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CONTRACTIONARY DEVALUATION, FISCAL POLICY AND DYNAMIC ADJUSTMENT OF EXPORTS AND WAGES

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1. Introduction.

Exchange rate changes have important and multiple effects on economic activity. When currency parities are fixed, as it happens in most developing countries, devaluation becomes a key policy option for the authority. The crucial task is then to assess the impact of a devaluation both on the external payments position of the country, which is likely to improve, and on the level of economic activity, a more controversial issue. International institutions typically recommend exchange rate increases as a way of coping with "fundamental" imbalances in the countries' external situation, while at the same time domestic authorities are reluctant to devalue.

Early economic approaches to this problem were centered around the well-known Marshall-Lerner condition, initially stated in a partial equilibrium framework in which the trade account was in balance and substantial unemployment existed. In the early fifties this condition was extended, to a general equilibrium, open-econonomy Keynesian multiplier scenario which did not signifficantly affect the previous result. Subsequent developments considered situations of initial trade imbalance, as empirical evidence overwhelmingly suggested. On the other hand, the absorption approach stressed the trade balance as the result of an aggregate income-expenditure relationship, an appropriate framework to study the distribution effects coming from a devaluation.

Krugman and Taylor (1978) develop a general equilibrium model integrating income redistribution effects of a devaluation from an initial trade imbalance situation. In addition, they explicitly introduce the impact of exchange rate changes on fiscal revenue, a much neglected issue in previous studies. Their key conclusion is that a devaluation has contractionary effects on domestic income, while improving the trade balance.

This paper extends their analysis to consider first the effects of a trade-financed fiscal sector which runs a balanced budget. In this scenario a devaluation has an ambiguous effect on income because the distribution effects coming from the private sector as a whole to the government are now expansionary. If income taxes instead of trade duties are the source of fiscal revenue, the sign of Krugman and Taylor's result is not altered but its magnitude increases.

Next, a dynamic structure is added to the model by allowing sluggish adjustment of wages through a traditional Phillips curve. Under these conditions a devaluation is again contractionary, but this time the system is unstable due to the interaction of a demand determined home good sector, a fixed supply of exports and the Phillips curve. After the exchange rate increase there are no forces in the model to stop the downward trend.

Available empirical evidence suggests a more realistic scenario where exports respond to price incentives in addition to wages. In this case the export response is not only expansionary, but also pushes the system towards stability. It is possible, however, that even with a large long run elasticity of exports with respect to wages, the economy does not smoothly return to equilibrium after a devaluation. If the export sector does not react fast enough to a devaluation the economy is unstable around the steady state. Nonetheless, even in this case it may be possible to show that a Poincare-Bendixson limit cycle exists, thus stopping the downward trend of the economy. Under some circumstances the existence of a Hopf bifurcation cycle may also occur. At least one of these cycles is stable.

The paper starts with a brief review of devaluation theory and evidence, placing Krugman and Taylor in its appropriate relation to it. Section 3 considers alternative behaviours of the fiscal sector and their implications in front of a devaluation. The next section introduces wage dynamics and studies the stability properties of the model, while section 5 considers both wage and export adjustment. Finally, section 6 states the main conclusions.

2. A brief review on devaluation theory and evidence.

Early analyses of devaluation were centered around the well-known Marshall-Lerner condition[1] stating that a devaluation will improve the trade balance as long as

$$\eta_m + \eta_x^* > 1$$

where η_m is the home country's price-elasticity of demand for imports and η_x^* is the world's price-elasticity of demand for the country's exports.

This condition was derived starting from a scenario in which the home country specializes in the production of an exportable good whose supply in terms of domestic currency is infinitely elastic. As a corollary, the devaluation brings about a one-to-one deterioration in the terms of trade if the country is a price taker for imports. The trade account is assumed in equilibrium at the moment of the devaluation.

Further theoretical developments come with the work of Robinson (1947)[2] and Hirschman (1949), who investigate the effects of a devaluation starting from a trade imbalance. Under these conditions it becomes necessary to distinguish between the trade balance expressed in domestic currency and its counterpart in foreign currency, since they will not necessarily move in the same direction. The practical

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[1] Marshall (1923), Appendix J. Lerner (1944), Chapter 28, p. 377-380.

[2] Robinson (1947), Part III "The foreign exchanges", p. 142-143.

relevance of this analysis is immense since most -if not all- countries devalue their currency in the face of a trade deficit. What matters then to solve the payments problem is the foreign-currency balance, which is more likely to improve. However, it is the trade balance expressed in domestic currency which is relevant in terms of aggregate demand; this one is more likely to deteriorate. Thus, a not uncommon outcome of a devaluation in this scenario is a contractionary effect on domestic income coupled with an improvement in the foreign currency denominated trade balance.[3]

Intuition for this result may be strengthened by thinking of a devaluation as having two types of effects: (i) a valuation effect on the initial quantities of imports and exports at the higher exchange rate, and (ii) a quantity effect, given by the responsiveness (i.e. the elasticities) of imports and exports to the price change, evaluated at the previous exchange rate. When trade is initially balanced, the higher cost of imports exactly cancels out with the additional export revenue (at the original quantities). The valuation effect is nil in this case and only the quantity effect is left. But when the country starts from a trade deficit the valuation effect operates towards a deterioration in the domestic currency denominated balance and thus contracts internal demand for domestic goods (unless there is an offsetting effect coming from a reduction in savings).

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[3]This point has been stressed, among others, by Cooper (1971a).

The elasticities approach was originally stated as a partial equilibrium relationship involving only the markets of imports and exports. Harberger (1950) and Laursen and Metzler (1950) adequately restate it by considering the general equilibrium effects coming from the Keynesian open-economy multiplier. The modified relationship, however, presents the same qualitative result as before: an improvement in the trade balance following a devaluation requires that the sum of the relevant price elasticities exceeds one.

Sidney Alexander (1952) called attention to the fact that if a devaluation was to improve the current account it had to reduce in some way expenditure relative to income. His insight, coming from the national income identity, is the well known Keynesian "absorption approach". Looked in this perspective, the potential terms of trade deterioration arising from a devaluation was expected to reduce savings for a given level of income and thus to deteriorate the current account; this is better-known as the Laursen-Metzler effect. Recent contributions by Obstfeld (1982), Sachs (1981, 1982a) and Svensson and Razin (1983) have pointed out that the direction of the effect on the current account is ambiguous, and depends on the terms of trade deterioration being transitory or permanent.

Dornbusch (1976) studies the conditions under which the absorption approach can be properly integrated with the earlier elasticities approach. He also concludes that, starting from trade balance, if the terms of trade remain unchanged after the devaluation the commercial balance can not deteriorate.

Distribution effects can also play a role on expenditure determination following exchange rate movements. In particular, Diaz-Alejandro (1963) has argued that a devaluation is likely to redistribute income from workers to capitalists. If the former group has a higher marginal propensity to consume than the latter one, expenditure will go down and so will output in a demand determined model. The classical example is the Argentinian devaluation of 1958 which, according to Diaz-Alejandro (1965), importantly accounts for the 1959 recession in that country through its redistribution effect from workers to landowners.

A different line of argument has been stressed in the monetary approach to the balance of payments,[4] where a devaluation is analyzed through its effects on the money market. More precisely, an exchange rate increase will provoke a stock excess demand for money; with passive monetary policy, the only way to go back to equilibrium is by running balance of payments surpluses whose effects on the money stock are assumed not to be sterilized by the authority. This type of models, based in a line of thought dating as far back as David Hume (1752), have almost always been carried out under full employment and with money as the only asset.[5] When nontradeable goods are introduced

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[4]For a survey on the monetary approach see Johnson (1977).

