wages with perfect foresight (see Chapter 3 above) under each set of stability conditions it is seen that both employment and the balance of payments could worsen. This, again, highlights the sensitivity of the results to the alternative specifications of the money wage flexibility and of the inflationary expectations.

The above analysis reveals that, in general, the stability of the model alone does not preclude the possibility that devaluation can both contract employment and worsen the balance of payments. This result clearly contradicts Buffie's strong result mentioned above.

4.5 IMPLICATIONS OF PLAUSIBLE PARAMETER VALUES AND THE SLOPE CONDITIONS

In section 4.3 above, we pointed out that if the nominal wage is predetermined at each point in time and the aggregate demand function for goods is negatively sloped in the price/output plane, then Δ must have a positive value. Moreover, if the real wage is sticky at each point in time and if the aggregate demand function for goods is negatively sloped, then $\boldsymbol{R}$ must have a positive value. In these circumstances, it can be shown that with the sticky real wage the model is stable under stability condition <4.8> only. Similarly, when labour market participants have static expectations the model is stable under stability condition <4.10> only. In the above analysis we noticed that for sticky real wages if the model is stable under stability condition <4.8> and for static expectations if the model is stable under stability condition <4.10>, then devaluation cannot both contract employment and worsen the balance of payments in either model. Furthermore, it is also seen above that for sticky real wages if the model is stable under stability condition <4.8>, then devaluation necessarily improves the balance of payments.

From the above analysis it is evident that along with stability of the model, if we also assume that the aggregate demand function for goods is negatively sloped then despite the alternative specifications of the money wage flexibility and of inflationary expectations, Buffie's strong result that for stable economies devaluation cannot both contract employment and worsen the payments balance holds true. These results are summarized in table 4.2 on the next page.

TABLE 4.2

THE IMPACT EFFECTS OF DEVALUATION WHEN THE SYSTEM IS LOCALLY STABLE AND THE AGGREGATE DEMAND FUNCTION IS NEGATIVELY SLOPED

	ZERO CAPITAL MOBILITY		
	Sticky Money Wages		Sticky Real Wages
	Perfect Foresight	Static Expectations	
dN/de	?	?	?
dB/de	?	?	+
can both dN/de and dB/de be negative?	No	No	No

Finally, by assuming that the system is stable locally, the aggregate demand function for goods is negatively sloped, and that labour and the imported inputs are gross substitutes, we check how these set of assumptions can help us in determining the effects of devaluation on employment and the balance of payments.

For zero capital mobility, we mentioned above that if the aggregate demand function for goods is negatively sloped in the price/output plane, then the model will be stable only under those conditions in which ***R*** or Δ has a positive value. These stability conditions imply that the augmented Marshall-Lerner condition, $\eta_x+\delta_e-1>\varepsilon_e\delta_w/\varepsilon_w$ must be satisfied. In these circumstances, if we also assume that labour and the imported inputs are gross substitutes ($\varepsilon_e>0$), then using equations <3.44>, <3.46>, <4.18>, and <4.19> the reader can readily confirm that for the zero capital mobility case, despite the alternative specifications of the money wage flexibility and of inflationary expectations devaluations both increases employment and the balance of payments.

Similarly, using equation <4.20> it can be shown that if the MLC is satisfied and if labour and the imported inputs are gross substitutes $\varepsilon_e>0$, then in the perfect capital mobility case, both for static expectations and perfect foresight cases, devaluation definitely increases employment. For convenience these results are reported in table 4.3 on the next page.

TABLE 4.3

THE IMPACT EFFECTS OF DEVALUATION WHEN THE SYSTEM IS LOCALLY STABLE, THE AGGREGATE DEMAND FUNCTION IS NEGATIVELY SLOPED, THE MLC IS SATISFIED, AND LABOUR AND IMPORTED INPUTS ARE GROSS SUBSTITUTES

ZERO CAPITAL MOBILITY

	Sticky Money Wages		Sticky Real Wages
	Perfect Foresight	Static Expectations	
dN/de	+	+	+
dB/de	+	+	+

PERFECT CAPITAL MOBILITY

	Sticky Money Wages		Sticky Real Wages
	Perfect Foresight	Static Expectations	
dN/de	+	+	0

4.6 CONCLUSION

In this chapter we have performed some sensitivity tests in our corrected version of Buffie's model. These tests relate to alternative specifications of wage flexibility and of inflationary expectations, and to alternative degrees of capital mobility.

We have shown that, to some extent, the results are sensitive to the alternative specifications of wage flexibility and of inflationary expectations. Throughout the analysis it has also been shown that the condition on the slope of the aggregate demand function for goods coupled with the stability of the model plays a crucial role in determining the effects of devaluation on employment and the balance of payments.

The first thing which we noticed is that for zero capital mobility, no matter which specification of wage flexibility and of inflationary expectations is used, the stability of the model alone does not preclude the possibility of perverse outcomes of devaluation on both employment and the balance of payments. This finding contradicts Buffie's central result and therefore underlines the importance of our correcting the logical inconsistency in his original specification.

For perfect capital mobility, we noticed that the results are quite sensitive to the alternative specifications of wage flexibility and of inflationary expectations. It is seen that when workers have perfect foresight then devaluation has an ambiguous effect on employment; it has an expansionary effect when workers have static expectations; and it is neutral when the real wage is sticky at each point in time.

In this chapter, in order to remove the sign ambiguities of the devaluations multipliers, we made use of the stylized facts that the aggregate demand function for goods is negatively sloped in the price/output plane and that the MLC is always satisfied. With these additional restrictions, along with the presumption of stability, then, in the zero capital mobility case, we noticed that although devaluation has an ambiguous effects on both employment and balance of payments (except for sticky real wages where devaluation definitely improves the balance of payments), it cannot both contract employment and worsen the payments balance. Buffie's result stands.

Finally, to further remove the sign ambiguities of the multipliers, we considered the case of labour and the imported inputs being gross substitutes. With all the restrictions (stability, a negatively sloped aggregate demand function, and labour and the imported inputs are gross substitutes) we noticed that for the zero capital mobility case, despite the alternative specifications of wage flexibility and of inflationary expectations, devaluation both increases employment and the balance of payments. Similarly, for the perfect capital mobility case we found that if the MLC is satisfied and that labour and the imported inputs are gross substitutes then with sluggish money wages and perfect foresight, it is seen that devaluation definitely increases employment (see table 4.3).

The main conclusion of this chapter is that, in general, Buffie's claim that the stability of the model alone is sufficient to preclude the perverse effects of devaluation on both employment and the balance of payments is not true. The Buffie's results do hold if along with stability we assume that the aggregate demand function for goods is negatively sloped.

Appendix To Chapter 4

Derivation of Equations <4.10> and <4.11>

For convenience, we rewrite the goods market equilibrium condition <3.20>, the equation of Phillips curve <4.2>, and the balance of payments equation <3.18>:

<4A.1> $$s\pi_p(w,p,e) = (1-s)(e/p)\pi_e(w,p,e) + \psi M/p + X(e/p)$$

<4A.2> $$\dot{w} = \beta[1 + \pi_w(w,p,e) - \bar{\mu}]$$

<4A.3> $$\dot{M} = \psi p[k(\pi_p(w,p,e) + (e/p)\pi_e(w,p,e)) - M/p]$$

Total differentiation of equation <4.1> coupled with the use of <3.6> gives:

<4A.4> $$dp = A_1 dw + A_2 dM$$

where

$$A_1 = \frac{-s\phi_w\theta_I^{-1} - (1-s)\delta_w}{\Delta}, \quad A_2 = \frac{\psi}{\Delta X}, \quad \textit{and}$$

$$\Delta = \eta_x + s v_x^{-1} + (1-s)(\delta_p - 1) + s\phi_p\theta_I^{-1}$$

Totally differentiating equation <4A.2> and <4A.3> (while holding e constant) coupled with the use of <3.6> and of <4A.4>, and writing them in matrix form yields:

<4A.5>
$$\begin{pmatrix} d\dot{w} \\ d\dot{M} \end{pmatrix} = \begin{pmatrix} h_1 & h_2 \\ h_3 & h_4 \end{pmatrix} \begin{pmatrix} dw \\ dM \end{pmatrix}$$

where

$$h_1 = \beta\pi_w(-\varepsilon_w + \varepsilon_p A_1)$$

$$h_2 = \beta\pi_w \varepsilon_p A_2$$

$$h_3 = \pi_p(z_1 + z_2 A_1)$$

$$h_4 = \pi_p(z_3 + z_2 A_2)$$

$$z_1 = s\phi_w - s\theta_l \delta_w$$

$$z_2 = s\phi_p - s\theta_l(\delta_p - 1) + \frac{\psi M}{\pi_p}$$

$$z_3 = -\frac{\psi}{\pi_p}$$

This system will be stable if and only if the determinant and the trace of the matrix of the coefficients in <4A.5> take positive and negative values respectively, that is,

<4A.6> $\Omega = h_1 h_4 - h_2 h_3 > 0$

<4A.7> $Trace = h_1 + h_4 < 0$

By following the procedure shown in Chapter 3 and its appendix, the reader can readily confirm that the determinant will be positive if and only if:

<4A.8> $$\frac{\eta_x + \delta_e - 1 - \dfrac{\varepsilon_e \delta_w}{\varepsilon_w}}{\Delta} > 0$$

and the trace will take a negative value if and only if:

<4A.9> $$\frac{-\beta\pi_w\varepsilon_w}{\Delta}[\eta_x+\delta_e-1-\frac{\varepsilon_e\delta_w}{\varepsilon_w}] - \frac{\psi}{\Delta}[\eta_x+\delta_e-1-\delta_w] < 0$$

where

$$\Delta = \eta_x + sv_x^{-1} + (1-s)(\delta_p-1) + s\phi_p\theta_I^{-1}$$

From <4A.8> it is evident that $\Omega > 0$ either if

<4A.10> $$\eta_x+\delta_e-1 > \frac{\varepsilon_e\delta_w}{\varepsilon_w}, \quad \textit{and}$$

$$\Delta = \eta_x+(1-s)(\delta_p-1)+sv_x^{-1}+s\theta_I^{-1}\phi_p > 0$$

or,

<4A.11> $$\eta_x+\delta_e-1 < \frac{\varepsilon_e\delta_w}{\varepsilon_w}, \quad \textit{and}$$

$$\Delta = \eta_x+(1-s)(\delta_p-1)+sv_x^{-1}+s\theta_I^{-1}\phi_p < 0$$

Similarly <4A.9> will be satisfied either if

<4A.12> $$-\beta\pi_w\varepsilon_w[\eta_x+\delta_e-1-\frac{\varepsilon_e\delta_w}{\varepsilon_w}] - \psi[\eta_x+\delta_e-1-\delta_w] < 0, \quad \textit{and}$$

$$\Delta = \eta_x + s v_x^{-1} + (1-s)(\delta_p - 1) + s\phi_p \theta_I^{-1} > 0$$

or,

<4A.13> $$-\beta\pi_w\varepsilon_w[\eta_x + \delta_e - 1 - \frac{\varepsilon_e\delta_w}{\varepsilon_w}] - \psi[\eta_x + \delta_e - 1 - \delta_w] > 0, \quad \textit{and}$$

$$\Delta = \eta_x + s v_x^{-1} + (1-s)(\delta_p - 1) + s\phi_p \theta_I^{-1} < 0$$

Two interesting points can be noted here. First, unlike the perfect foresight case, the determinant condition alone is not sufficient for local stability of the model. However, if labour and the imported input are gross complements δ_w, $\varepsilon_e < 0$ then the condition <4A.10> necessarily satisfies the trace condition <4A.12>. While if labour and the imported input are gross substitutes δ_w, $\varepsilon_e > 0$ then the condition <4A.11> necessarily satisfies the trace condition <4A.13>. These are the conditions reported in the text. The second important point to note here is that unlike the perfect foresight case, the condition on Δ, which appears in the denominator of all the static multipliers, is determined by the stability of the model.

Derivation of Equations <4.12> and <4.13>

For perfect capital mobility the dynamics of the model involve adjustment in the nominal wage only. In this situation the stability of the model requires only that the nominal wage should adjust through time in such a way that in the long-run the actual rate of unemployment coincides with the natural rate of unemployment. This will be the case if and only if

<4A.14> $$\frac{d\dot{w}}{dw} < 0$$

Holding e constant and initializing $w=p=e=1$ locally, the time derivative of the variables in goods market equilibrium condition <4.7> coupled with the use of <3.6> gives:

<4A.15> $$\dot{p} = \frac{\delta_w}{\eta_x + \delta_p - 1}\dot{w}$$

For convenience, we rewrite the equation of the Phillips curve <4.1> above:

<4A.16> $$\dot{w} = \beta[1 + \pi_w(w,p,e) - \bar{\mu}] + \dot{p}\ , \quad \beta < 0$$

Now, by solving equation <4A.16> and <4A.15> simultaneously we have:

<4A.17> $$\dot{w} = \zeta\beta[1 + \pi_w(w,p,e) - \bar{\mu}]$$

where

$$\zeta = \frac{\eta_x + \delta_p - 1}{\eta_x + \delta_e - 1}$$

From <4A.14> and <4A.17> it is evident that stability of the system will be achieved if and only if:

<4A.18> $$\frac{d\dot{w}}{dw} = \beta\zeta\pi_w[-\varepsilon_w + \varepsilon_p\frac{dp}{dw}] < 0$$

Further, holding e constant, the total differentiation of equation <4.7> coupled with the use of <3.6> and taking $w=p=e=1$ initially, gives:

<4A.19> $$\frac{dp}{dw} = \frac{-\delta_w}{\eta_x + \delta_p - 1}$$

Substituting <4A.19> back into <4A.18> and by making use of $\delta_e = \delta_p + \delta_w$ gives:

$\frac{d\dot{w}}{dw} < 0$ *if and only if*

<4A.20> $$\frac{\eta_x + \delta_e - 1 - \varepsilon_e \delta_w / \varepsilon_w}{\eta_x + \delta_e - 1} > 0$$

From <4A.20> it is evident that $d\dot{w}/dw < 0$ either if

<4A.21> $$\eta_x + \delta_e - 1 > \frac{\varepsilon_e \delta_w}{\varepsilon_w}$$

or,

<4A.22> $$R_1 = \eta_x + \delta_e - 1 < 0$$

These are the stability conditions which are reported in section 4.2.3 above.