[5]An extension to more than one asset is found in Dornbusch (1975) in what could be called a portfolio approach rather than a monetary approach.

in this framework the devaluation has real effects, but only in the short run. The link is formally made by Dornbush (1974) using the ad-hoc expenditure function, later grounded in optimizing behavior by Dornbusch and Mussa (1975). The initial excess demand for money provoked by the devaluation is translated into an excess of income over expenditure which pushes downward the relative price of nontradeable goods, thereby causing consumption and production switches and a surplus in the balance of payments. The effect lasts only while there is unsatisfied excess demand for money, and so it dissappears through time. The only way in which a devaluation can have long run effects (other than reserve accumulation) is in the presence of wage/price stickiness, where it serves to simultaneously achieve internal and external balance.[6]

Krugman and Taylor (1978), hereafter referred to as K-T, pursue a structuralist approach for an economy composed of three types of goods: exportables, importables and nontradeables. A Keynesian stand is taken in the home good market, where output is demand determined. Imports are neither produced nor consumed domestically but rather used as intermediate inputs in the production of the home good and exports are in fixed supply. In this sense, the Keynesian and structuralist approaches towards exports can be considered as two extremes, with neoclassic analysis (the one used in the monetary

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[6]See Dornbusch (1974).

approach, if any) standing somewhere in the middle.

Two crucial features of K-T have been borrowed from the earlier contributions discussed in this section: the existence of two groups of agents with different marginal propensities to consume and the starting point of the economy from a trade deficit. But K-T introduce an element to which surprisingly little attention has been paid both before and after the publication of their paper: the presence of a fiscal sector whose finances are influenced by a devaluation.

An extension of K-T to account for substitutability both in production and in consumption is provided by Hanson (1983). His results challenge those of K-T regarding the effect of a devaluation on domestic income and the balance of payments. Indeed, K-T's conclusions come as no surprise in view of their assumptions which close any possible channel through which a devaluation could be expansionary.

Empirical work on the effects of devaluation does not abound. Cooper (1971b), analyzing the short run effects (after one year) of 24 devaluations for the period 1953-66, "...including most of the major devaluations by developing countries in the early 1960s..."[7] finds that in nearly three-fourths of the cases the trade balance improved. He also reports a negligible impact of the exchange rate change on the terms of trade and a response of domestic wages and pri-

[7] Cooper (1971b), p. 20.

ces that falls short of the currency depreciation. Connolly and Taylor (1976) study 18 devaluation episodes in 14 mostly developing countries for the period 1959-70. They conclude that exchange rate increases appear on average not to have a significant effect on economic activity while at the same time generally improving the balance of payments. Krueger (1978) analyzes 22 devaluations in 10 third world countries to conclude that only in three cases it was followed by a signifficant recession.

More recently, Gylfasson and Schmid (1983) have developed and tested a one sector model in which output is determined by the interaction of supply and demand. A devaluation influences the former through the cost of intermediate inputs and the latter through substitution, income and real balance effects. The results for a group of 10 countries (5 industrialized and 5 developing) show a contractionary effect of an exchange rate increase only in 2 cases (India and the U.K.). Larrain (1985) presents evidence indicating that medium to large devaluations tend to decrease the product wage, at least in the short run, except in economies undergoing strong and steady depreciation of their currencies, and that employment in the tradeables sector is a decreasing function of the product wage.

One of the reasons for the lack of empirical work on devaluations no doubt arises from the difficulty of separating it from other parallel influences in the economy. In particular, exchange rate changes in developing countries are usually accompanied by liberalization and/or stabilization attempts, as stressed by Cooper (1971b) and thoroughly studied in the NBER project headed by Krueger and Bhagwati.

3. Contractionary devaluation and fiscal policy.

As already discussed in the preceeding section, K-T is one of the very few analyses of devaluation which allow a role to be played by the fiscal sector. In their framework, however, the level of government spending is fixed regardless of the evolution of fiscal revenues. Therefore, if we start for simplicity from a position of balanced budget,[8] variations in the exchange rate will provoke a mismatch between outlays and receipts in the fiscal sector which needs to be somehow accomodated. But in a model where the only financial asset (money) is fully commited to maintain the interest rate at a given level, it cannot also be the channel to accommodate the fiscal imbalance. This leaves an important issue unexplained in the model.

Aside from this theoretical issue, it has been argued that in practical terms it is very hard to adjust expenses to revenues in the fiscal sector and so that it will be correct as a first approximation to treat government spending as fixed. Although this argument may be appealing for downward movements in revenues it does not seem so valid when an increase in fiscal income is at stake; in this latter case it is very likely that the extra income will be spent. Since a devaluation increases fiscal revenue in the K-T framework, it will be assumed in what follows that the government runs a balanced budget, in other words that the authority has a marginal propensity to spend of

[8]This is a simplifying assumption since in general devaluations occur in situations of budget deficit (in fact, the budget deficit may have precipitated the devaluation). In this case, and under K-T conditions, the devaluation merely serves to reduce the deficit.

one.

In order to study the effects of a devaluation in this context we consider two alternative ways in which public income may be generated. Initially we maintain the K-T scenario of trade taxes on both imports and exports; later on, we concentrate on the case in which taxes on income are the only source of government revenue.

3.1. Trade taxes.

We present below the new framework which emerges when the government runs a balanced budget. The original K-T notation is kept as much as possible for comparative purposes. The modified model looks like

(1) $P_h = (a_{lh}w+a_{mh}P_m)(1+z)$

(2) $P_x = (1-t_x)P_x^*e$

(3) $P_m = (1+t_m)P_m^*e$

(1)-(3) are the price formation equations, with tax-corrected purchasing power parity for tradeables and mark-up pricing for the home good, where

P_h = price of the home good

a_{lh} = amount of labor to produce a unit of the home good

a_{mh} = amount of the imported input to produce a unit of the home good

w = nominal wage

z = fixed mark-up over costs

P_x = internal price of exports

t_x = ad-valorem tariff on exports

P_x^* = world price of exports

e = nominal exchange rate

P_m = internal price of the imported input

t_m = ad-valorem tariff on the imported input

P_m^* = world price of the imported input

(4) $Y_w = (a_{1h}H + a_{1x}X)w$

(5) $Y_r = z(a_{1h}w + a_{mh}P_m)H + (P_x - a_{1x}w)X$

Y_w and Y_r define the incomes of workers and capitalists respectively, H are the units of the home good and X stands for the volume of exports. Y_r is derived both from a fixed mark-up over cost in domestic goods production and from profits in exports. With this latter sector in fixed supply output can only vary through home goods which are demand determined, as specified below.

(6) $H = C_w(Y_w/P_h) + C_r(Y_r/P_h) + I(r) + G$

Imports (M) are intermediate goods used exclusively in the production of nontradeables, and thus

(7) $M = a_{mh}H$

K-T's general expression for the effect of a devaluation in output (not presented in their paper) is

$$(8)\quad \frac{dh}{de}\frac{e}{h} = \frac{(1+z)}{D_0 P_h H}\{ -(\gamma_w-\gamma_r)K_0 - (\gamma_w MP_m{}^*e-\gamma_r XP_x{}^*e)K_1 - (\gamma_w t_m MP_m{}^*e+\gamma_r t_x XP_x{}^*e)K_1 \}$$

where

$$D_0 = \{a_{1h}w((1-\gamma_w)+z(1-\gamma_r))+a_{mh}P_m{}^*e(1+t_m)(1+z(1-\gamma_r))\} > 0$$

$$K_0 = a_{1x}wXa_{mh}P_m{}^*e(1+t_m)$$

$$K_1 = a_{1h}w$$

A brief interpretation of equation (8) seems worthwhile. The first term inside the parenthesis shows the negative impact of the income redistribution from workers to capitalists brought about by a devaluation in front of fixed nominal wages, when the marginal propensity to consume of workers (γ_w) is greater than that of capitalists (γ_r). The second term combines the former effect with the contractionary outcome of an exchange rate increase in the presence of an initial trade deficit. Finally, the third term reveals the negative effect of the devaluation due to the income redistribution from the private sector as a whole to the government, which is assumed to totally save this extra revenue.