Derivation of Equations <4.20>

First, we rewrite equation <3.4> above

<4A.23> $$N = -\pi_w(w,p,e)$$

Since *w* is predetermined at a point in time, total differentiation of equation <4A.23> coupled with the use of <3.6> gives:

<4A.24> $$\frac{dN/N}{de} = \varepsilon_p \frac{dp}{de} + \varepsilon_e$$

Holding *w* constant, total differentiation of goods market equilibrium condition <4.7> coupled with the use of <3.6> and taking *w=p=e=1* initially gives:

<4A.25> $$\frac{dp}{de} = \frac{\eta_x + \delta_e - 1}{\Delta_1}$$

where

$$\Delta_1 = \eta_x + \delta_p - 1 \gtrless 0$$

Substituting the above expression for *dp/de* into <4A.24> and after some manipulation we get the equation <4.20> which is reported in the text:

<4A.26> $$\frac{dN/N}{de} = \frac{\eta_x + \delta_e - 1 - \varepsilon_e \delta_w / \varepsilon_w}{\Delta_1}$$

Chapter 5

PROPORTIONAL VS. NON-PROPORTIONAL TAXES: THE IMPLICATIONS FOR THE CONTRACTIONARY DEVALUATION DEBATE

5.1 INTRODUCTION

In this chapter we perform some sensitivity tests on the work of Lai and Chang (1989) (henceforth L-C). Throughout their analysis, Lai and Chang have emphasized the role of the nature of the tax system *(progressive vs. proportional)* and the degree of money illusion in determining the output effect of devaluation. By assuming 'Walrasian stability' in particular, they have established the following results (see L-C p. 292):

(a) Regardless of whether the income tax is progressive or proportional, currency devaluation has a negative impact on output if workers are free of money illusion.

(b) When workers suffer from money illusion, the supply-side tax effects may result in contractionary devaluation.

(c) When the income tax is proportional, whether currency devaluation is expansionary or recessionary has nothing to do with the tax-induced aggregate-supply effects.

Since in this thesis we have focused our attention mainly on the supply-side effects of exchange rates and in the L-C model exchange rates have supply-side effects only if labour supplies do not have full money illusion (as we will explain), we focus on the first of L-C's results. Before proceeding it is necessary to discuss the L-C model briefly.

5.1.1 THE L-C MODEL

Aggregate Demand

The demand side of the model is defined by the following equations:

<5.1> $Q = C(Q^d) + I(r) + G + B\,(Q, ep^f/p)$ *IS Relationship*

<5.2> $Q^d = (1-t(pQ))Q$ *Disposable Income*

<5.3> $M/p = L(Q,r)$ *LM Relationship*

Aggregate Supply

The supply side of the model is defined as follows:

<5.4> $Q = Q(N)$ *Production Function*

<5.5> $w = pQ_N(N)$ *Demand for Labour*

<5.6> $(1-t(pQ))w = h(N,g)$ *Supply of Labour*

<5.7> $g = \alpha ep^f + (1-\alpha)p$ *Consumer Price Index*

Dynamics

The dynamics of the system are determined by the following balance of payments equation:

<5.8> $\dot{M} = pB(Q, ep^f/p) + K(r)$

The notation is as follows:

Q domestic output
Q^d disposable income
C consumption expenditure
t income tax rate
p domestic currency price of domestic good
I investment expenditure
r domestic interest rate
G government expenditure
B balance of trade
e nominal exchange rate measured in domestic currency
p^f foreign currency price of imports
L real money demand
M nominal money supply
K net capital inflow
$\dot{M}$ balance of payments surplus
α proportion of expenditure on foreign good
g consumer price index
w nominal wage rate
Q_N marginal productivity of labour
$h(\ )$ inverse labour supply function
$Q(N)$ production function
N level of employment or number of hours worked

By solving equations <5.1>, <5.2> and <5.3> L-C derive the aggregate demand function for the domestic good, Q. By solving <5.4> through <5.7> simultaneously they derive the aggregate supply function of that good. The exchange rate, e, has a demand side effect through the balance of trade (see equation <5.1>). The exchange rate also has direct supply side effects as long as workers are not suffering from perfect money illusion ($h_g = \partial h(N,g)/\partial g \neq 0$; see equation <5.6> above). Furthermore, if the nominal wage rate is not fixed at some point in time the tax rate, t, also has supply-side effects. The sign of the slope of the aggregate supply function of the domestic good depends upon the tax elasticity (see section 5.3.2 below for more detail). By using these aggregate demand and supply functions L-C derive the condition that ensures Walrasian stability and the comparative static results mentioned above.

5.1.2 LIMITATIONS OF THE L-C ANALYSIS

Although the L-C study is the only one that studies devaluation while allowing the supply-side effects of both the exchange rate and the tax rate to interact, there are several points on which the L-C model can be criticized.

(1) L-C have deducted taxes from all incomes but, in defining the money demand function <5.3>, they have assumed that demand for money depends upon the nominal interest rate which is not subject to tax. This assumption is unduly restrictive; in practice, interest earnings are generally subject to tax. To achieve consistency in equations <5.3>

and <5.8> the rate of interest, r, could be replaced by $r^* = (1\text{-}t(pQ))r$. In the investment function $I(r)$ of equation <5.1> the replacement of r by r^* is debatable. Usually, it is assumed that firms borrow money from commercial banks at a rate of interest, r, to finance the cost of production. On the other hand, economists who stress the micro-economic underpinning of investment decisions argue that a firm, before making an investment decision, will work out the expected rate of return from the investment project under consideration. Only if the expected rate of return is greater than the amount what the firms' owners could earn by depositing funds in commercial banks will it undertake the project. In this circumstance the interest rate, r, should be replaced by r^* in the investment function.

(2) In the L-C model imports consist of consumer goods. Agents consume both domestic and imported goods. The proportions of expenditure on foreign and domestic goods are given by α and $1\text{-}\alpha$ respectively (see equation <5.7> above). In this situation, before making a consumption decision an agent is expected to consider after tax real income. L-C, on the other hand, assume that the demand for domestic goods depends on disposable income while the demand for imported goods depends on gross income (see equation <5.1>). This difference in treatment is not appealing. Given that government expenditures are fixed, for consistency the demand for imports should also be defined as a function of disposable income.

(3) The third thing that is debatable in the L-C model is that throughout the analysis L-C have assumed that any balance of payments, surplus or deficit, will not change the

nominal money supply because of full sterilization. They further assume 'Walrasian Stability'[1] to justify the sign of one mathematical expression which appears in the denominator of all multipliers. The full sterilization assumption seems to be very restrictive and hard to justify on empirical grounds. Moreover, in the model where it is assumed that prices adjust continuously to clear the goods market the appeal to Walrasian stability is not compelling (see Chapter 3 above for more detail). Since the L-C model involves adjustment in money stock through the balance of payments, the formal stability analysis must rely on this dynamic process.

(4) The fourth thing that is debatable in the L-C model is that the level of the real money stock and disposable income are defined in terms of domestic goods. In open economy models, however, when imports consist of consumer goods, agents' transaction demand for money should reflect the consumption of both domestic and imported goods. Moreover, instead of defining disposable income in terms of domestically produced goods it is more reasonable to assume that agents measure their incomes in terms of a "basket" that consists of both foreign and domestic goods. It seems reasonable that disposable income and the stock of money should both be defined in terms of such a basket. Furthermore, the scale variable in the money demand function should also be defined in these terms. These changes allow the model to embody the Laursen and Metzler (1950) effects (see more details below).

[1]The system is stable in the Walrasian sense if the price level increases when the goods market is in excess demand.

(5) Another limitation in the L-C model is that it does not include the government budget constraint. This seems highly restrictive, especially when attention is focused on alternative tax systems.

(6) A further consideration is that in defining the labour supply function (equation <5.6>) L-C have assumed that instead of the wage rate, w, the tax rate depends on nominal output, pQ. This assumption is also restrictive; in practice the tax rate may vary with the level of the wage rate (see, for example, Smyth (1982)). However, the reader can readily confirm that if we assume zero profitability, then the total wage bill, wN, and total nominal income, pQ, will be equal and this allows us to specify tax as a function of nominal income.

(7) Finally, L-C did not interpret their results for the case of a regressive tax system and for various degrees of capital mobility.

5.1.3 SCOPE OF THE CHAPTER

Keeping the devaluation debate within the L-C framework in this chapter, an attempt is made to enrich the L-C analysis by removing some of the limitations mentioned above. In the next section a generalized L-C (henceforth GLC) model is developed. For convenience, we solve the model for two cases; one addresses taxation issues (henceforth TI); the other deals with the Laursen and Metzler (1950) (henceforth L-M) effects. In the TI case, the L-C model is solved by re-specifying the money demand and import functions. Contrary to L-C it is assumed that the demand for money depends on the after-tax interest rate. Similarly, the demand for foreign goods is specified as a function of disposable income. More importantly, instead of assuming full sterilization and relying on the concept of Walrasian stability, the stability conditions of the model are derived by involving the balance of payments equation (which L-C cited but did not use). Furthermore, we assume that there exists some kind of lump-sum tax which keeps the government budget balanced at every point in time. Also, the results are interpreted for a regressive tax system. In the L-M case, on the other hand, the stock of money and disposable income are defined in terms of a basket that includes both the home and foreign goods. In addition, following Salop (1974) and Ahtiala (1989), the scale variable in the money demand function is defined in terms of such a basket. Since under these definitions of disposable income, the real money stock, and the scale variable in the money demand function, real disposable income and saving are directly effected by changes in the exchange rate we call this special case the L-M case. Laursen and Metzler argue that since saving is a function of real income, and an improvement in real income resulting from an improvement in the terms of trade will increase saving, a worsening will reduce it. This leads to the conclusion that a favourable shift in the terms of trade will reduce national income by raising real income and increasing saving. In contrast, Stolper (1950) argues that saving and imports are competitors for the consumer's dollars. In this situation, an increase in import prices (worsening of the terms of trade) increases saving by reducing spending on imports. Total spending then declines and income falls. In our model, due to the definition of disposable income, the real stock of money, and the scale variable in the money demand function in terms of basket that includes both home and foreign goods, for a given level of prices and output, devaluation of the domestic currency increases the saving level, which in turn has a negative impact on output. Since an increase in exports has a positive impact on output, the net effect of devaluation depends upon the two competing effects.

The models in the TI and L-M cases are solved for both zero and perfect capital mobility. However, for simplicity and to make the results comparable with those of L-C, we maintain the assumptions that (due to perfect competition) profits are zero and agents are homogeneous. These assumptions enable us to avoid complications that would stem from an unequal distribution of income.

It is seen that the tax system plays an important role in determining the stability conditions of the model. However, with a plausible set of parameter values we find that the model is stable under unique stability conditions. As far as comparative static results are concerned we find that with plausible parameter values and zero capital mobility the strong L-C result that currency devaluation has a negative impact on output if workers are free of money illusion, whether the income tax is progressive or proportional, holds true. However, when we permit some degree of money illusion, it is seen that the direction of the output effect of devaluation cannot be determined conclusively.

With perfect capital mobility, or with government policy that fixes the domestic rate of interest, TI case predicts that if workers are not suffering from money illusion, then the tax system plays a crucial role in determining the output effect of devaluation.

It is seen that devaluation is neutral for proportional taxation, contractionary for progressive taxation, and expansionary for regressive taxation. The same results also hold in the L-M case for plausible parameter values. Similarly, when we permit some degree of money illusion, it is seen that in the TI case, output will increase with devaluation with both proportional and regressive taxation, while in the case of progressive taxation, the output effect largely depends on the tax elasticity and on the degree of money illusion. With plausible parameter values the same result hold in the L-M case.

Finally, it is seen that if the model is solved by specifying investment demand as a function of the after-tax interest rate, then the stability and comparative static results of either the TI or L-M cases do not change qualitatively. For reasons of brevity we do not report these results.

The plan of this chapter is as follows. In section 5.2 we develop a model which contains the Lai and Chang model, the TI case, and L-M case as special cases. We call this model a "Generalization of the Lai and Chang model". In section 5.3 we solve the TI case discussed above, for zero capital mobility, and we derive some comparative static results. For convenience of comparison, we derive the results for the no money illusion case only. In section 5.4 we perform the first sensitivity test. In this section we solve the TI case with perfect capital mobility and derive the results for no money illusion. In section 5.5 we perform the second sensitivity test; we solve the L-M case for zero capital mobility. As in sections 5.3 and 5.4 we derive the results only for no money illusion. Similarly, in section 5.6 we solve the L-M case for perfect capital mobility; we refer to this as our third sensitivity test. In this section too we derive the results for no money illusion. Finally, in section 5.7 we perform our fourth sensitivity test. Here we derive the results for all the models discussed above by assuming that workers have some money illusion. The conclusion of the chapter is given in section 5.8.

We now proceed to a discussion of the generalized L-C (GLC) model.

5.2 A GENERALIZATION OF THE L-C MODEL

Aggregate Demand

The demand side of the model is represented by the following equations:

<5.9> $$Q = C(Q^d) + I(r) + G + B(Q^*, ep^f/p)$$

<5.10> $$Q^d = \left[(1-t(pQ))Q - a_1 S\right]\left[a_2 p + (1-a_2)g\right]/g$$

<5.11> $$g = \alpha e p^f + (1-\alpha)p$$

<5.12> $$Q^* = a_3 Q + (1-a_3)Q^d$$

<5.13> $$M/p^* = L(Y, r^*)$$

<5.14> $$p^* = a_4 p + (1-a_4)g$$

<5.15> $$Y = \left[a_5 p + (1-a_5)g\right]Q/g$$

<5.16> $$r^* = \left[(1-t(pQ))a_6 + (1-a_6)\right]r$$

a_j, j=1,...,6 are dummy variables that take value 1 or 0 to nest three different models (see detail below)

Supply Side

The supply side of the model is represented by:

<5.17> $$Q = Q(N)$$

<5.18> $$w/p = Q_N(N)$$

<5.19> $$h(N,g) = (1-t(pQ))w$$

Government Budget Constraint

The government budget constraint is represented by:

<5.20> $$G = t(pQ)Q + S$$

Dynamics

The dynamics of the model are represented by the balance of payments equation:

<5.21> $$\dot{M} = pB(Q^*,ep^f/p) + K(r-r^f-\dot{e}/e)$$

The notation other than that used in the L-C model is as follows:

Q^* imports of final goods
p^* characterizes either money stock as measured in terms of domestic output, or the basket of goods
Y scale variable in the money demand function
r^f foreign rate of interest
$\dot{e}$ time derivative of the exchange rate
a_j where j=1,...,6 are dummy variables taking value 1 or 0 to nest three different models (see detail below)
r^* nominal interest rate
S lump-sum tax

Equation <5.9> represents the equality between supply and demand for the domestically produced good, Q, whose price is p. The variables C and I represent the consumption of domestic and foreign goods by private agents. G represent the consumption of foreign and domestic goods by the government. To avoid overstatement of the demand for domestic goods, net exports, $B(Q^*,ep^*/p)$, are added in equation <5.9>. As usual, private consumption and investment are specified as functions of disposable income and rate of interest, respectively. Also it is assumed that along with the terms of trade, ep^f/p, the demand for imports depends either on gross output ($a_3=1$) or disposable income ($a_3=0$), while the demand for exports is defined as a function of the terms of trade and foreign income. For simplicity, we assume that foreign income is fixed, and it is therefore omitted. Equation <5.10> determines the disposable income of private agents. $t(pQ)$ is the tax rate function and S is a lump-sum tax. We are assuming that

$t(0)=0$ and if $t'(pQ)[=dt(pQ)/dpQ]=0$ (in the sense in which "proportional" is used by L-C), the tax system is deemed to be proportional. If, over the relevant range (that is total tax revenues always less than the total gross income), the tax rate is increasing, $t'(pQ)>0$, then tax system is progressive; and if, over the relevant range, the tax rate is nonincreasing, $t'(pQ)<0$, the tax system is regressive. A point to note is that disposable income can be defined either in terms of the domestic good ($a_2=0$) or the basket of goods ($a_2=1$) that consists of both domestically produced and final imported goods. We are assuming throughout that $a_1=1$. While if we assume $a_1=0$ and $a_2=0$ then our specification of the disposable income is exactly the same as defined by L-C (see equation <5.2> above).

Equation <5.11> defines the consumer price index (CPI). For convenience it is assumed that the CPI is a weighted average of the prices of domestic and foreign goods, the weights being fixed. This assumption, however, is not completely arbitrary. Samuelson and Swamy (1974) have shown that <5.11> represents a true cost of living index if the domestic residents' utility function, defined with domestic goods and imports as arguments, is Cobb-Douglas.

Equation <5.13> is the standard LM equation (note the difference between LM and L-M). It stipulates equilibrium in the money market. It is assumed that the demand for money is negatively related to the interest rate r^* and positively related to output. The scale variable in the money demand function, Y, could be defined either in terms of the domestic good ($a_5=0$) or the basket of goods ($a_5=1$). Similarly, the demand for money could be specified as a function of the pre-tax interest rate ($a_6=0$) or the after-tax rate ($a_6=1$). A point to note is that the level of money stock, M, could be defined either in terms of the domestic good ($a_4=1$) or the basket of goods ($a_4=0$).

As far as the supply side of the model is concerned, equation <5.17> shows that output is produced by involving only labour as the variable factor. Equation <5.18> and <5.19> represent labour demand and supply, respectively. The demand for labour is obtained by solving the firm's profit maximization problem. The supply is obtained by maximizing labour's utility function, defined with after-tax real income and leisure as arguments, subject to the time constraint. The labour demand function shows that, for a price-taker firm, profit (loss) will be a maximum (minimum) if the nominal wage rate, w, is equal to the value of labour's marginal product, pQ_N. In inverse form, the demand for labour, N^d, could be defined as a function of the money wage, w, divided by the producer price, p ($N^d=N(w/p)$). Similarly, the supply of labour, N^s, could be defined, in inverse form, as a function of the after-tax nominal wage, $(1-t)w$, and the consumer price index, g ($N^s=N((1-t(pQ))w, g)$. A careful reader could note here that in contrast to the treatment of labour demand, the supply of labour is specified as a function of the after-tax wage rate and the consumer price index, which is defined as a weighted average of the prices of the domestic and imported consumer goods. Furthermore, for a given wage rate, prices, and taxes, the variable N^d represents the number of hours of work demanded by an individual firm while N^s represents the number of hours a typical worker is willing to work. To avoid complications of aggregation we assume that all workers and all firms are homogeneous. This assumption allows us to obtain aggregate demand and supply functions easily from the demand and supply functions of individual workers.

Equation <5.20> states that the government budget is always in balance. $t(pQ)Q$ measures the total tax revenue while S is a lump-sum subsidy which keeps the government budget continuously balanced.

The last equation, <5.21>, introduces some dynamics into the system. It determines the balance of payments, which is defined as the sum of current and capital accounts. It also explains the spending and earning of foreign exchange. $B(Q^*, ep^f/p)$, the current account balance, represents the net earnings of foreign exchange resulting from exports of domestic goods and imports of final goods. If the money value of exports exceeds (falls short of) the money value of imports, the trade balance is in surplus (deficit) and the current account is positive (negative). $K(r-r^f-\dot{e}/e)$, on the other hand, measures the net earnings of foreign exchange resulting from the net inflow of capital. The yield on domestic bonds is represented by the domestic rate of interest, r, and the expected yield on foreign bonds is equal to the sum of returns on such bonds, r^f, plus expected capital gains, $\dot{e}/e$. Since it is assumed that the exchange rate is an exogenous variable, which we only permit to change in a once-for-all fashion, the expected gain or loss on holding foreign bonds is taken to be zero through time and is therefore omitted from the model[3].

This completes the basic introduction of the model. In the impact period there are nine endogenous variables Q, Q^d, p, r, N w, g, S and $\dot{M}$, which could be derived by solving equations <5.9> through <5.21>, which reduces into the system of nine equation when we impose the restriction on the "a_j" coefficients discussed below.

As mentioned above, the prime objective of this chapter is to check the validity of the L-C's result (a), while keeping the analysis within the L-C framework. For this reason we are assuming throughout that the country in question is importing only final consumption goods and that the labour market clears at every point in time. Although it introduces a stock-flow mis-specification problem, for simplicity we ignore international debt service payment and wealth effects.

This general model can be solved for several special cases: (the L-C model and the two cases discussed above) by imposing the following alternative conditions on the "a_j" coefficient:

L-C Model

$a_1 = 0$, $a_2 = 0$, $a_3 = 1$, $a_4 = 1$, $a_5 = 0$, $a_6 = 0$ ***and drop the equation <5.20>.***

[3]See Turnovsky (1981) for the implications of expected capital gains in determining the output effects of devaluation.

Generalized L-C Model:

Taxation Issues

$a_1 = 1,\ a_2 = 0,\ a_3 = 0,\ a_4 = 1,\ a_5 = 0,\ a_6 = 1$

Generalized L-C Model:

Laursen-Metzler Effects

$a_1 = 1,\ a_2 = 1,\ a_3 = 0,\ a_4 = 0,\ a_5 = 1,\ a_6 = 1$

We now move to the next section of the chapter, in which the model is used to throw light on taxation issues.

5.3 Generalized L-C Model: Taxation Issues: Zero Capital Mobility

5.3.1 INTRODUCTION

Zero capital mobility implies no capital flow into or out of the country. In this polar case (also known as the Keynesian approach to the balance of payments; see Chapter 2 above for more detail), the trade balance or current account in <5.21> is the sole determinant of the balance of payments. Agents hold only domestic money and domestic bonds.

In the impact period the flow of money, $\dot{M}$, is treated as an endogenous variable, while the level of money stock, M, is considered to be predetermined. In the long-run, however, if the system is stable, then $\dot{M}$ converges to zero and M becomes endogenous. In the short-run there are nine endogenous variables, namely Q, Q^d, p, r, N w, g, S, and $\dot{M}$ which could be determined by solving equations <5.9> through <5.21>, which reduces into a system of nine equations when we impose the restrictions on the "a_j" coefficients defined for the TI case above:

5.3.2 PRELIMINARY MANIPULATIONS

As usual, throughout the analysis we are assuming that:

$$1 > c \equiv \frac{\partial C}{\partial Q^d} > 0$$

$$I_r \equiv \frac{\partial I(r)}{\partial r} < 0$$

$$1 > m^d \equiv -\frac{\partial B}{\partial Q^d} > 0 \ , \ m^d < c$$

$$L_Q \equiv \frac{\partial L}{\partial Q} > 0$$

$$L_r \equiv \frac{\partial L}{\partial r} < 0$$

$$B_\tau \equiv \overline{IM}(\eta_x + \delta_e - 1) > 0$$

$$h_g \equiv \frac{\partial h(N,g)}{\partial g} \geq 0$$

$$h_w \equiv \frac{\partial h(N,g)}{\partial w} > 0$$

$$K_r = \frac{dK}{dr} \geq 0$$

where

C: is marginal propensity to consume,

$\eta_x = \dfrac{dX(ep^x/p)}{d(ep^x/p)}.\dfrac{ep^x/p}{\overline{X}}$ *export price elasticity,*

δ_e is price elasticity of imported good,

$\overline{IM}$ is initial value of imports,

Bar represents the initial value of the variable.

We first represent the model in the following compact form which will be helpful in deriving stability conditions and comparative static results:

$$\langle 5.22 \rangle \qquad \begin{pmatrix} 1 & -\delta_1 & 0 \\ 1 & -\phi_p & 0 \\ -\overline{z}_1 & -\overline{z}_2 & 1 \end{pmatrix} \begin{pmatrix} d\ln Q \\ d\ln p \\ d\dot{M} \end{pmatrix} = \begin{pmatrix} \delta_2 & \delta_3 & \delta_4 \\ 0 & 0 & 0 \\ \overline{z}_3 & 0 & -\overline{z}_2 \end{pmatrix} \begin{pmatrix} d\ln M \\ d\ln G \\ d\ln e \end{pmatrix}$$

The equations in <5.22> are derived as follows:

Total differentiation of equation <5.9> gives

<5.23> $$d\ln Q = \frac{(c-m^{d})Q^{d}}{Q}d\ln Q^{d} + \frac{I_r}{Q}dr + \frac{G}{Q}d\ln G + \frac{B_{\tau}ep}{Q}(d\ln e - d\ln p)$$

Substituting <5.20> into <5.10> and then differentiating <5.10> gives

<5.24> $$d\ln Q^{d} = \frac{Q}{Q^{d}}d\ln Q - \frac{G}{Q^{d}}d\ln G$$

Also, total differentiation of <5.13> gives

<5.25> $$dr = \frac{1}{L_r(1-t)}[\bar{M}d\ln M - (L_Q - L_r r' t)Q\ln Q + (L_r r' t Q - \bar{M})pd\ln P]$$

By solving <5.23>, <5.24>, and <5.25> we can obtain the following aggregate demand function for the home good, which is written in rate-of-change form:

<5.26> $$d\ln Q = \delta_1 d\ln p + \delta_2 d\ln M + \delta_3 d\ln G + \delta_4 d\ln e$$

where

$$\delta_1 = \frac{1}{\delta_0}\left[\frac{I_r(L_r r' t Q - \bar{M})\bar{p}}{L_r(1-t)Q} - \frac{B_{\tau}ep}{Q}\right]$$

$$\delta_2 = \frac{I_r\bar{M}}{\delta_0 Q L_r(1-t)}$$

$$\delta_3 = \frac{G}{Q\delta_0}[1 - (c - m^d)]$$

$$\delta_4 = \frac{B_\tau ep}{Q\delta_0}$$

$$\delta_0 = 1-(c-m^d) + \frac{(L_Q - L_r r t')I_r}{L_r(1-t)}$$

$$t' \equiv \frac{dt(pQ)}{dpQ}$$

$$for\ t' \geq 0\ ,\delta_0,\delta_2,\delta_3,\delta_4 > 0\ ,\delta_1 < 0$$

$$if\ t' < 0\ then\ \delta_0,\delta_2,\delta_3,\delta_4,\ \delta_1 \lesseqgtr 0$$

The reader could note here that for non-regressive taxes, $t'(pQ) \geq 0$, the aggregate demand function for the home good is negatively sloped in the p/Q plane. In addition, the demand function will shift outwards as a result of devaluation if the Marshall-Lerner condition (MLC)[3] is satisfied. However, in the case of regressive taxes, $t'(pQ) < 0$, the slope of the demand function is ambiguous. At the same time in the event of devaluation demand for the home good may or may not be increased, even if the MLC holds.