So far, this is the K-T model. We introduce below a different type of fiscal behavior; rather than maintaining fixed the level of public spending as revenue varies, the government will now run a balanced budget. As in K-T all fiscal expenses fall on the home good; a more general scenario in which the public sector also buys imports and/or exports will require a significant change in the structure of the model.[9] To be consistent with the previous formulations everything is being measured in terms of home goods.

$$(9)\quad G = (t_x X P_x^* e + t_m M P_m^* e)/P_h$$

Now we can consider the effect of a devaluation on nontradeable production; since exports are in fixed supply this is all we need to know to assess its impact in total output and employment. Substituting equations (1)-(5) and (9) in (6) and making use of (7) we can compute expression (10), written in elasticity form

$$(10)\quad \frac{dH}{de}\frac{e}{H} = \frac{(1+z)}{D_1 P_h H}\{ -(\gamma_w-\gamma_r)K_0 - (\gamma_w M P_m^* e - \gamma_r X P_x^* e)K_1 + ((1-\gamma_w)t_m M P_m^* e + (1-\gamma_r)t_x X P_x^* e)K_1 \}$$

where

$$D_1 = \{a_{lh}w((1-\gamma_w)+z(1-\gamma_r)) + a_{mh}P_m^* e(1+t_m)(1+z(1-\gamma_r)) - t_m a_{mh}P_m^* e\}$$

In comparing (8) with (10) we see that the first two terms in the right hand side of both equations coincide. The difference between the two expressions arises from two types of effects:

(i) The denominator D_1 is smaller than D_0 and thus the

[9]In the K-T structure the only goods consumed at home are nontradeables. This assumption is responsible for the absence of a separate effect of relative prices on consumption, which is only influenced by income effects.

multiplier $(1/D_1)$ is greater than $(1/D_0)$. This, of course, tells nothing about the sign of the expression; it only says that the outcome inside the key brackets will be amplified by a higher number.

(ii) More interestingly, the effect of a devaluation on output and employment becomes ambiguous when the government runs a balanced budget. This comes from the influence of the third term of expression (10), which shows that the net impact of the fiscal sector on aggregate demand is now expansionary. The intuition for this result goes as follows: an exchange rate increase redistributes income from workers and capitalists (with propensities to consume smaller than one) to the government, which has a marginal propensity to consume of one. The net result of this transference is to raise aggregate demand and hence output and employment.

Thus, besides the popular income redistribution within private agents there is another and perhaps more important one from the private sector as a whole to the government. Different fiscal behavior can fundamentally alter the the real income effects of redistributions arising from a devaluation.

3.2. Taxes on income.

It has been assumed until now that trade taxes are the only source of government revenue. In this section we will study the effects of a devaluation on a totally liberalized economy $(t_x=t_m=0)$ where public expenses are financed by taxes levied on the incomes of workers and capitalists at a constant but not necessarily equal rate. The new scenario involves some changes in the model, as shown below

(2') $P_x = P_x{}^*e$

(3') $P_m = P_m{}^*e$

(4') $Y_w = (a_{lh}H+a_{lx}X)w(1-t_w)$

(5') $Y_r = \{z(a_{lh}w+a_{mh}P_m)H + (P_x-a_{lx}w)X\}(1-t_r)$

where t_w and t_r represent the ad-valorem tax rates on labor income and profits respectively.

If the government has a marginal propensity to save of one (the K-T assumption) we can readily obtain the general expression for the effects of a devaluation on output

(11) $\frac{dH}{de}\frac{e}{H} = \frac{(1+z)}{D_2P_hH}\{-(\gamma_w'-\gamma_r')K_0 - (\gamma_w'MP_m{}^*e-\gamma_r'XP_x{}^*e)K_1\}$

where $\gamma_w'=\gamma_w(1-t_w)$

$\gamma_r'=\gamma_r(1-t_r)$

$D_2 = \{a_{lh}w\{1-\gamma_w(1-t_w)+z(1-\gamma_r(1-t_r))\}+a_{mh}P_m{}^*e\{1+z(1-\gamma_r(1-t_r))\}\}$

If we compare (11) with its counterpart under trade taxes -expression (8)- it is clear that the first two terms inside the parentheses should receive analogous interpretation as before, with the relevant marginal prpensities to consume in (11) being those out of disposable income (γ_w' and γ_r'). However, the absence of a third term reveals that fiscal policy has lost the "separate" influence that it had under trade taxes.[10] Indeed, if $t_w = t_r > 0$, $\gamma_w = \gamma_r$ and if the economy starts from a balanced budget, the devaluation has no effect on output even if affecting fiscal revenues. These same conditions in the presence of trade taxes would produce a contractionary outcome, as clear from (8).

The reason for the above result becomes more evident when we consider the effects of a devaluation under a balanced fiscal budget, shown below

$$(12)\quad \frac{dH}{de}\frac{e}{H} = \frac{(1+z)}{D_3 P_h H}\Big\{-((\gamma_w'-\gamma_r')+(t_w-t_r))K_0 - ((\gamma_w'+t_w)MP_m^*e-(\gamma_r'+t_r)XP_x^*e)\Big\}$$

where

$$D_3=\{a_{lh}w((1-\gamma_w)(1-t_w)+z(1-\gamma_r)(1-t_r))+a_{mh}P_m^*e(1+z(1-\gamma_r)(1-t_r))\}$$

Some comments on the above expression are required:

(i) As could be expected, the greater is t_w with respect to t_r, the more contractionary is the effect of a devaluation because a relatively heavier burden falls on agents with a higher propensity to consume.

(ii) Unlike the case of trade taxes, the expansionary effect of the

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[10] Of course, the devaluation occurs without a change in the tax rates.

balanced government budget has dissappeared. Just as in (11), fiscal policy has lost its separate influence. Indeed, if we abstract from differences in tax rates, when direct taxes are levied on private income, government revenues and hence expenses will increase only when total income increases. Thus, if a devaluation is contractionary under fixed G it will be more contractionary when the fiscal sector runs a balanced budget because public spending will also go down. Conversely, if an exchange rate increase is expansionary under fixed G, it will be more expansionary in the new scenario. This result can be formally seen both because the multiplier in (11) is smaller than its counterpart in (12) and because there is a new negative term multiplying the trade deficit in the latter expression.

The asymmetry with the former case is by now evident. Put in other words, when trade taxes are the only source of fiscal income a devaluation unambiguously raises government revenue and thus, with a balanced budget, it pushes up total spending and income. Under income taxes, however, the effect of an exchange rate increase in fiscal income is ambiguous.

4. Nominal wage adjustment.

Many empirical studies, as well as casual evidence, have shown the existence of some stickiness in the behavior of nominal wages for different countries and sample periods. But sticky wages are not the same as fixed wages, as K-T assume, and once we depart from the very short run it is necessary to provide a mechanism for wage adjustment.