By solving equations <5.11>, <5.17>, <5.18>, and <5.19> the following aggregate supply function for the home good, Q, written in rate-of-change form, can be obtained:

<5.27> $$d\ln Q = \phi_p d\ln p + \phi_e d\ln e$$

[3]The satisfaction of the MLC means that the sum of export and import elasticities must be greater than unity (see Chapter 2 above for more detail.)

where

$$\phi_p = \frac{Q_N h}{\phi}\left[(1-\alpha)\delta - 1 + \frac{\eta t}{1-t}\right]$$

$$\phi_e = \frac{\alpha Q_N h_g e}{Q\phi} = \frac{\alpha h Q_N \delta e}{Q\phi}$$

$$\phi = (1-t)Q_{NN} - t' Q_N^2 - h_N$$

$\eta = \dfrac{t' p Q}{t}$ *is the nominal output elasticity of the tax system*

for $t' > 0$, $\phi, \phi_e < 0$, $\phi_p \gtrless 0$

for $t' < 0$, $\phi, \phi_e, \phi_p \gtrless 0$

for $t' = 0$, $\phi, \phi_e < 0$, $\phi_p > 0$

$\delta = h_g g/h$ is the parameter which measures the degree of money illusion: $\delta=0$ means that workers have perfect money illusion, $\delta=1$ implies no money illusion, and $0<\delta<1$ indicates that workers are suffering from partial money illusion.

A point to note is that if $t'<0$ then ϕ may take a positive value, which implies that devaluation could have positive supply-side effects. Another point to note is that if workers have perfect money illusion then ϕ_e equals zero, which implies that in this case changes in the exchange rate have no supply-side effects. Since in the analysis presented below attention is focused mainly on the negative supply-side effects of changes in the exchange rate, the cases which involve zero or positive supply-side effects are ignored. It can be shown that for non-progressive taxation the aggregate supply function, ϕ_p, is positively sloped in the p/Q plane, while for progressive taxation the aggregate supply may or may not be positively sloped.

Finally, by assuming that the balance of payments is in equilibrium initially, total differentiation of <5.21>, coupled with the use of <5.24> and <5.25>, gives the following reduced form of the balance of payments equation, in rate-of-change form:

<5.28> $$d\dot{M} = \bar{z}_1 d\ln Q + \bar{z}_2 d\ln p + \bar{z}_3 d\ln M$$

where

$$\bar{z}_1 = -m^d Q - \frac{L_Q - L_r r t')QK_r}{L_r(1-t)}$$

$$\bar{z}_2 = \frac{K_r}{L_r(1-t)}(L_r r t' Q - \bar{M})\bar{p} - B_\tau \bar{p} + \bar{B}$$

$$\bar{z}_3 = \frac{K_r \bar{M}}{L_r(1-t)}$$

$$\bar{z}_4 = m^d G$$

$\bar{B}$ is the initial trade balance

By writing equations <5.26>, <5.27> and <5.28> in matrix form, we get the system of equations given in <5.22> above.

5.3.3 STABILITY ANALYSIS

The dynamics of this model involve adjustment of the money stock. The system will necessarily be stable if and only if the following condition holds:

$$\frac{d\dot{M}}{dM} = \frac{d\dot{M}}{M d\ln M} < 0$$

Applying Cramer's rule to <5.22>, and doing a series of manipulations, we get:

$$\frac{d\dot{M}}{d\ln M} = \frac{\bar{M}}{\Delta \delta_0 L_r (1-t)} \left[\frac{B_\tau}{\bar{Q}}(I_r - K_r) - K_r \delta_0 \phi_p - \bar{B} + \frac{K_r I_r (L_Q - L_r r t') \phi_p}{L_r (1-t)} + m^d I_r \phi_p \right] \qquad \text{<5.29>}$$

where

bar represents the initial value of the variable

$$\Delta = \delta_1 - \phi_p \gtrless 0$$

$$\phi_p = \frac{Q_N h}{\phi}\left[(1-\alpha)\delta - 1 + \frac{\eta t}{1-t}\right] \gtrless 0, \quad \phi < 0, \quad 1 \leq \delta = \frac{h_g}{h} \geq 0$$

$$B_\tau = I\bar{M}(\eta_x + \delta_e - 1 - \bar{B}/I\bar{M}) > 0$$

Throughout the analysis we are assuming that the country in question either has a trade deficit or that trade is in balanced initially $\bar{B} \leq 0$.

Setting $K_r=0$, the reader can readily confirm that, in general, the signs of the numerator and denominator in <5.29> (see appendix to Chapter 5 for the derivation of <5.29>) cannot be determined conclusively.

An interesting result emerges if a proportional system is assumed. Substituting $t'=0$ in <5.29> and doing some manipulations we get:

<5.30>
$$\frac{d\dot{M}}{d\ln M} = \frac{\bar{M}I_r}{\Delta\delta_0 L_r(1-t)}\left[\frac{B_\tau}{\bar{\bar{Q}}} - \bar{B} + \frac{m^d Q_N h}{\phi}[(1-\alpha)\delta - 1]\right]$$

Since $B_\tau > 0$, $\bar{B} \leq 0$ and $\phi < 0$, the numerator in <5.30> must be positive. In this special case $\Delta<0$ becomes both necessary and sufficient for local stability of the system[4].

Following the above procedure the reader can readily confirm that for zero capital mobility and regressive taxation, stability of the model could be achieved if Δ and δ_0 had opposite signs.

Finally, it can be shown that $\Delta<0$ cannot assure stability, if progressive taxation is assumed. However, if we assume a plausible set of parameter values, for example, $\alpha = 0.30$, θ_L*(labour's share in total output)* $= 0.75$, $t = 0.5$, $\eta_x=1.1$, $\delta_e = 0.95$, ϑ^d *(real*

[4]Using the aggregate demand and supply functions for goods it can be shown that if the aggregate demand function is negatively sloped in the price/output plane and the aggregate supply function is positively sloped, then Δ must have a negative value. If, on the other hand, the aggregate supply function is also negatively sloped, then Δ again have a negative value if the absolute slope of the aggregate demand function is less than the absolute slope of the aggregate supply function.

wage elasticity of labour demand) = 1, ε^s (real wage elasticity of labour supply) = 0.1, $\bar{IM}$ *= 0.3, c = 0.9, m^d=0.6,* ***a (income elasticity of money demand) = 1, σ (interest elasticity of investment demand) = 0.34, θ (interest elasticity of money demand) = 0.25, r = 0.10***, and $p = Q = 1$ initially, then for progressive taxation Δ must have a positive value for stability if $\eta>15.49$ (or $t'(pQ)>7.74$), which seems to be restrictive. Similarly, for regressive taxation δ_0 will take a negative value if and only if $\eta<-9.75$, which is highly restrictive[5]. For this reason, in the analysis presented below we are assuming that the model is stable under a unique condition i.e $\Delta<0$.

Assuming stability we now derive some short-run comparative static results.

5.3.4 COMPARATIVE STATIC RESULTS

Throughout the derivation of the results below we are assuming that $e=p=p^f=1$ in the steady state.

Applying Cramer's rule to <5.22> and carrying out a series of manipulations we get:

$$\text{<5.31>} \qquad \frac{d\ln Q}{d\ln e} = \frac{-Q_N h\bar{I}}{\delta_0 \phi Q^2 \Delta}\left[\left(\frac{\sigma\eta t}{1-t}+\frac{\sigma}{\theta(1-t)}\right)\alpha\delta + \frac{B_\tau}{\bar{I}}\left(\delta-1+\frac{\eta t}{1-t}\right)\right]$$

where

$\theta = -L_r(1-t)r/\bar{L}>0$ *(interest elasticity of money demand)*

[5] See below for more explicit definition of σ, a, and θ.

$\sigma = -I_r r/\bar{I} > 0$ *(interest elasticity of investment demand)*

If workers are free of any money illusion, $\delta = 1$, then <5.31> (see appendix to Chapter 5 for the derivation of <5.31>) is reduces to:

$$\text{<5.32>} \qquad \frac{d\ln Q}{d\ln e} = \frac{-Q_N h\bar{I}}{\delta_0 \phi Q^2 \Delta}\left[\left(\frac{\sigma\eta t}{1-t} + \frac{\sigma}{\theta(1-t)}\right)\alpha + \frac{B_\tau}{\bar{I}}\left(\frac{\eta t}{1-t}\right)\right]$$

If the tax rate is proportional, $\eta = 0$, then the expression in the square brackets in <5.32> will have a positive value. Also, we notice above that the model will be stable if and only if Δ has a negative value. In these circumstances devaluation obviously reduces gross output. The reason is as follows: Using equations <5.26> and <5.27>, and holding output constant at some level, it can be shown that when $\delta = 1$ and $\eta = 0$, then

$$0 < \left.\frac{d\ln p}{d\ln e}\right|_{Q^d = \bar{Q}} = \frac{B_\tau}{\dfrac{MI_r}{L_r(1-t)} + B_\tau} < 1$$

$$\left.\frac{d\ln p}{d\ln e}\right|_{Q^s = \bar{Q}} = -1$$

This shows that in these circumstances the negative supply-side effects of the exchange rate dominate the positive demand-side effects, and therefore that output will be lower with devaluation.

It can be shown too that if $\delta = 1$ and the tax function is progressive, then devaluation again reduces output.

Similarly, it can be shown that if the tax function is regressive, then devaluation has an ambiguous effect on output.

The above results strengthen the L-C strong result that ''regardless whether the income tax is progressive or proportional, currency devaluation definitely has a negative impact on output if the workers are free of money illusion'' (p. 292).

5.3.5 CONCLUDING REMARKS

In section 5.3.3 the stability conditions for the TI case of the GLC model were derived for zero capital mobility. In section 5.3.4 we derived some comparative static results which follow from devaluation of the domestic currency. The first important thing to be noted is that for progressive taxes there exist two sets of conditions under which the system is stable. However, with a plausible set of parameter values, we noticed that the system is stable under a unique stability condition.

As far as the impact effect of devaluation on gross output is concerned, attention has been given only to those results which depend upon the assumption that workers are free of any money illusion. It is found that the L-C strong result that, *''regardless whether the income tax is progressive or proportional, currency devaluation definitely has a negative impact on output if the workers are free of money illusion'' (p. 292)* holds true. For regressive taxation, however, it is seen that the output effect of devaluation is ambiguous.

The above analysis reveals that although the L-C strong result mentioned above is not sensitive to the changes which we have made in the L-C model, these changes are important in the sense that they remove the inconsistencies which exist in the L-C model. More importantly, instead of assuming full sterilization and relying on an implicit Walrasian stability analysis, we have carried out an explicit stability analysis of the model, given the accumulation identity which is part of the model. After these findings we now move to our first sensitivity test where the TI case is solved under the assumption of perfect capital mobility. Like zero capital mobility, in this perfect capital mobility regime too we will concentrate only on those results which are derived for no money illusion. However, before getting into the details of our sensitivity analysis, for the convenience of the reader and to facilitate comparison of results, we first summarize the findings of our sensitivity tests with the help of Tables 5.1 and 5.2 below.

TABLE 5.1

THE OUTPUT EFFECTS OF DEVALUATION WHEN WORKERS HAVE NO MONEY ILLUSION

ZERO CAPITAL MOBILITY

Tax System	Proportional	Progressive	Regressive
TI Case	-	-	?
L-M Case	-	-	?

PERFECT CAPITAL MOBILITY

Tax System	Proportional	Progressive	Regressive
TI Case	0	-	+
L-M Case	0	-	+

TABLE 5.2

THE OUTPUT EFFECTS OF DEVALUATION WHEN SOME MONEY ILLUSION IS PERMITTED

ZERO CAPITAL MOBILITY

Tax System	Proportional	Progressive	Regressive
TI Case	?	?	?
L-M Case	?	?	?

PERFECT CAPITAL MOBILITY

Tax System	Proportional	Progressive	Regressive
TI Case	+	?	+
L-M Case	+	?	+

5.4 SENSITIVITY TEST 1

Generalized L-C Model:

Taxation Issues:

Perfect Capital Mobility:

5.4.1 INTRODUCTION

In this section the TI case is solved under the assumption of perfect capital mobility. With perfect capital mobility the money stock, M, becomes an endogenous variable, while the domestic rate of interest, r, becomes exogenous. The stock of money always makes a discrete jump to keep the domestic rate of interest from exceeding or falling short of the foreign rate r^f. The same situation will occur if the monetary authority fixes the domestic rate of interest at some desired level.

With perfect capital mobility, or when the monetary authority fixes the domestic rate of interest, the model can be solved by employing two different methods. The first involves solving the model for some degree of capital mobility, K_r, and then deriving the stability condition(s) and comparative static multipliers by letting $K_r \rightarrow \infty$. The second and easier method involves assuming perfect capital mobility from the outset and solving the model by dropping the balance of payments equation, since in this polar case the balance of payments equation cannot be defined. Instead of a balance of payments equation we now have an equation that tells us that the domestic rate of interest is always equal to the foreign rate, or that the desired difference between the domestic and foreign rates is always maintained[6]. The cost of using this second method, however, is that we cannot be assured of stability of the model. Furthermore, to justify the signs of some mathematical expressions we have to rely on an argument such as that given by Buiter and Miller (1983, p. 328) that any policy which increases the demand for goods must raise output for a given level of competitiveness.

If the model is solved according to the second method then we have seven endogenous variables, Q, Q^d, M, g, N, p, and w, which can be given values by solving equations <5.9> through <5.21>, which reduces into a system of seven equations when we impose the restrictions on the a coefficients mentioned for the TI case above.

5.4.2 PRELIMINARY MANIPULATIONS

By assuming $e=p=p^f=1$ in the steady state, and solving equations <5.9> and <5.10>, the following aggregate demand function is obtained:

<5.33> $$Q = Q(p,e,G)$$

---

[6]This result can be obtained by totally differentiating both sides of equation <5.21> and letting $K_r \rightarrow \infty$

Total differentiation of both sides of <5.33> gives:

<5.34> $$d\ln Q = \alpha_1 d\ln p + \alpha_2 d\ln G + \alpha_3 d\ln e$$

where

$$\alpha_0 = 1 - (c - m^d)$$

$$\alpha_1 = \frac{-B_\tau}{Q\alpha_0}$$

$$\alpha_2 = \frac{G(1-(c-m^d))}{\alpha_0 Q}$$

$$\alpha_3 = \frac{B_\tau}{Q\alpha_0}$$

c, m^d, and B_τ are the same as defined above

$\alpha_1 < 0 \quad \alpha_0, \alpha_2, \alpha_3 > 0$

The aggregate supply function will remain the same as shown by <5.27> above. These aggregate demand and supply function of goods help us in deriving the comparative statics of the model below.

5.4.3 STABILITY ANALYSIS

From <5.29> above it can be seen that:

$$\lim_{K_r \to \infty} \frac{d\dot{M}}{M d\ln M} = \lim_{K_r \to \infty}\left(\frac{K_r}{\Delta \delta_0 L_r (1-t)}\right)\left[-\frac{B_\tau}{Q} - \phi_p(1-(c-m^d))\right] \tag{5.35}$$

It was noted above that for non-progressive taxes ϕ_p must have a positive value. In these circumstances, from <5.35> it is evident that if taxes are proportional, then Δ must has a negative value for stability, while for regressive taxation Δ and δ_0 must have opposite signs. Moreover, for progressive taxation, if ϕ_p has a positive value, then again Δ must have negative value for stability, but if ϕ_p has a negative value then depending upon the other parameters values of the model, Δ may have either sign for stability of the model[7]. For example, it can be shown that for no money illusion if α*=0.30,* θ_L*(labour's share in total output) = 0.75, t = 0.5,* η_x *= 1.1,* δ_e *= 0.95,* ϑ^d *(real wage elasticity of labour demand) = 1,* ε^s *(real wage elasticity of labour supply) = 0.1,* $\bar{IM}$ *= 0.30, c = 0.9,* m^d *= 0.60*, and *p=Q=1* initially, then for stability Δ must have a negative value. Similarly, we have noticed above that with a plausible set of parameter values it is very unlikely that δ_0 will have a negative value. For this reason, in the analysis below we assume that for all taxation regimes the system is stable under $\Delta<0$.

[7]If we solve the model by using method 1 discussed above and follow the Buiter and Miller (1983, p.328) argument, then we can show that for $\Delta<0$, any policy that has only demand-side effects and which increases demand for the home good must also increase the price level.

With the above information in hand we now move to the next sub-section of this chapter where some comparative static results which follow from devaluation of the domestic currency are derived.

5.4.4 COMPARATIVE STATIC RESULTS

Solving <5.34> and <5.27> simultaneously and setting $e=p=p^f=p^{im}=1$ in the steady state we have:

$$\text{<5.36>} \qquad \frac{d\ln Q}{d\ln e} = \frac{-hQ_N}{\phi Q^2 \Delta \alpha_0}\left[B_\tau(\delta - 1 + \frac{t\eta}{1-t})\right]$$

where

δ, η *are the same as defined above,*

$\Delta = \alpha_1 - \phi_p < 0$ *is needed for stability of the system,*

If workers have no money illusion, $\delta=1$, then from <5.36> (see appendix to Chapter 5 for the derivation of <5.36>) the reader can readily derive the following results:

(i) *if* $\eta > 0$ *then* $\frac{d\ln Q}{d\ln e} < 0$

(ii) *if* $\eta = 0$ *then* $\frac{d\ln Q}{d\ln e} = 0$

(iii) *if* $\eta < 0$ *then* $\frac{d\ln Q}{d\ln e} > 0$

These results reveal that for progressive taxes devaluation is contractionary, for proportional taxes devaluation is neutral, and for regressive taxes devaluation is expansionary. The reasoning behind these outcomes runs as follows:

Holding output constant at some level, from the aggregate demand function for goods <5.34> the reader can readily determine that:

$$\left.\frac{d\ln p}{d\ln e}\right|_{\bar{Q}} = 1$$

From the aggregate supply function <5.27> by holding output constant at some level and assuming $\delta = 1$ the reader can also determine that:

$$\left.\frac{d\ln p}{d\ln e}\right|_{\bar{Q}} = \frac{-\alpha}{-\alpha + \frac{\eta t}{1-t}}$$

for $\eta = 0$ $\left.\frac{d\ln p}{d\ln e}\right|_{\bar{Q}} = 1$

for $\eta = > 0$ $\left|\left.\frac{d\ln p}{d\ln e}\right|_{\bar{Q}}\right| > 1$

for $\eta = < 0$ $\left|\left.\frac{d\ln p}{d\ln e}\right|_{\bar{Q}}\right| < 1$

These manipulations make clear that if the tax rate is proportional, then in response to devaluation both the aggregate demand and the aggregate supply functions shift vertically by exactly the same amount and leave output unchanged. In the case of progressive taxes however, the absolute shift in the aggregate supply function is greater than that of the shift of aggregate demand function. This implies that the negative supply-side effects of exchange rate changes dominate the positive demand-side effects, and therefore output will decrease with devaluation. Lastly, in case of regressive taxes the absolute shift in the aggregate demand function is greater than that of the shift in the supply function, which implies that the positive demand-side effects of exchange rate changes offset the negative-supply-side effects, and therefore output will increase with devaluation.

These results reveal that the output effect of devaluation is very sensitive to the degree of capital mobility. L-C have concluded that if workers fully perceive the increase in the living cost then regardless of whether the tax rate is progressive or proportional devaluation is definitely contractionary. For zero capital mobility, on the other hand, it is seen that if workers are free of any money illusion then for non-regressive taxation output will decrease with devaluation, while for regressive taxation devaluation has an ambiguous effect.

5.4.5 CONCLUDING REMARKS

In section 5.4.2 we derived the stability conditions of the TI case of the GLC model for perfect capital mobility, while in section 5.4.4 some comparative static results were derived which follow from currency devaluation.

As in the case of zero capital mobility we noticed that the tax system plays an important role in determining the stability of the model. However, with a plausible set of parameter values we found that the model is stable under one stability condition.

As far as comparative static results are concerned it is seen that the results of the TI case are sensitive to the degree of capital mobility. For zero capital mobility and no money illusion, the L-C model and the TI case predict that for non-regressive taxation output will decrease with devaluation, while for regressive taxation devaluation has an ambiguous effect on output. For perfect capital mobility, on the other hand, we found that the tax system plays an important role in determining the output effect of devaluation. It is seen that devaluation is neutral for proportional taxation, contractionary for progressive taxation, and expansionary for regressive taxation.

After these brief concluding remarks we now move to our second sensitivity test in which the L-M case of the GLC model is solved for zero mobility.

5.5 SENSITIVITY TEST 2

Generalized L-C Model:

Laursen-Metzler Effects:

Zero Capital Mobility

5.5.1 INTRODUCTION

It was pointed out above that since in the L-C model all imports are final goods, demand for imports should be defined as a function of disposable income. Similarly, L-C emphasized the importance of the nature of the tax system (proportional versus progressive) in evaluating the effects of devaluation, and thus the demand for money should be specified as a function of the after-tax interest rate. This basically explains the fact that for cash holding decisions agents always consider the after-tax interest earnings on their potential savings. In the TI case of the GLC model above we have studied the implications of these changes in the L-C model. In the analysis presented below we will check the sensitivity of the results derived above to the definition of some crucial variables such as the stock of real money, the scale variable in the money demand function, and disposable income in terms of the consumer price index (CPI). Due to these definitions the exchange rate becomes a direct shift variable for the LM curve, and we can show that for a given level of output and prices, devaluation increases the CPI. This in turn reduces the demand for money (increases the demand for output) through a fall in real output, which is defined in terms of the CPI. At the same time, due to a fall in the real money balances devaluation increases the demand for money (decreases the demand for output). The direction of the shift of the LM equation, however, depends upon these competing effects[4], since due to redefinition of the real money stock, and the scale variable in the money demand function in terms of the CPI, the real income and savings of the country are directly affected by changes exchange rate. These changes allow the model to embody the Laursen and Metzler (L-M) effects defined above, and we can call this special case as the L-M case of the GLC model.

The GLC model reduces to the model having all the features discussed above by imposing the conditions on the "a_j" coefficients defined for the L-M case. We now move to the next sub-section of this chapter where the stability conditions of the model are derived.

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[4]By using LM equation and holding rate of interest constant at some level, the reader can readily prove that if the income elasticity of money demand is equal to one then in the event of devaluation LM curve cannot shift. While if the income elasticity of money demand is greater than one then LM curve will shift outwards and *vice versa*.

5.5.2 STABILITY ANALYSIS

The model will be stable if the following condition holds:

<5.37>

$$\frac{d\dot{M}}{Md\ln M} = \frac{z_4}{\Delta_1}\left[m^d Q^d \alpha + B_\tau - B + \frac{m^d Q_N h}{\phi}\left((1-\alpha)\delta - 1 + \frac{\eta t}{1-t}\right)\right]$$

$$\frac{K_r \bar{\gamma}_1}{z_0 \Delta_1}\left[-B_\tau + (c-m^d)(\bar{Q}-\bar{G})\alpha - \phi_p(1-c+m^d)\right] < 0$$

where

$$\bar{\gamma}_1 = \frac{M}{L_r(1-t)}$$

$$\bar{\gamma}_2 = \frac{-(L_Q - L_r r t')}{L_r(1-t)}$$

$$\bar{\gamma}_3 = \frac{L_r r t' Q - M}{L_r(1-t)}$$

$$\bar{\gamma}_4 = \frac{\alpha(QL_Q - M)}{L_r(1-t)}$$

$$z_0 = 1 - c + m^d - \frac{I_r \bar{\gamma}_2}{Q}$$

$$z_1 = \frac{1}{z_0}\left[(c-m^d)(\bar{Q}-\bar{G})\alpha - B_\tau + I_r(\bar{\gamma}_3 - \bar{\gamma}_4)\right]$$

$$z_4 = \frac{I_r \bar{\gamma}_1}{z_0}$$

$$\Delta_1 = z_1 - \phi_p$$

In general, for zero capital mobility, $K_r=0$, the sign of the right hand side of <5.37> (see appendix to Chapter 5 for the derivation of <5.37>) is not known. However, it can be shown that for proportional taxes the stability will be achieved if Δ_1 takes a negative value. For regressive taxes, stability of the model can be achieved if Δ_1 and z_0 have opposite signs. For progressive taxation, on the other hand, depending upon the parameter values of the model, Δ_1 may a take positive or negative value for stability.

However, it can be shown that for progressive taxation and with the plausible parameter values mentioned above, Δ_1 has a positive value for stability if and only if $\eta>31.29$, which is highly restrictive. Similarly, it can also be shown that with the same parameter values, it is highly restrictive that z_0 will have a negative value. For this reason, in the analysis presented below we are assuming that the model is stable under a unique stability condition, i.e $\Delta_1<0$.

Assuming stability of the system we now derive some comparative static results which follow from devaluation of the domestic currency.

5.5.3 COMPARATIVE STATIC RESULTS

By following the procedure given in the appendix to Chapter 5, the reader can readily derive the following multiplier:

<5.38>

$$\frac{d\ln Q}{d\ln e} = \frac{-Q_N h\bar{I}}{Q^2 z_0 \Delta_1 \phi\theta}\left[\left(\frac{\sigma}{1-t}+\frac{\theta\sigma\eta t}{1-t}\right)\alpha\delta + \left(\frac{B_\tau\theta}{\bar{I}} - \frac{(1-a)\alpha\sigma}{1-t} - \frac{\alpha\theta\bar{Q}^d(c-m^d)}{\bar{I}}\right)\left(\delta-1+\frac{\eta t}{1-t}\right)\right]$$

where

$a = L_Q Q/\bar{M}$ *income elasticity of money demand*

$\theta, \sigma, \eta, \Delta_1, z_0, \phi$ *are the same as defined previously*

From <5.38> it can be shown that if workers are free of money illusion $\delta = 1$, and if taxes are non-proportional then devaluation has an ambiguous effect on output. However, if taxes are proportional then devaluation necessarily contracts output[9]. However, with the plausible set of parameter values specified above, it can be shown that output will decrease with devaluation for both proportional and regressive taxation. For progressive taxation, on the other hand, output will increase if and only if $\eta > 12.05$. This is highly restrictive. These are the same results as those obtained in the TI case for zero capital mobility.

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[9] If workers are free of any money illusion, $\delta = 1$, then <5.38> reduces to

$$\frac{d\ln Q}{d\ln e} = \frac{-Q_N h}{Q^2 z_0 \Delta_1 \phi\theta}\left[\frac{B_\tau\theta\eta t}{I(1-t)} + \frac{\sigma\alpha}{1-t} + \frac{\alpha\sigma\eta t}{1-t}\left(\theta - \frac{(1-a)}{1-t}\right) - \frac{\alpha(c-m^d)\bar{Q}^d\theta\eta t}{(1-t)^2}\right] \gtrless 0$$

It is seen above that for proportional taxes Δ_1 must have a negative value for stability. For proportional taxation all the terms having η will drop out, and we are left with this expression, which is necessarily negative. This implies that output will decrease with devaluation.