Doing so will imply adding a dynamic structure to an otherwise static model. In the new scenario wages will be sticky in the sense that they will not react instantaneously to clear the labor market; rather, they will adjust downwards under conditions of excess supply in the labor market and upwards when excess demand prevails. This defines a Phillips curve type equation which is specified below

$$(13)\quad \dot{w} = \phi(L-L^*) \qquad \text{if } w>0$$

$$= \max[0,\ \phi(L-L^*)] \qquad \text{if } w=0$$

$$\text{with} \quad \phi'>0,\ \phi''=0,\ \phi(0)=0$$

where $\dot{w}$=dw/d(time)

L=current level of employment

L^*="natural" or noninflationary employment level

Inflationary expectations are not included in (13) because the exchange rate and world prices are assumed to be fixed and thus there is no inflation in the long run. We further assume no population growth and a totally inelastic labor supply; with this L^* becomes a constant.[11]

4.1. Wage dynamics in the original K-T framework.

The model consists now of equations (1)-(7) and (13). It is clear that in this modified scenario the immediate effect of a devaluation can not be different than in K-T since nominal wages are fixed on impact. Rather, we will be interested in studying the dynamic properties of the system. In particular, stability requires that $d\dot{w}/dw<0$, since the model has only one differential equation. We notice that

$$(14)\quad d\dot{w}/dw = (d\dot{w}/dL)(dL/dw) = \phi' a_{1h}(dH/dw)$$

Our equation for output determination in the home good market is obtained by replacing (1)-(5) and (7) in (6). Using this, and after some computations, we can express (14) in terms of the underlying parameters of the model as

$$(15)\quad \frac{d\dot{w}}{dw} = \frac{\phi' a_{1h}(1+z)}{D_0 P_h}\{(\gamma_w-\gamma_r)K_0'+a_{1h}(\gamma_w M P_m{}^*e-\gamma_r X P_x{}^*e) +a_{1h}(\gamma_w t_m M P_m{}^*e+\gamma_r t_x X P_x{}^*e)\}$$

where $K_0'=a_{1x}Xa_{mh}P_m{}^*e$

Expression (15) is clearly positive under the original K-T assumptions, rendering the model unambiguously unstable.

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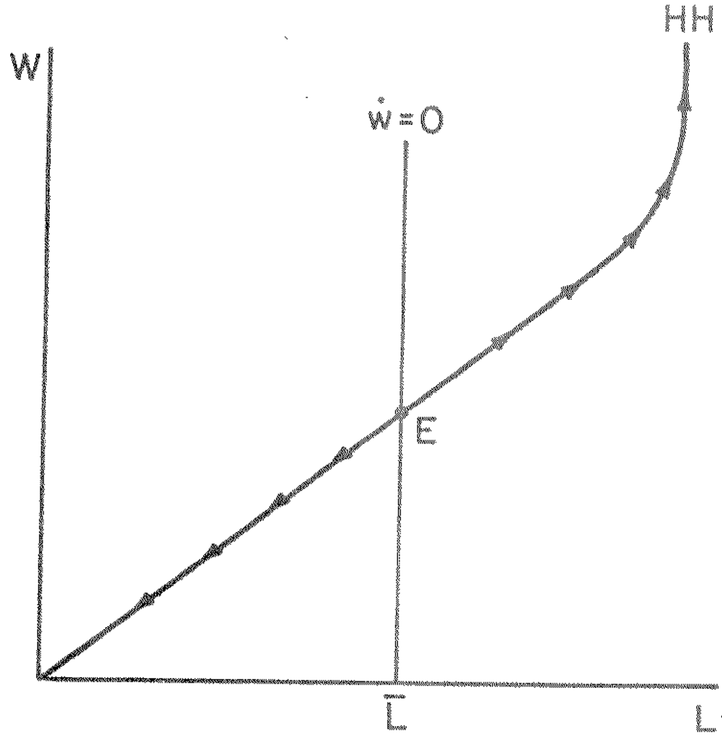
[11]For the effects of labor supply responsive to the wage rate in a static version of this model see Hanson (1983).

The intuition for this instability result goes as follows. The devaluation, by decreasing real wages, depresses demand for home goods and hence output and employment. But the increase in unemployment, through the Phillips curve, drives downward the nominal wage and with it the real wage. This further decreases demand and there are no forces in the model to stop this downward trend. Formally, we can notice that the sign of $d\dot{w}/dw$ is exactly the opposite as that of dH/de; thus, whenever a devaluation is contractionary instability is also present.

Graphically we can plot the equation of wage dynamics and the general equilibrium relationship between employment and wages from the home good market (HH) in (w,L) space, as presented in figure 1. The initial assumption about domestic goods being demand determined implies that the economy will always lie in some point of the HH schedule, with the long run equilibrium also requiring wages to be at rest (point E). The preceding discussion tells us that if any shock (e.g. a devaluation) moves the economy away from steady state, forces in the model will further move us away from equilibrium. This explains the divergent arrows being drawn through HH. We notice that the divergence of the economy is discontinuous in the right direction. After a while wages will turn so high that they will account for practically 100% of the costs of producing H. At this point real wages become constant and emloyment and home good output stabilize while nominal wages continue their upward trend.

Figure 1

WAGE DYNAMICS AND INSTABILITY



The conclusion coming out from this analysis is twofold: (a) The original K-T model is considerably weakened if we allow for some plausible response in wages, because by becoming unstable it can not be used for comparative static purposes.

(b) The fundamental result of K-T remains true, in the sense that a devaluation has perverse effects. But this time the contraction persists through time driving both output and employment to zero.

4.2. Wage dynamics, fiscal policy and stability.

If government revenue comes entirely from taxes on trade but now the fiscal sector runs a balanced budget, the stability issue may be raised once again. Avoiding intermediate steps we can write down the final expression for $d\dot{w}/dw$ as

$$(17)\quad \frac{d\dot{w}}{dw} = \frac{\phi' a_{1h}(1+z)}{D_1 P_h} \{(\gamma_W-\gamma_r)K_0' + (\gamma_W MP_m{}^* e - \gamma_r XP_x{}^* e)a_{1h} - (1-\gamma_W)t_m MP_m{}^* e a_{1h} - (1-\gamma_r)t_x XP_x{}^* e a_{1h}\}$$

Thus, if the government runs a balanced budget we are no longer hopeless of achieving stability, depending on the latter two terms of (17) being bigger in absolute value than the former two.

This result is quite intuitive; the devaluation continues transfering income in the "wrong" direction within the private sector. But private agents as a whole redistribute income to the balanced budget fiscal sector. If the former effect dominates, the devaluation depresses real wages on impact, aggregate demand and hence output and employment; this further reduces real wages and the economy continues its downward trend. However, if the latter effect dominates a net expansion in output and employment will occur, reversing the downward trend in wages, and stability would be achieved.

A balanced-budget fiscal sector not only exerts a positive influence in the economy in front of a devaluation but also contributes, as a by-product, to its stability.

5. Wage and export dynamics.

5.1. The new setup.

We have already shown that if wages alone adjust dynamically one possible way to achieve stability is having a fiscal sector which spends the extra revenue generated through trade taxes by a devaluation. Nonetheless, it is a bit uncomfortable to have to rely on this redistribution effect to be able to get back to equilibrium.

A most natural way to search for stabilizing forces would be to relax the K-T assumption of a fixed supply of exports determined by existing capacity, which has been carried on until now. Indeed, available international studies such as Sachs (1982b, 1983) and Larrain (1985) show a significant, negative response of employment (and thus of output) to real wages in the tradeable sector for both industrialized and developing countries. The fact that the employment response is contemporaneous suggests that a devaluation, operating through a reduction in real wages, has an effect in the supply of tradeable goods even in the short run.

A straightforward extension of the K-T model to allow for export response to prices in a static framework will simply introduce another source of ambiguity in the devaluation effect on real income. Our attempt is, however, to study the dynamic adjustment of the economy after a shock. We will assume accordingly that exports are neither in fixed supply, nor that they adjust instantaneously; rather, they will respond through time to movements in the real wage. An adjustment pattern such as this can be formally derived from an intertemporal profit-maximizing firm facing adjustment costs in hiring/firing labor. This strategy has not been pursued to keep the model as simple as possible, avoiding expectational issues.