5.5.4 CONCLUDING REMARKS

As in the TI case we found that with a plausible set of parameter values the model is stable under a unique condition. As far as comparative static results are concerned we noticed that if workers have no money illusion then output will decrease with devaluation if the tax system is proportional. For non-proportional taxation, we found that devaluation has an ambiguous effect on output but with a plausible set of parameter values it was seen that output will decrease with devaluation for proportional taxation and increase for regressive taxation. These are the same results as those found for the TI case with zero capital mobility. The above findings reveal that with plausible parameter values the no money illusion results are not sensitive to the above mentioned extensions. Moreover, it again strengthens the L-C strong result (a), noted above.

We now move to our third sensitivity test where we solve the L-M case for perfect capital mobility and derive the results under the assumption of no money illusion.

5.6 SENSITIVITY TEST 3

Generalized L-C Model:

Laursen-Metzler Effects:

Perfect Capital Mobility

5.6.1 STABILITY ANALYSIS

Using <5.37> it can be shown that in a perfect capital mobility regime the model will be stable if and only if

$$\lim_{K_r \to \infty} \frac{d\dot{M}}{Md\ln M} = \lim_{K_r \to \infty} \frac{K_r \bar{\gamma}_1}{z_0 \Delta_1}\left[-B_\tau + (c - m^d)(\bar{Q} - \bar{G})\alpha - \phi_p(1 - c + m^d)\right] < 0 \qquad \text{<5.39>}$$

From <5.39> it is evident that regardless of the tax system the model may not necessarily be stable if Δ_1 has a negative value. However, if we assume the plausible set of parameter values specified earlier, then for non-progressive taxation the model will necessarily be stable if Δ_1 is a negative. Furthermore, for progressive taxation Δ_1 must have a positive value for stability if and only if η has a value greater than 12.2, which is highly restrictive. For this reason, in the analysis below we assume that for all taxation regimes the system is stable under Δ_1<0. We now derive some comparative static results.

5.6.2 COMPARATIVE STATIC RESULTS

By following the arguments given in section 5.4 above the reader can readily derive the following multiplier:

<5.40>
$$\frac{d\ln Q}{d\ln e} = \frac{Q_N h}{Q^2 \phi \Delta_1 \Omega}\left[\left((c-m^d)(\bar{Q}-\bar{G})\alpha \ - \ B_\tau\right)(\delta - 1 + \frac{\eta t}{1-t})\right]$$

where

$$\Omega_0 = 1 - c + m^d$$

$$\Omega_1 = \frac{1}{\Omega_0}\left[(c-m^d)(\bar{Q}-\bar{G})\alpha \ - \ B_\tau\right]$$

$$\Delta_1 = \phi_p - \Omega_1$$

If workers have no money illusion, $\delta = 1$, then from <5.40> (see appendix to Chapter 5 for the derivation of <5.40>) it can be seen that if taxes are proportional then devaluation is neutral, while in the case of non-proportional taxation the output effect of devaluation cannot be determined conclusively. However, if we assume plausible parameter values, such as $c = 0.9$, $m^d = 0.6$, $\alpha = 0.3$ $\overline{IM} = 0.3$, $\bar{G} = 0.25$ and $\bar{Q} = 1$, then for progressive taxation (regressive taxation) output will increase with devaluation if and only if $\eta_x + \delta_e - 1 < 0.225$ ($\eta_x + \delta_e - 1 > 0.225$). This shows that if we assume $\eta_x = 1.1$, $\delta_e = 0.95$ (as we did previously) then for progressive taxation output will decrease with devaluation, while it will increase for regressive taxation. The reader can note that these are the same results as those predicted for the TI case in the perfect capital mobility regime.

5.6.3 CONCLUDING REMARKS

The foregoing analysis reveals that, as in the TI case for perfect capital mobility, with a plausible set of parameter values the system is stable under a unique stability condition. As far as comparative static results are concerned we observed that if workers are free of money illusion then the tax system plays an important role in determining the output effect of devaluation. It was seen that for progressive taxation devaluation is neutral while for plausible parameter values devaluation depresses output for progressive taxation and increases it for regressive taxation. The same results were found when we solved the TI case with perfect capital mobility. This shows that for perfect capital mobility and for no money illusion, results are not very sensitive to alternative definitions of the money stock, disposable income, and the scale variable in the money demand function.

We now move to the last major sub-section of the this chapter where we test the sensitivity of the results derived above to the degree of money illusion.

5.7 SENSITIVITY TEST 4

Generalized L-C Model:

Some Money Illusion Permitted

5.7.1 COMPARATIVE STATIC RESULTS

From <5.31>, <5.36>, <5.38>, and <5.40> we can show that:

ZERO CAPITAL MOBILITY

TI CASE

<5.41>

$$\frac{d\ln Q}{d\ln e} \gtrless 0 \quad as \quad \left(\frac{\sigma\eta t}{1-t}+\frac{\sigma}{\theta(1-t)}\right)\alpha\delta + \frac{B_\tau}{\bar{I}}\left(\delta-1+\frac{\eta t}{1-t}\right) \lessgtr 0$$

L-M CASE

<5.42>

$$\frac{d\ln Q}{d\ln e} \gtrless 0 \quad as$$

$$\left(\frac{\sigma}{1-t}+\frac{\theta\sigma\eta t}{1-t}\right)\alpha\delta + \left(\frac{B_\tau\theta}{\bar{I}}-\frac{(1-a)\alpha\sigma}{1-t}-\frac{\alpha\theta\bar{Q}^d(c-m^d)}{\bar{I}}\right)\left(\delta-1+\frac{\eta t}{1-t}\right) \lessgtr 0$$

PERFECT CAPITAL MOBILITY

TI CASE

<5.43> $$\frac{d\ln Q}{d\ln e} \gtrless 0 \quad as \quad (\delta - 1 + \frac{t\eta}{1-t}) \lessgtr 0$$

L-M CASE

<5.44> $$\frac{d\ln Q}{d\ln e} \gtrless 0 \quad as \quad ((c-m^d)(\bar{Q}-\bar{G}))\alpha \; - \; B_\tau(\delta - 1 + \frac{\eta t}{1-t}) \gtrless 0$$

From <5.41> and <5.42> it is evident that if we permit some money illusion, $0<\delta<1$, then for zero capital mobility in both the TI and L-M cases the output effect of devaluation cannot be determined on analytical grounds. This result is different from the results which we obtained for the TI and L-M cases with no money illusion. For zero capital mobility and no money illusion, the TI case predicts that for non-regressive taxation output will decrease with devaluation while in the case of regressive taxation the effect of devaluation on output is ambiguous. The same results hold in the L-M case with plausible parameter values. From <5.41> and <5.42>, on the other hand, it can be seen that along with other parameters the output effect of devaluation depends largely upon the degree of money illusion. For example, using <5.41> it can be shown that for proportional taxation and the previously specified parameter values, the output will increase (decrease) with devaluation if $\delta<0.52$ ($\delta>0.52$).

For perfect capital mobility, on the other hand, using <5.43> it can be shown that if workers have partial money illusion and if the tax system is non-progressive, then in the TI case output will definitely increase with devaluation. On the other hand, in the case of progressive taxation output will increase (decrease) if the aggregate supply function for goods is positively sloped, $\delta - 1 + \eta t/(1-t) < 0$ (negatively sloped, $\delta - 1 + \eta t/(1-t) < 0$,).

Similarly, using <5.44> the reader can confirm that in the L-M case, if workers have partial money illusion, then for perfect capital mobility the output effect of devaluation cannot be determined conclusively. Using <5.44> it can be shown that for non-progressive taxation $\frac{d\ln Q}{d\ln e} \gtrless 0$ *as*

$$\eta_x + \delta_e - 1 \gtrless \frac{(c - m^d)(\bar{Q} - \bar{G})\alpha}{\bar{IM}}$$

and with plausible parameter values defined above, the output will increase with devaluation. With the same set of parameter values it can further be shown that for progressive taxation output will increase (decrease) with devaluation if the aggregate supply function is positively sloped (negatively sloped). These results are different from those which we obtained for the no money illusion case. For example, the TI case with perfect capital mobility predicted that if workers have no money illusion the tax system will play a crucial role in determining the output effect of devaluation. Devaluation is neutral for proportional taxation, contractionary for progressive taxation, and expansionary for regressive taxation. The same results holds in the L-M case with the plausible set of parameter values. These differences in the results make clear the sensitivity of the effects of devaluation on output to the degree of money illusion.

5.7.2 CONCLUDING REMARKS

In section 5.7.1 we tested the sensitivity of the results by allowing some degree of money illusion. We showed that for zero capital mobility, in both the TI and L-M cases, and regardless of the tax system (proportional versus non-proportional), the output effect of devaluation can not be determined on analytical grounds. On the other hand, for no money illusion the TI case with zero capital mobility predicts that devaluation will be contractionary for non-regressive taxation. The same results also hold for the L-M case with a plausible set of parameter values. These differences in the results demonstrate the sensitivity of the effects of devaluation to the degree of money illusion.

For perfect capital mobility, on the other hand, we found much larger variations in the results. For example, in the TI case we noticed that if workers are free of any money illusion then in a perfect capital mobility regime, devaluation is neutral for proportional taxation, contractionary for progressive taxation, and expansionary for regressive taxation. The same results were also obtained for the L-M case with plausible parameter values, while when we permitted some money illusion, then in the TI case devaluation found to be expansionary for non-progressive taxation. For progressive taxation, however, we observed that output will increase (decrease) with devaluation if the aggregate supply function is positively (negatively) sloped. In the L-M case, on the other hand, we noticed that for proportional and regressive taxation output will increase with devaluation if the price elasticities of exports and imports have high values. The same result also holds for progressive taxation if the aggregate supply function is positively sloped in the p/Q plane.

5.8 CONCLUSION

The findings of this chapter reveal that along with stability the output effect of devaluation depends upon certain other characteristics of the model such as money illusion, the tax system, alternative degrees of capital mobility, price elasticities of export and imports, and the interest elasticity of money demand.

We found that money illusion and the tax system play crucial roles in determining the effects of devaluation. In our models a high degree of money illusion is associated with low supply-side effects of exchange rates, and *vice versa,* while the tax system coupled with the degree of money illusion determines the slope of the aggregate supply function for goods. In most cases above, it was found that if workers are free of any money illusion and if the tax system is proportional then stability of the model ensures that output will decline with devaluation.

In the forgoing analysis it was also seen that perfect capital mobility coupled with the tax system plays a crucial role in determining the effects of devaluation on output.

In our models perfect capital mobility suppresses the contractionary demand-side effects of exchange rates which stem from both the transaction and speculative demand for money. Consequently, the likelihood that devaluation will be expansionary is increased. In both the TI or L-M cases we noticed that for perfect capital mobility with no money illusion, devaluation is neutral for proportional taxes, contractionary for progressive taxes, and expansionary for regressive taxes.

The main conclusion of this chapter is that the supply-side effects of the tax rate coupled with the supply-side effects of the exchange rate seriously challenge the conclusions of the orthodox devaluation literature. Given that modern macroeconomic models involve more sophisticated analyses of the labour market, we feel that we have demonstrated that there is a need to develop a model involving such features as efficiency wages or wage contracts, to further explore the importance of the supply-side implications of the tax system when there is exchange rate devaluation.

Appendix To Chapter 5

Derivation of Equation <5.29>

From <5.28> we have

<5A.1> $$\frac{d\dot{M}}{d\ln M} = \bar{z}_1\frac{d\ln Q}{d\ln M} + \bar{z}_2\frac{d\ln p}{d\ln M} + \bar{z}_3$$

Applying Cramer's rule to <5.22> we get:

<5A.2> $$\frac{d\ln Q}{d\ln M} = \frac{-\delta_2\phi_p}{\Delta} \qquad \frac{d\ln p}{d\ln M} = \frac{-\delta_2}{\Delta}$$

where

$$\Delta = \delta_1 - \phi_p$$

Substituting <5A.2> into <5A.1> we get:

<5A.3> $$\frac{d\dot{M}}{Md\ln M} = \frac{1}{\Delta}\left[-\bar{z}_2\delta_2 + \bar{z}_3\delta_1 - \phi_p(\bar{z}_3 + \bar{z}_1\delta_2\right]$$

The reader can readily confirm the following relationships:

$$-\bar{z}_2\delta_2 = \frac{I_r\bar{M}}{\delta_0 QL_r(1-t)}\left(B_\tau - \frac{K_r}{L_r(1-t)}(L_r r\dot{t}Q - \bar{M}) - B\right)$$

$$\bar{z}_3\delta_1 = \frac{K_r\bar{M}}{Q\delta_0 L_r(1-t)}\left[\frac{I_r(L_r r t' Q-\bar{M})P}{L_r(1-t)} - B_\tau ep\right]$$

By combing the above two expressions and cancelling terms we get:

<5A.4>
$$-\bar{z}_2\delta_2 + \bar{z}_3\delta_1 = \frac{\bar{M}}{Q\delta_0 L_r(1-t)}\left[(I_r-K_r)B_\tau - \bar{B}I_r Q\right]$$

Similarly we can show that:

<5A.5>
$$\bar{z}_3 + \bar{z}_1\delta_2 = \frac{\bar{M}}{L_r(1-t)}\left[K_r - \frac{I_r m^d}{\delta_0} - \frac{I_r K_r}{\delta_0}\frac{(L_Q-L_r r t')}{L_r(1-t)}\right]$$

By substituting <5A.4> and <5A.5> into <5A.3> we get equation <5.29> reported in the text:

<5A.6>
$$\frac{d\dot{M}}{d\ln M} = \frac{\bar{M}}{\Delta\delta_0 L_r(1-t)}\left[(I_r-K_r)\frac{B_\tau}{Q} - \phi_p K_r\delta_0 - BI_r Q + \phi_p I_r m^d + \frac{\phi_p I_r K_r(L_Q - L_r r t')}{L_r(1-t)}\right]$$

<u>Derivation of Equation <5.31></u>

Applying cramer's rule to <5.22> we get:

<5A.7>
$$\frac{d\ln Q}{d\ln e} = \frac{\delta_1 \phi_e - \phi_p \delta_4}{\Delta}$$

Substituting the expressions for ϕ_p, ϕ_e, δ_1, and δ_4 in <5A.7> we get:

<5A.8>
$$\frac{d\ln Q}{d\ln e} = \frac{\alpha Q_N h_g}{\Delta \delta_0 Q \phi}\left[\frac{I_r (L_r r\acute{t} Q - \bar{M})}{L_r (1-t)} - B_\tau\right] - \frac{Q_N h B_\tau}{\Delta \delta_0 Q \phi}\left[(1-\alpha)\delta - 1 + \frac{\eta t}{1-t}\right]$$

By making use of $\delta = \frac{h_g}{h}$, $\sigma = \frac{-I_r}{I}$, $\theta = \frac{-L_r}{L}$ and cancelling the terms we get equation

<5.31> reported in the text:

<5A.9>
$$\frac{d\ln Q}{d\ln e} = \frac{-Q_N h \bar{I}}{\Delta \delta_0 Q^2 \phi}\left[\left(\frac{\sigma \eta t}{1-t} + \frac{\sigma}{\theta(1-t)}\right)\alpha \delta\right] - \frac{Q_N h \bar{I}}{\Delta \delta_0 Q^2 \phi}\left[\frac{B_\tau}{\bar{I}}\left(\delta - 1 + \frac{\eta t}{1-t}\right)\right]$$

Derivation of Equation <5.36>

Solving <5.34> and <5.27> we get:

<5A.10> $$\frac{d\ln Q}{d\ln e} = \frac{\alpha_1 \phi_e - \phi_p \alpha_4}{\Delta}$$

Substituting the expressions for α_1, and α_3 in <5A.10> we get:

<5A.11> $$\frac{d\ln Q}{d\ln e} = \frac{-B_\tau}{Q\alpha_0 \Delta}\left[\phi_e + \phi_p\right]$$

Finally by substituting the expressions for ϕ_p and ϕ_e in <5A.11> above and cancelling terms we get equation <5.36> which is reported in the text.

<5A.12> $$\frac{d\ln Q}{d\ln e} = \frac{-Q_N h}{\Delta \alpha_0 Q^2 \phi}\left[\left(\delta - 1 + \frac{\eta t}{1-t}\right) B_\tau\right]$$

Derivation of Equation <5.37>

For convenience, equation <5.37> is derived after the derivation of <5.38>.

Derivation of Equation <5.38>

By following the procedure given in section 5.3.2 the reader can derive the following aggregate demand function which is written in rate-of-change form:

<5A.13> $$d\ln Q = z_1 d\ln p + z_2 d\ln e + z_3 d\ln G + z_4 d\ln M$$

where

$$z_0 = 1 - c + m^d - \frac{I_r \bar{\gamma}_2}{\bar{Q}}$$

$$z_1 = \frac{1}{z_0}\left[(c - m^d)(\bar{Q} - \bar{G})\alpha - B_\tau + I_r(\bar{\gamma}_3 - \bar{\gamma}_4)\right]$$

$$z_2 = \frac{1}{z_0}\left[I_r \bar{\gamma}_4 - (c - m^d)(\bar{Q} - \bar{G})\alpha + B_\tau\right]$$

$$z_3 = \frac{\bar{G}}{z_0}[1 - c + m^d]$$

$$z_4 = \frac{I_r \bar{\gamma}_1}{z_0}$$

$$\bar{\gamma}_1 = \frac{\bar{M}}{L_r(1-t)}$$

$$\bar{\gamma}_2 = \frac{-(L_Q - L_r r\acute{t})}{L_r(1-t)}$$

$$\bar{\gamma}_3 = \frac{L_r r\acute{t} Q - \bar{M}}{L_r(1-t)}$$

$$\bar{\gamma}_4 = \frac{\alpha(\bar{Q}L_Q - \bar{M})}{L_r(1-t)}$$

The aggregate supply function will remain the same as given by <5.27>. By solving <5.27> and <5A.13> we get:

$$\langle 5A.14 \rangle \qquad \frac{Qd\ln Q}{d\ln e} = \frac{z_1\phi_e - z_2\phi_p}{\Delta_1}$$

Substituting the expression for z_1, z_2, ϕ_e, and ϕ_p into <5A.14> and cancelling terms we get:

<5A.15> $$\frac{Q d\ln Q}{d\ln e} = \frac{Q_N h}{Q\phi z_0 \Delta}\left[I_r\bar{\gamma}_3\alpha\delta \ - \ (B_\tau + I_r\bar{\gamma}_4 - (c-m^d)(\bar{Q}-\bar{G})\alpha)(\delta - + \frac{\eta t}{(1-t)}\right]$$

Substituting the expressions for $\bar{\gamma}_3$, $\bar{\gamma}_4$ in <5A.15> and using the definitions of σ and θ we get equation <5.38> reported in the text:

<5A.16> $$\frac{d\ln Q}{d\ln e} = \frac{-Q_N h\bar{I}}{Q^2\phi z_0\Delta\theta}\left[\left(\frac{\sigma\theta\eta t}{1-t} + \frac{\sigma}{1-t}\right)\alpha\delta + \left(\frac{B_\tau\theta}{\bar{I}} - \frac{\alpha\sigma(1-a)}{1-t} - \frac{\alpha(c-m^d)\bar{Q}^d\theta}{\bar{I}}\right)\left(\delta - 1 + \frac{\eta t}{1-t}\right)\right]$$

Derivation of Equation <5.37>

By setting $a_1 = 1, a_2 = 1, a_3 = 0, a_4 = 0, a_5 = 1, a_6 = 1$, equation <5.21> can be written as:

<5A.17> $$\dot{M} = p\left[X(\frac{ep^x}{p}) - \frac{ep^f}{p}IM(Q^d, \frac{e^f}{p})\right] + K(r - r^f - \frac{\dot{e}}{e})$$

where

$$Q^d = (1 - t(pQ))\frac{Qp}{g}$$

Holding e, p^f constant and differentiating totally both sides of <5A.17> gives:

<5A.18> $$\frac{d\dot{M}}{d\ln M} = -\bar{IM}\left[\eta_x + \delta_e - 1 - \frac{\bar{B}}{\bar{IM}}\right]\frac{d\ln p}{d\ln M} - \frac{m^d Q^d d\ln Q^d}{d\ln M} + \frac{K_r dr}{d\ln M}$$

where $\bar{B}$ is the same as defined above.

Using the aggregate demand for goods, the aggregate supply function, and the LM equation <5.13>, it can be shown that:

<5A.19> $$\frac{d\ln p}{d\ln M} = \frac{-z_4}{\Delta}, \quad \frac{d\ln Q}{d\ln M} = \frac{-z_4\phi_p}{\Delta}, \quad \frac{dr}{d\ln M} = \left[\bar{\gamma}_1 + (\bar{\gamma}_3 - \bar{\gamma}_4)\frac{d\ln p}{d\ln M} + \bar{\gamma}_2\frac{d\ln Q}{d\ln M}\right]$$

Substituting <5A.19> into <5.A.18> we get:

<5A.20> $$\frac{d\dot{M}}{d\ln M} = \frac{z_4 M_1}{\Delta_1} + K_r M_2$$

where

$$M_1 = m^d Q\phi_p + m^d(\bar{Q} - \bar{G})\alpha + B_\tau - \bar{B}$$

$$M_2 = \left[\frac{\bar{M}}{L_r(1-t)} - (\bar{\gamma}_3 - \bar{\gamma}_4)\frac{I_r\bar{\gamma}_1}{z_0\Delta_1} - \frac{\bar{\gamma}_2\phi_p I_r\bar{\gamma}_1}{z_0\Delta_1}\right]$$

Substituting the expression for ϕ_p in M_1 we get:

<5A.21> $$M_1 = m^d(\bar{Q} - \bar{G})\alpha + B_\tau - \bar{B} + \frac{m^d Q_N h}{\phi}\left((1-\alpha)\delta - 1 + \frac{\eta t}{1-t}\right)$$

Substituting the expressions for Δ_1, z_4, $\bar{\gamma}_2$, $\bar{\gamma}_3$, *and* $\bar{\gamma}_4$ in M_2 and cancelling terms we get:

<5A.22> $$M_2 = \frac{\bar{\gamma}_1}{z_0\Delta_1}\left[-B_\tau - \phi_p(1 - c + m^d) + (c - m^d)(\bar{Q} - \bar{G})\alpha\right]$$

Finally, by substituting <5A.21> and <5.A.22> back into <5A.20> we get equation <5.37> reported in the text.

<5A.23>

$$\frac{d\dot{M}}{Md\ln M} = \frac{z_4}{\Delta_1}\left[m^dQ^d\alpha + B_\tau - \bar{B} + \frac{m^dQ_Nh}{\phi}\left((1-\alpha)\delta - 1 + \frac{\eta t}{1-t}\right)\right]$$

$$\frac{K_r\bar{\gamma}_1}{z_0\Delta_1}\left[-B_\tau + (c-m^d)(\bar{Q}-\bar{G})\alpha - \phi_p(1+c-m^d)\right] < 0$$

Derivation of Equation <5.40>

By following the procedure given in section 5.4.2 above, we can derive the following aggregate demand function for goods which is written in the rate-of-change form:

<5A.24> $$d\ln Q = \Omega_1 d\ln p + \Omega_2 d\ln e + \Omega_3 d\ln G$$

where

$$\Omega_0 = 1 - c + m^d$$

$$\Omega_1 = \frac{1}{\Omega_0}\left[(c-m^d)(\bar{Q}-\bar{G})\alpha - B_\tau\right]$$

$$\Omega_2 = -\Omega_1$$

$$\Omega_3 = \bar{G}$$

The aggregate supply function will remain the same as given by <5.27>. By solving the aggregate demand and supply function we get:

<5A.25> $$\frac{d\ln Q}{d\ln e} = \frac{\Omega_1\phi_e - \Omega_2\phi_p}{Q\Delta_1}$$

Substituting the expressions for Ω_1 *and* Ω_2 into <5A.25> we get:

<5A.26> $$\frac{d\ln Q}{d\ln e} = \frac{1}{\Delta_1\Omega_0 Q}\left[((c-m^d)(\bar{Q}-\bar{G})\alpha - B_\tau)\phi_e + ((c-m^d)(\bar{Q}-\bar{G})\alpha - B_\tau)\phi_p\right]$$

By substituting the expressions for ϕ_e and ϕ_p in <5A.26> and cancelling terms we get equation <5.40> reported in the text:

<5A.27> $$\frac{d\ln Q}{d\ln e} = \frac{Q_N h}{Q^2\phi\Delta_1\Omega_0}\left[\left((c-m^d)(\bar{Q}-\bar{G})\alpha - B_\tau\right)\left(\delta - 1 + \frac{\eta t}{1-t}\right)\right]$$

Chapter 6

SUMMARY OF THE FINDINGS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The devaluation debate becomes interesting when special attention is given to supply-side effects of exchange rates. Prior to Krugman and Taylor (1978) currency devaluation issues were mainly concentrated on demand-side effects of exchange rates. For example, conventional Keynesian economists such as Robinson (1947) and Meade (1951) and others claimed that as long as the MLC holds, devaluation of the domestic currency increases the demand for the domestic good and in turn increases output and the payments balance of the country. Diaz-Alejandro (1963), on the other hand, argued that despite the absence of supply-side effects of exchange rates and despite the assumption of nominal wage rigidity, a perverse outcome of devaluation is possible on analytical grounds. For example, devaluation changes the distribution of income in favour of profit makers who have a low marginal propensity to consume and against labourers who have a high marginal propensity to consume. Consequently, aggregate demand for the home good can fall. This in turn could lead to a deterioration of the payments balance and contraction of employment.

Following the Krugman and Taylor (1978) article the scope of the devaluation debate became much wider. Negative supply-side effects of exchange rate changes began to be explored. A number of one-sector and two-sector models have been developed which show that negative supply-side effects of the exchange rate can dominate the expansionary demand-side effects of devaluation policy. Thus, we cannot rule out perverse outcomes on employment, output, and the balance of payments.

Recently, some studies have made use of the correspondence principle to relate the effects of devaluation to the stability of the system. For example, Calvo (1983) and Larrian and Sach (1986) have developed models which have both demand and supply-side effects of exchange rates, and they have shown that devaluation will be contractionary only if the system is locally unstable. Buffie (1986b) on the other hand, derived the result that, for a very general specification of technology, devaluation cannot both contract employment and worsen the payments balance. Either a reduction in employment or a worsening in the payments balance is ruled out by stability of the model. Furthermore, either if the production function is separable or if labour and the imported input are gross substitutes then devaluation will both increase employment and improve the payments balance (given stability).

More recently, Lai and Chang (1989) pointed out the importance of the nature of the tax system (*proportional vs. progressive*) and the degree of money illusion on the part of workers in determining the output effects of devaluation. In particular, by assuming

Walrasian stability they have established the result that if workers are free of any money illusion then devaluation definitely reduces the output independent of the tax system.

Our literature survey (Chapter 2) led us to appreciate several limitations in the existing literature. These limitations can be placed into the following three categories.

(1) The scope of a number of results such as those by Krugman and Taylor (1978), Glyfson and Schimid (1983), and Shea (1976) are limited to a specific form of the production function.

(2) The dynamic analysis of exchange rates is almost everywhere absent. Calvo (1983), Larrian and Sachs (1986), and Buffie (1986b) are the few examples on this subject. As a result the explicit relationship between stability and the potential effects of devaluation is hardly developed. Furthermore, due to the static nature of the models, the time path of the variables in question in the event of devaluation cannot be studied.