Let the long run supply of exportable goods (X^*) respond to unit profits in the standard form

$$(18)\quad X^* = \theta(P_X{}^*e-a_{1X}w) \qquad \theta>0 \qquad \text{for } (P_X{}^*e-a_{1X}w)>0$$
$$= 0 \qquad\qquad\qquad\qquad \text{for } (P_X{}^*e-a_{1X}w)\leq 0$$

The above equation is ad-hoc in at least one important respect. In principle, output should respond not only to the current level of profits but also to the entire path of future profits. This limitation becomes serious in an economy where nominal wages quickly respond to price changes,[12] but looses importance the slower wages catch up with inflation. Available empirical evidence tends to support this latter view. In a study of 24 devaluations for the period 1953-66, and including most major exchange rate changes in developing countries, Cooper (1971b) found that "...twelve months after devaluation..., general wholesale prices will have risen less than this, consumer prices will have risen by about the same as wholesale prices and, except where devaluations are small, manufacturing wages

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[12]For example, if short-lagged wage indexation is a widespread phenomena.

will have risen by less than consumer prices...Thus nonwage income of employed factors -mostly profits and rents- show an increase in real terms a year later and it is this increase that provides the incentive for the necessary reallocation of resources..."[13] Larrain (1985) has also presented evidence for 12 developing countries indicating that devaluations, except when small, tend to reduce the product wage in the manufacturing and mining sectors.

In our scenario the level of X is fixed on impact; its response through time is given by[14]

$$(19)\quad \dot{X} = \Psi(X^{*}-X) \qquad \text{if } X>0$$
$$= \max[0,\ \Psi(X^{*}-X)] \qquad \text{if } X=0$$
$$\text{with } \Psi'>0,\ \Psi(0)=0$$
$$\Psi''>0 \text{ for } X^{*}>X$$
$$\Psi''<0 \text{ for } X^{*}<X$$
$$\lim_{X^{*}\to\infty} \Psi(X^{*}-X) = -\infty$$

The parameter of export response (Ψ') has been specified as an increasing function of the difference between the current and desired level of exports. Thus, the more a devaluation increases per-unit profit, the faster will exports increase towards their long run equilibrium. On the other hand, if profits are squeezed by wage

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[13]Cooper (1971b), p. 27-28.

[14]It is immediate to se that a function like $\Psi\{(X^{*}-X)/X^{*}\}$, which has the same conceptual interpretation as $\Psi(X^{*}-X)$, satisfies the limit condition in (19). We have not used it for reasons of tractability.

increases so that (X^*-X) turns negative, exports will contract increasingly faster as this gap widens. When profits are down to zero or turn negative export production will tend to stop altogether. This pattern of response is illustrated in figure 2.

Replacing (18) in (19) we get

$$(20)\quad \dot{X} = \Psi\{\theta(P_X{}^*e-a_{1X}w)-X\}$$

From (20) we can start studying the Jacobian matrix of the dynamic system

$$(21)\quad \partial\dot{X}/\partial X = -\Psi'$$

$$(22)\quad \partial\dot{X}/\partial w = -\Psi'\theta a_{1X}$$

Wage dynamics are specified starting from equation (13); after some computations we arrive to

$$(23)\quad \frac{\partial\dot{w}}{\partial w} = \frac{\phi' a_{1h}(1+z)}{D_4 P_h}\{(\gamma_w-\gamma_r)K_0{}''+a_{1X}(\gamma_w M P_m{}^*e-\gamma_r X P_X{}^*e)\}$$

where

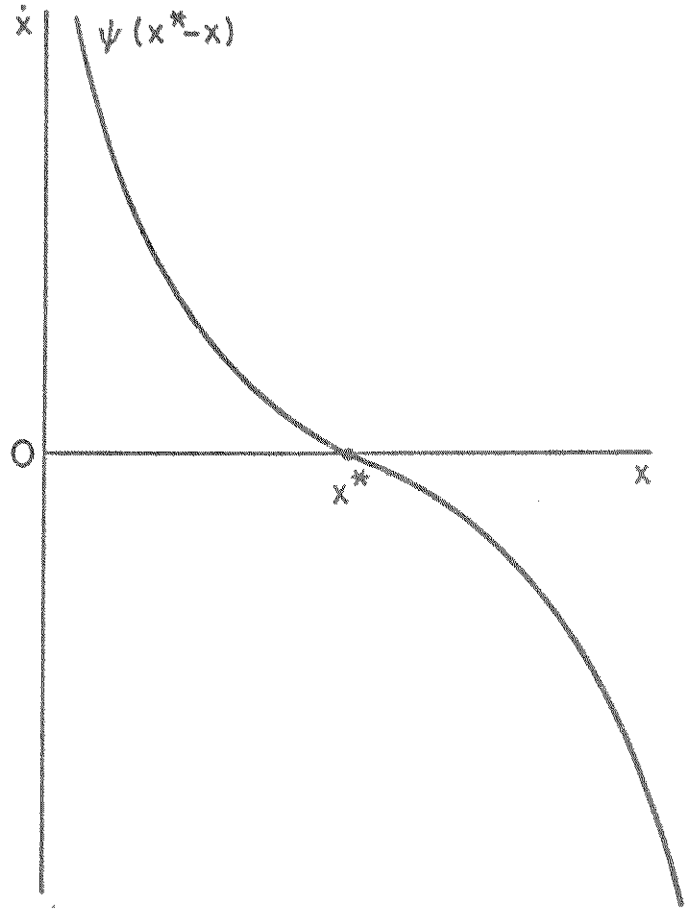
$$D_4 = \{a_{1h}w((1-\gamma_w)+z(1-\gamma_r))+a_{mh}P_m{}^*e(1+z(1-\gamma_r))\}$$

$$K_0{}''=a_{1X}Xa_{mh}P_m{}^*e$$

From (13) and the employment identity

$$(24)\quad \frac{\partial\dot{w}}{\partial X} = \phi'\{\frac{a_{1h}}{D_4}((\gamma_w-\gamma_r)a_{1X}w+\gamma_r P_X{}^*e)+a_{1X}\}$$

Figure 2
EXPORT ADJUSTMENT



Both expressions (23) and (24) are positive under the current working assumptions.

5.2. Local stability.

We have thus two downward sloping schedules in (X,w) space ($\dot{X}=0$ and $\dot{w}=0$) whose relative slopes will presumably be related to the issue of stability. Writing the dynamic system in matrix form around the steady state

$$(25)\quad \begin{vmatrix} \dot{X} \\ \dot{w} \end{vmatrix} = Z \begin{vmatrix} X-X^* \\ w-w^* \end{vmatrix}$$

Where Z is the Jacobian or transition matrix whose elements are (21), (22), (23) and (24). Local stability in this predetermined-variables model requires both trace(Z)<0 and determinant(Z)>0 to guarantee that the real part of the eigenvalues of Z will be negative.

$$(26)\quad tr(Z)=-\Psi' + \frac{\phi' a_{1h}(1+z)}{D_4 P_h}\{(\gamma_w-\gamma_r)a_{1x}Xa_{mh}P_m+a_{1h}(\gamma_w MP_m-\gamma_r XP_x)\}$$

$$(27)\quad det(Z)=\Psi'\phi'\{\theta a_{1x}\{(a_{1h}/D_4)((\gamma_w-\gamma_r)a_{1x}w+\gamma_r P_x)+a_{1x}\} - \frac{a_{1h}(1+z)}{D_4 P_h}\{(\gamma_w-\gamma_r)a_{1x}Xa_{mh}P_m+a_{1h}(\gamma_w MP_m-\gamma_r XP_x)\}\}$$

where Ψ' has been evaluated at steady state.

Even though both (26) and (27) have ambiguous signs, there are three parameters which play a key role in the above expressions:

(a) The speed of adjustment of exports toward their long run level (Ψ'); the higher this value, the more likely that the trace condition will be satisfied, although it has no effect on the sign of the determinant.

(b) The parameter of wage adjustment (ϕ') influences only the trace; the higher it is, the more likely the unstable outcome occurs.

From (26) the exact relationship between these two coefficients and the parameters of the model for a stable trace condition is:

$$(28)\quad \Psi' > \frac{\phi' a_{1h}(1+z)}{D_4 P_h}\{(\gamma_w-\gamma_r)a_{1x}Xa_{mh}P_m+a_{1h}(\gamma_w MP_m-\gamma_r XP_x)\}$$

(c) The long run response of exports to price incentives (θ), even if it plays no role in the trace, the higher its value the more likely that the determinant will be positive. The exact relationship for this condition to be satisfied is:

$$(29)\quad \theta > \frac{\{(\gamma_w-\gamma_r)a_{1x}Xa_{mh}P_m+a_{1h}(\gamma_w MP_m-\gamma_r XP_x)\}}{\{a_{1h}((\gamma_w-\gamma_r)a_{1x}w+\gamma_r P_x)+a_{1x}D_4\}}$$

Therefore, stability requires both a fast adjustment of exports and a high long run response of them to price incentives. That the source of potential instability arises from the interaction of a demand determined home good sector and the Phillips curve is also clear. Indeed, if the contractionary effects from a devaluation coming from the different marginal propensities to consume and the initial trade deficit were not present, conditions (28) and (29) get immediately satisfied.

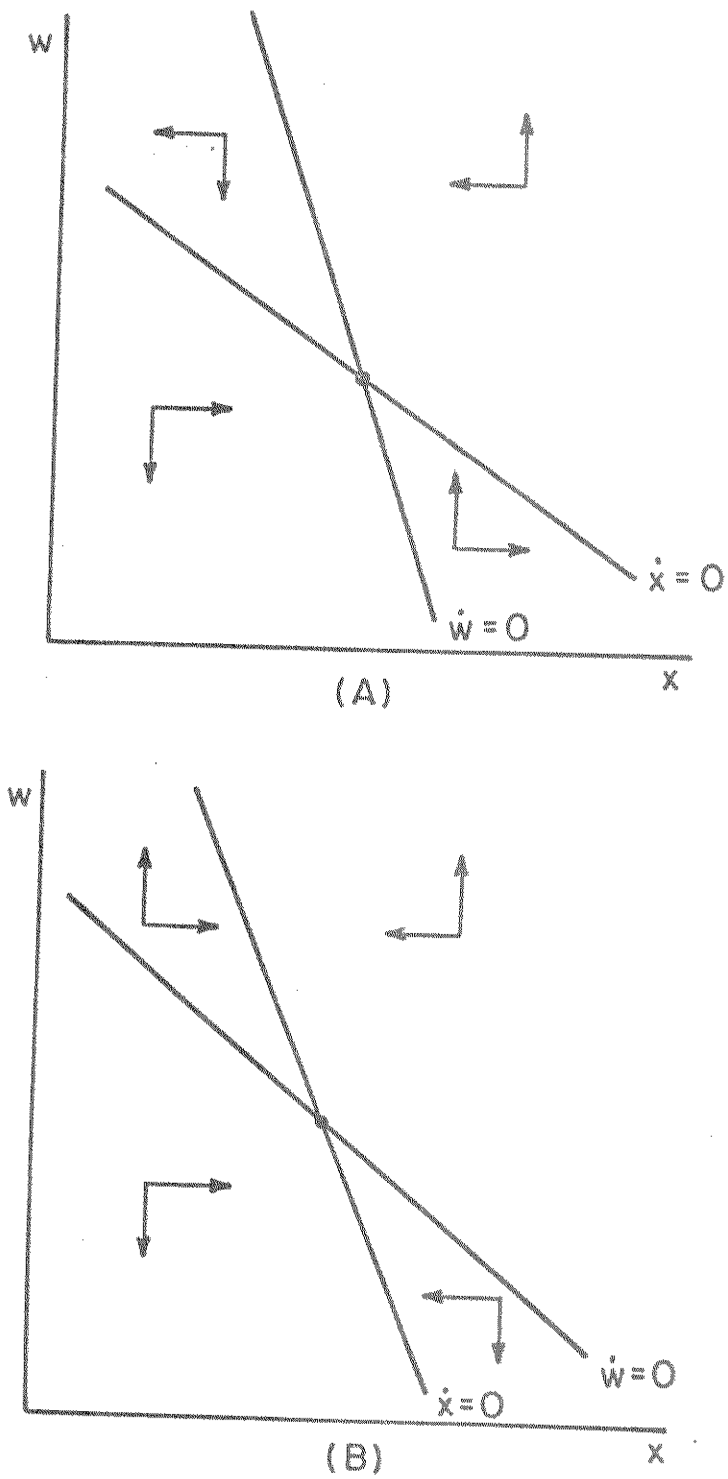
We also notice that, as could be expected, the relative slopes of the two loci and the stability issue are not independent. From equations (23), (25) and (29) it is apparent that the value of θ required to make the determinant positive is exactly the same one needed for the $\dot{w}=0$ locus to be steeper than $\dot{X}=0$.

In figure 3 the two possible cases are presented. From the transition matrix Z we can draw the corresponding arrows of motion and study the direction of forces implied by the resulting vectors in each of the four regions. This confirms our earlier discussion; when $\dot{X}=0$ is steeper than $\dot{w}=0$ (case of a low θ) a clearly divergent path when away of equilibrium arises. On the other hand, when $\dot{X}=0$ is flatter than the wage schedule the system presents a counterclockwise movement.

What is the economics out of these stability conditions? We recall that a devaluation, by cutting real wages, has both a contractionary effect in the demand for home goods and an expansionary influence on exports through time. In figure 3B the long run export response is not big enough and the contractionary effect dominates; in this case unemployment will increase putting downward pressure on the wage rate and leading to the unstable outcome. However, θ being sufficiently high to guarantee that the relative slopes are correct as in figure 4A is not enough for a stable outcome. From now on we will con-

Figure 3

WAGE AND EXPORT ADJUSTMENT:
HIGH (A) AND LOW (B) LONG-RUN RESPONSE
OF EXPORTS



centrate in the case in which stability depends on the relative speeds of adjustment of wages and exports (the trace condition), assuming the determinant to be positive and thus ruling out case 3B.

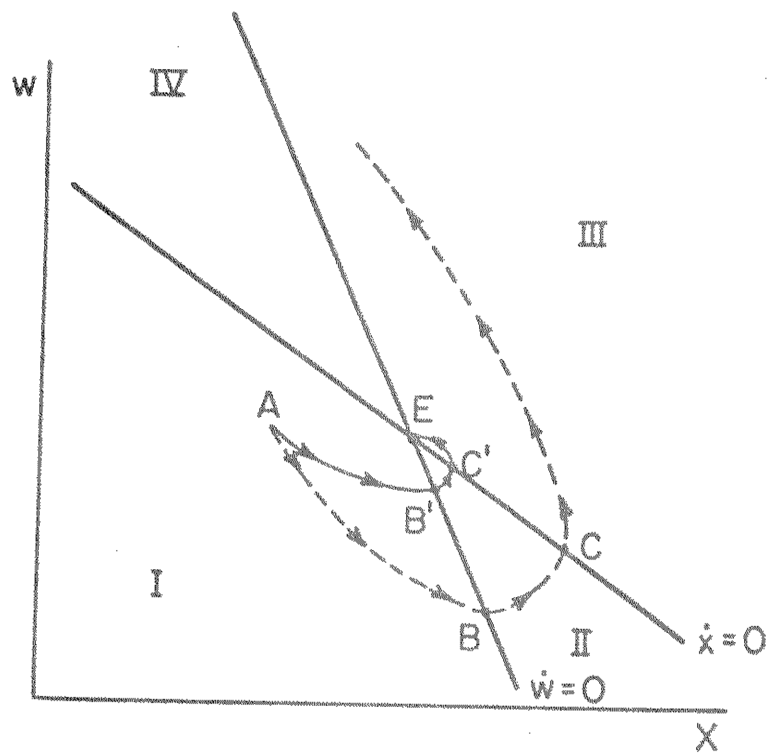
Since the trace is now the sole condition which determines stability, we can distinguish two possible cases from equation (28) which will be illustrated graphically and conceptually with the help of figure 4.