(3) Except for Lai and Chang (1989), none of the studies have examined devaluation effects under different tax systems.

In this thesis an attempt is made to extend the devaluation literature in light of some of the issues mentioned above. Models that impose the bare minimum restriction on the production relationship and pay explicit attention to dynamics have been extended. The thesis can be viewed as two main essays. In the first main essay (Chapter 3 and Chapter 4) inconsistencies in Buffie (1986b) are corrected. Furthermore, some sensitivity tests are performed on the corrected model. These stem from alternative specifications of money wage flexibility, inflationary expectations, the definition of money demand function, and alternative degrees of capital mobility. In the second main essay (Chapter 5) we have performed some sensitivity tests on the work of Lai and Chang (1989).

In Chapter 3 the major error discussed is that there exists an inconsistency between Buffie's comparative statics and his dynamic stability analysis. In calculating the impact effects, Buffie assumes that the nominal wage is predetermined at a point in time, while the price of the domestic good adjusts continuously to clear the goods market. These assumptions imply that the real wage must be continuously adjusting. Yet Buffie's dynamic analysis assumes that the real wage adjusts sluggishly over a period of time as the actual rate of unemployment exceeds or falls short of the natural rate of unemployment. That is, at a point in time the real wage is pegged. These two parts of his paper are inconsistent. Since Buffie was trying to establish a correspondence between stability and the impact effects of devaluation this flaw could undermine his key results.

A second problem with Buffie's analysis stems from the justification of the sign of one mathematical expression which appears in the local stability conditions of the model. To sign the expression, Buffie makes an illegitimate use of the Walrasian stability condition. Walrasian stability imposes conditions on the slope of demand and supply functions of goods/services in question for stability in the particular market. This can be criticized on the following grounds. In the Buffie model the time path of the variables are explained through the wage adjustment and balance of payments equations. Thus, the conditions regarding the slope of aggregate demand and aggregate supply function of goods may derive from the dynamic equations that are already specified as part of the model. The equation of the Walrasian stability condition cannot also be part of the model. Furthermore, the Walrasian stability is based on the assumption that the goods price adjusts **sluggishly** to restore equilibrium in the goods market. This, in fact, contradicts Buffie's assumption that the goods price adjusts continuously to clear the market.

These problems are corrected in two alternate ways. First, we have assumed that the nominal wage is predetermined at a point in time, and the adjustment of the nominal wage towards its full equilibrium level is explained with a standard expectations-augmented Phillips curve. This refers to the proposition that workers have perfect foresight. We referred to this special case as: "Sluggish Money Wages with Perfect Foresight" (see Chapter 3). Secondly, we assumed that the real wage is predetermined at each point in time and adjusts sluggishly as the actual rate of unemployment exceeds or falls short of the natural rate of unemployment. We referred to this special case as: "A Sluggish Real Wage Phillips curve" (see Chapter 4). For sensitivity tests, however, we assumed that the nominal wage is predetermined at a point in time and is adjusting sluggishly as the actual rate of unemployment exceeds or falls short of the natural rate of unemployment. As far as changes in the price level are concerned we assumed that it does not have any direct bearing on the wage rate. This specification involves static expectations, so we referred to this special case as: "Sluggish Money Wages with Static Expectations" (see Chapter 4).

In Chapter 3 we found that, in general, Buffie's strong result mentioned above does not hold. Under each set of stability conditions we noticed that devaluation can both contract employment and worsen the payments balance. Similarly, devaluation may not necessarily increase employment and improve the payments balance, even if labour and imported inputs are gross substitutes. However, when we assumed that, for all economies, the aggregate demand function for goods is negatively sloped in the price/output plane, then all the results derived by Buffie hold true. The main conclusion of our Chapter 3 is that the presumption of stability is not enough to preclude both perverse outcomes. However, a limited set of additional priors, for example, that the aggregate demand function for goods is negatively sloped, is sufficient to be sure that devaluation cannot both contract employment and worsen the payments balance.

Regarding the sensitivity tests in Chapter 4, we noticed in particular that for perfect capital mobility, the results are quite sensitive to the alternative specifications of wage flexibility and of inflationary expectations. It is seen that when the money wage is predetermined at each point in time and workers have perfect foresight, devaluation has an ambiguous effect on employment. However, devaluation is expansionary when workers have static expectations. When the real wage is sticky at each point in time, devaluation has no effect on employment.

Chapter 5 is based on a criticism and extension of a Lai and Chang (1989) study. Lai and Chang (L-C) have extended the Salop (1974) model by incorporating taxes. Like Salop, L-C have investigated the output effects of devaluation when exchange rates have supply-side effects through the labour market. We have criticized the L-C study on the following five points: (i) Although L-C have deducted taxes from total income, in defining the money demand function they have assumed that the demand for money depends on the pre-tax nominal interest rate. This seems restrictive, since in actual practice, interest earnings are also taxed. (ii) In the L-C model, the dynamics involve adjustment in the stock of money. Instead of deriving stability conditions by involving the balance of payments equation, L-C have assumed full sterilization of the money stock and further assumed that the system is stable in a Walrasian sense in order to defend the sign of one expression which appears in comparative static multipliers. This is inappropriate because the full sterilization assumption seems to be very restrictive and hard to justify on empirical grounds. Moreover, in the model where it is assumed that prices adjust continuously to clear the goods market the appeal to Walrasian stability is not compelling. Since the L-C model involves adjustment in the money stock through the balance of payments, the formal stability analysis must rely on this same intrinsic dynamic process. (iii) L-C assume that the consumer consumes both domestically produced and foreign goods. However, they assume that the demand for the domestic good depends on disposable income while the demand for the foreign good depends on gross income. This seems inconsistent. (iv) L-C deflate the supply of money by the price of the home good. However, if expenditures are on both domestic and foreign goods, the index should be over both types of goods. (v) Finally L-C model does not include a government budget constraint. This seems restrictive, especially when attention is focused on alternative tax systems.

We have developed a model that contains the L-C model as a special case. We have solved the model for two cases, one which addresses taxation issues (TI) and one which deals with the Laursen and Metzler (1950) effects (L-M) (see detail below). The models in both TI and L-M cases are solved for zero and perfect capital mobility.

In the TI case, the L-C model is solved after re-specifying the money demand and import demand functions. Contrary to L-C, it is assumed that the demand for money depends on the after-tax interest rate. In addition, the demand for foreign goods is specified as a function of disposable income. Furthermore, we assumed that the government budget constraint is always in balance. For this purpose we assumed that there exists a lump-sum subsidy which keeps the government budget balanced. More importantly, instead of assuming full sterilization of the money stock and appealing to the concept of Walrasian stability, the stability conditions of the model are derived by using the balance of payments accumulation identity. Also, contrary to L-C, the results are interpreted for a regressive tax system (not just progressive and proportional) and for perfect capital mobility.

In the L-M case, on the other hand, the stock of money and disposable income are defined in terms of a consumer price index (CPI). In addition, the scale variable in the money demand function is also defined in these terms. In this special case the disposable income, the real money stock, the scale variable in the money demand function, the real disposable income and savings of the country are directly effected by changes in the exchange rate. These changes allow the model to embody the L-M effects.

As far as comparative static results are concerned both TI and L-M cases demonstrate that with plausible parameter values and with zero capital mobility, the strong L-C result that currency devaluation has a negative impact on output if workers are free of money illusion, whether the income tax is progressive or proportional, holds true. However, when we allow some degree of money illusion, we noticed that the output effect of devaluation cannot be determined conclusively.

With perfect capital mobility, or with government policy that fixes the domestic rate of interest, then the TI case demonstrates that if workers are not suffering from money illusion, then the tax system plays a crucial role in determining the output effect of devaluation. It is seen that devaluation is neutral for proportional taxation, contractionary for progressive taxation, and expansionary for regressive taxation. The same results also hold in the L-M case with plausible parameter values. Similarly, when we allow some degree of money illusion, we noticed that in the TI case the output will increase with devaluation both for proportional and regressive taxation. Moreover, in the case of progressive taxation, the output effect of devaluation largely depends upon the tax elasticity and of the degree of money illusion. With plausible parameter values the same results hold in the L-M case.

The main conclusion of our Chapter 5 is that when the supply-side effects of the exchange rate are coupled with the supply-side effects of the tax system, the conclusions of the orthodox devaluation literature are seriously challenged.

RECOMMENDATIONS FOR FUTURE RESEARCH

The present study and literature survey reveal that the effects of devaluation is difficult to determine on analytical grounds, due to the complex nature of the models. The effects become ambiguous as economists attempt to integrate different sectors of the economy. We cannot then conclude whether devaluations are contractionary or not. The net effect can be determined either by direct empirical estimation, or by numerical simulation (involving numerical values for the parameters of the model that have been selected from existing empirical studies). There are certain advantages and disadvantages associated with each of these approaches.

We recommend that the effects of devaluation should be examined through numerical simulations, since it is the natural extension of the theoretical issues of currency devaluation that have been investigated in the thesis. There is almost no study which has done a dynamic theoretical analysis of the devaluation policy.

For this purpose a fairly general model which more closely depicts the true economic picture of the devaluing country is needed. This more general model could be developed by integrating the corrected versions of Buffie (1986b) and Lai and Chang (1989) models. In the extended model, we can think of incorporating both finished goods and intermediary inputs. Similarly, to incorporate the effects of exchange rates which arise due to the distinction between nominal and the real interest rates, private investment can be specified as a function of the real interest rate. Furthermore, we can also think of the following important extensions in our suggested simulation model.

(i) Extended Dynamics (Stock/Flow Mis-Specification)

In our models there is a stock flow mis-specification problem (which arises both in L-C and the Buffie model by not including net payments to foreigners who are holding bonds of the devaluing country) which should be corrected. This would allow another source of contractionary demand-side effects of devaluation. With devaluation, net payments to foreigners on outstanding bonds that are denominated in foreign currency units will increase. This increase in debt service obligations reduces the level of disposable income of private agents. Furthermore, by including such payments to foreigners in the model, we would need to add one further accumulation identity to the model. The system would become a 3rd-order differential equation system.

Similarly, in our models we did not include the foreign debt. This debt usually arises when the government borrows a substantial amount of foreign currency from international organizations such as the IMF to finance their budget. In these circumstances devaluation increases the amount of foreign debt measured in the home currency. This compels the government, for example, to increase taxes. In addition, due to the increase in debt payments wealth as well as the disposable income of agents will fall.

Another thing which is missing in our models is foreign remittances. Foreign remittances are the foreign exchange amounts which workers abroad send back home to their spouses and relatives. Since these foreign remittances are considered to be a major source of foreign exchange earnings for the country, it is important that we include them in future modelling. The simplest implication of including foreign remittances is that it explains the fact that in the event of devaluation the value of a given level of foreign remittances measured in the domestic currency will increase. This in turn increases the demand for domestic and foreign goods.

Another limitation of our models is that they did not include capital as a variable factor of production. This assumption seems restrictive. Private investment and capital are linked with an accumulation identity (private investment is equal to the increase in the capital stock from the last period plus the deprecation on the last priod's capital stock). If we extend our suggested simulation model in this direction then we could see the following changes in the model. First, another (a fourth) differential equation which explains the time path of investment will need to be added in the model. Secondly, the interest rate has supply-side effects.

If we developed a model which contained all the features discussed above, it would not be possible to derive the sign of the comparative static multipliers purely on analytical grounds. Thus, the model's properties would need to be explored through numerical simulations with extensive sensitivity tests involving alternative parameter values.

(ii) Expectations of Devaluation

In our models it is assumed that agents formed no expectations about the exchange rate. This assumption is restrictive. The analysis could be improved by incorporating these expectations into the model. These expectations will have both demand-side and supply-side effects (see, for example, Turnovsky (1981) for more details). In the presence of expectations, devaluation effects could be studied under at least three sets of possibilities. First, when agents predict changes in exchange rates accurately. Second, when agents over-predict changes in exchange rates. Finally, when agents under-predict changes in exchange rates. In this framework the issues related to the announcement of the devaluation policy such as the time inconsistency problem could also be studied.

(iii) Unbalanced Government Budget and an Initial Current Account Deficit

Once numerical simulation methods are employed, we can consider alternative financing schemes for government expenditures and an initial imbalance of the current account. One implication of an initial current account imbalance is that it directly effects the agents expectations about devaluation of the currency. If the initial trade account is in deficit, then agents expect a devaluation prior to actual devaluation of the currency, and change their decisions accordingly. Similarly, an initial deficit in the government budget and its alternative method of financing could change the agents decisions prior to devaluation policy. Our simulations results will become more realistic if we extend our suggested model in these directions. Furthermore, we can also test the significance of IMF advice to LDCs that to reduce the trade deficit and inflation they should devalue their currency and reduce the money supply at the same time.

(iv) Cost of Working Capital

Firms borrow money to finance their wage bill and their payments for imported inputs. In the economics literature, such demand for cash is usually known as the cost of working capital.

A simple implication of including the cost of working capital in the model is that rate of interest will have direct negative supply-side effects. For example, in the event of devaluation the rate of interest will increase, this increase the cost of production of a given level of output by increasing firm's interest payments on the outstanding loans. This in turn increases the likelihood of contractionary devaluation, even if firms are producing output by involving labour only and the nominal wage is predetermined at a point in time. Economists such as Taylor (1981), Lizondo and Monteil (1989), and Van Wijnbergen (1983) have developed models which explicitly deal with the cost of working capital. Our suggested simulation model would be more realistic if it were extended in this direction as well.

Thus, we end as did Lizondo and Montiel, with a call for an integration of dynamics and further structural features that will require numerical simulation methods to explore. In this thesis, we have taken a limited step in this direction, by correcting and extending that part of devaluation literature that has been directly concerned with the integration of multipliers effects and dynamic convergence.

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