(i) If exports adjust slowly relative to wages condition (28) will not be satisfied and we can expect the unstable outcome. This situation may be visualized by starting at a point like A in figure 4, where the wage is low enough to encourage the export sector and unemployment prevails. The economy begins moving south-east through the dotted line with the wage declining due to unemployment and exports moving slowly upwards. At B the wage stops moving (the natural level of unemployment is reached), but there still remain incentives to expand exports; this leads to overemployment and w starts rising. At C exports stop growing but overemployment keeps increasing wages. Now, if exports would respond fast we will soon move in the horizontal direction; but this is not the case and the adjustment is more upwards than to the left. Continuing the analysis it is easy to see that the system diverges.

(ii) Conversely, if exports are fast to react relative to wages condition (28) will be satisfied and local stability is guaranteed. Let us start again from point A; this time the low wage makes exports expand rapidly and the economy moves from A to B' through the solid line. Once w crosses the $\dot{X}=0$ level (above C') exports take a small

Figure 4

DIFFERENT SPEEDS OF ADJUSTMENT IN EXPORTS RELATIVE TO WAGES



period of time to contract. We quickly converge to equilibrium through the solid path AB'C'E.

Notice that in the adjustment process the home good sector is also reacting. In region I while wages fall employment is expanding because exports increase; the net effect on labor income and thus on the home good sector is ambiguous. Region II, with exports, wages and employment growing is a boom period for the whole economy. On the contrary, area IV is a period of generalized depression. The situation in the four regions is summarized in Table 1.

TABLE 1

Region	I	II	III	IV
Sector				
Home goods	?	expand	?	contract
Exports	expand	expand	contract	contract

5.3. Towards global stability.

So far, we have just analyzed local stability around the steady state and concluded that only if exports adjust fast enough relative to wages the economy will go back to equilibrium when a shock disrupts it. In this section we will show that even if this condition is not satisfied the system has forces that will drive it to a stable cycle at some distance of the equilibrium. Thus, the fact that the economy is not locally stable around steady state does not mean that it will explode through time.

It is clear that if the model were totally linear, local and global stability conclusions will necessarily coincide. Indeed, local dynamic analysis is done by linearizing around steady state which is obviously unnecessary when the system is already linear. Our model, however, has two sources of nonlinearity as defined: on the one hand it is defined only for positive values of w and X, and on the other, the speed of adjustment of exports (Ψ') increases the farther away is the current level with respect to the desired one. The idea behind this formulation is that if we start from equilibrium, as wages fall (increase) the export sector becomes increasingly profitable (unprofitable) for given exchange rate and world price, and thus exports would react faster.

We are then interested in studying the case where local instability occurs ($tr(Z)>0$, $det(Z)>0$), but in which export responsiveness grows with the distance from equilibrium. Suppose for a moment that the value of Ψ' relative to the other parameters of the model is such that the trace at equilibrium is very close to zero (i.e. the system is borderline stable or unstable). Then we can appeal to Hopf bifurcation theory (see Mas-Colell (1985))[15] and obtain the existence of a Hopf bifurcation cycle as the economy goes from stable to unstable (or viceversa). Technically, it is necessary that the

[15]For an advanced mathematical treatment on Hopf bifurcation see Hassard, Kazarinoff and Wan (1981).

trace has some nonlinearity embedded, which is guaranteed in our model by the shape of the export adjustment function. It should be kept in mind, as Mas-Colell (1985) remarks, that Hopf bifurcation is still a local analysis of dynamics in the neighborhood of the steady state, since the trace condition looses its meaning when going away of equilibrium. A plausible form of the Hopf cycle is shown in figure 5.

The appropriate study of the stability properties of the Hopf cycle involves examining third, fourth and even higher order derivatives of the functions. This task may be perfectly justified for a mathematics study, but lacks any significant economic meaning and will not be attempted. Getting the correct stability conditions by ill-grounded assumptions about the Ψ and ϕ functions will not improve our understanding about how the economy works.

Rather than going in that direction we will go in another, less restrictive way. An attempt will be made to show that the system has at least one stable cycle by using the Poincare-Bendixson theorem, valid for global dynamic analysis and with no restrictions in the size of the trace.[16] Following Beckman and Ryder (1969), Benassy (1984) and Mas-Colell (1985) the conditions for the existence of this type of cycle are:

(i) The long run equilibrium is unstable.

(ii) There exists a bounded, invariant and simply connected region.

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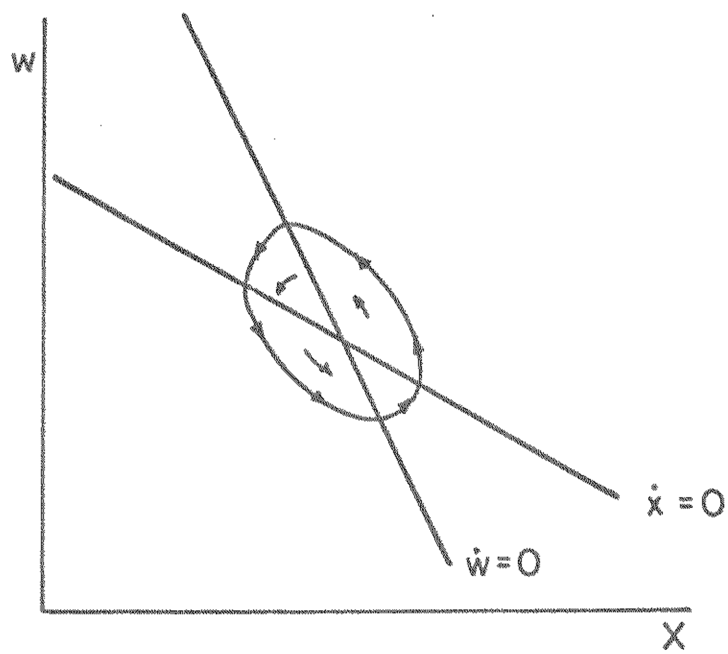
[16]The analysis of Poincare-Bendixson is carried through for the case in which the equilibrium is unique. If the global extension of condition (29) is met, uniqueness unambiguously holds. However, (29) is sufficient but not necessary for a unique equilibrium, and thus stronger than we need.

Figure 5
HOPF BIFURCATION CYCLE



Definitions:

(D.1) Invariant region is one which is absorbing in itself, that is, every point starting inside the region will remain inside it.

(D.2) Globally absorbing is a region where every point will enter in finite time (either starting inside or outside it).

(D.3) Informally, the simply connectedness condition means that the region has no holes inside it.

Theorem: The dynamic system defined in equations (13) and (19), under the conditions in (13), (18), and (19) contains at least one stable cycle.

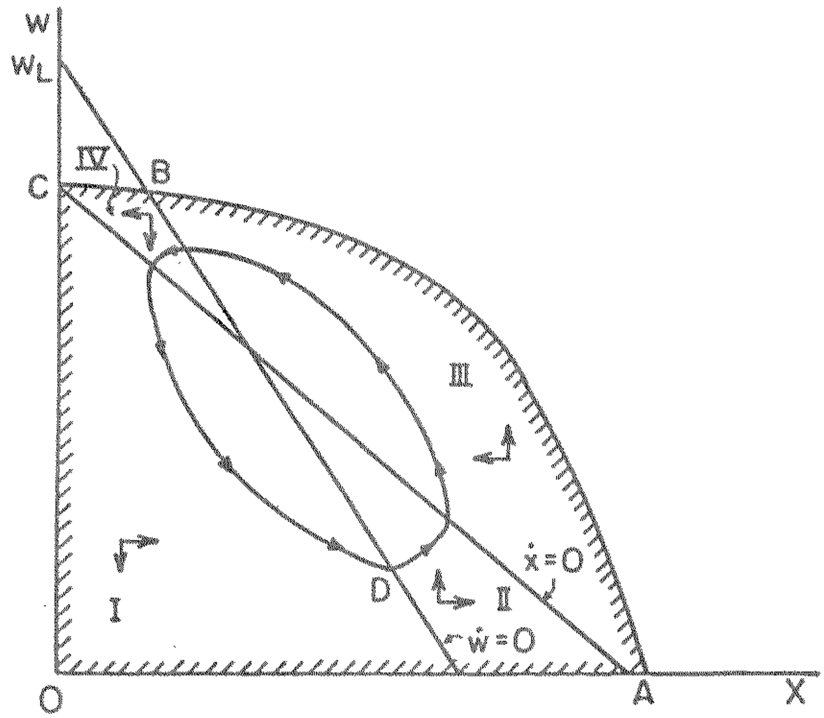
Proof: To demonstrate the theorem we must show that the requirements (i) and (ii) for a Poincare-Bendixson cycle are met. This is done below.

Condition (i) is immediately met when the trace is negative around the steady state, which is the case we are analyzing.

To show condition (ii) we need to construct a region with the desired characteristics, which will be done with the help of figure 6. We first notice that the two axes are natural boundaries since the system is only defined for positive w and X. Let us start in a point like A, to the right of the intersection between the $\dot{X}=0$ locus and the horizontal axis, where the level of X is higher than its equilibrium. The dynamics of the model start moving the economy north-west, with wages rising and exports contracting. As wages rise the export sector moves farther away from equilibrium, speeding up its

Figure 6

POINCARE-BENDIXSON CYCLE



own reaction; because export contraction finally dominates over the upward trend in wages the economy moves in a path like AB, collapsing in the vertical axis. By the conditions in (13) and (19) the point of intersection of this trajectory and the wage axis can be -at the most- at C. Exports are there at equilibrium but forces still exist in the economy to decrease wages. Once point C is crossed exports are again profitable and, with wages falling, the movement is south-east. It becomes then clear that OABCO is a bounded, invariant and simply connected region inside of which there exists at least one stable limit cycle as figure 6 shows. This completes the proof of the theorem.

The region OABCO is not globally absorbing since, for example, points starting above w_1 will not collapse into it within a finite time. Rather, those trajectories will touch the vertical axis above w_1 and will remain at the level of X=0 with nominal wages steadily increasing. Real wages, though, will converge to a constant value as labor approaches 100% of the costs of producing the home good. At that point all real variables in the model will have reached stationary values.

Combining the Hopf bifurcation (HB) and the Poincare-Bendixson (PB) analyses we have three possible cases:

(i) If the HB cycle exists and is stable, then there exists at least one stable cycle in the system, since it may happen that PB and HB coincide.

(ii) If the HB cycle exists and is unstable, there exists at least one other stable cycle, since PB is always stable. The minimum number of cycles in this situation is two: one stable and one unstable.

(iii) If the HB cycle does not exist, there is at least one stable cycle in the system (PB).

Notice that a large value of Ψ' (fast export adjustment) is not enough to generate cycles. If in addition $\Psi''=0$ the system will be globally stable, provided condition (28) is met, but no cycles will occur.

The theoretical results analyzed are an adequate representation of the situation lived by many third world nations. In particular, Latin-American countries typically undergo cycles in which periods of slow overall growth, booms and recessions alternate. This is in the spirit of the predictions of our model, as illustrated in the four regions of figure 6. If we start at point D, the economy is beginning a boom period (region II) with both exports and wages expanding. The boom runs out of steam because real wages get too high, squeezing exports (III) and a recession is ad-portas. The farther away from equilibrium with wages rising, the faster exports contract; at some point wages can no longer keep rising and unemployment starts developing. A deep recession then develops with wages and exports falling (IV). After a while wages have fallen enough and exports are again profitable (region I); wages will continue falling until the export sector has expanded enough. When the economy reaches point D a full cycle has been completed and the process is about to start again.

It is important to notice that the existence of cycles with large amplitudes can only be accounted for by Poincare-Bendixson type analysis. Hopf theory is only a local phenomenon occurring in the vicinity of the steady state which can not explain wide fluctuations.

This analysis suggests that for a good number of developing countries neither neo-classical nor structuralist models may be applicable. If the supply-response forces in the economy are weak enough around the steady state the long run equilibrium will never be reached. This does not imply that the economy will diverge towards zero output and employment, which would happen if wages keep falling and supply does not react. The outcome is likely to be somewhere in the middle, with the economy undergoing a stable cycle at some distance from the equilibrium.

6. Conclusion.

This paper has been focused on the potential contractionary effects of a devaluation and the subsequent dynamic adjustment of the economy after it. The starting point is Krugman and Taylor (1978) (K-T) who emphasize the redistribution effects of a devaluation from an initial trade deficit, drawing on earlier contributions by Diaz-Alejandro (1963, 1965), Robinson (1947), Hirschman (1949) and Cooper (1971a). Their main conclusion is that a devaluation is unambiguously contractionary, a hardly surprising result given that exports are in fixed supply and there is neither substitution in production nor in consumption in their model. An additional source of contraction arises from the fiscal sector whose level of expenditures is fixed regardless of the evolution of revenues.

If the government is allowed to run a balanced budget, the effect of a devaluation on output and employment becomes ambiguous. This result happens because the exchange rate increase redistributes income not only within the private sector but also from the private sector as a whole to the government, which fully spends the extra revenue. If the balanced budget fiscal sector is financed from income taxes rather than trade duties, the sign of the devaluation's effect on output is not altered from the K-T conclusion, and its magnitude is higher.

Dynamics are later introduced in the model by letting wages sluggishly adjust through time. In this scenario the devaluation continues being contractionary, but in addition the equilibrium is shown to be unstable because the initial reduction in real wages decreases demand for home goods which in turn reduce employment, bringing the real wage further down; there are no forces in the model to stop this downward trend.

A more realistic scenario is then set with exports adjusting through time in addition to wages. This extension is suggested by empirical studies such as Sachs (1982b, 1983) and Larrain (1985) which show a contemporaneous response of employment (and thus of output) to real wages in the tradeable sector for a group of industrialized and developing countries. In this framework, local stability around steady state is achieved both with a high long run response of exports to price incentives and with a higher speed of adjustment in exports than wages. Because the model has some nonlinearities embedded, the existence of local instability does not imply global instability. Indeed, when exports adjust slowly in relation to wages around the steady state the economy is locally unstable, while at the same time it undergoes at least one stable cycle. In particular, conditions are discussed under which a Hopf bifurcation cycle and a Poincare-Bendixson limit cycle exist.

The key element explaining the existence of a Poincare-Bendixson cycle (the one more relevant to explain wide fluctuations) is the pattern of export response, whose velocity increases (relative to wages) when going away from equilibrium. Thus, if we consider a devaluation which is contractionary on impact, at some distance of steady state the expansionary forces coming from export reaction to increased profitability will be strong enough to offset the negative influences arising from income redistribution and the initial trade deficit. This stops the divergent path of the economy.

This analysis seems an appropriate representation of the reality in a number of developing countries where neither neoclassical nor structuralist models seem fully appliccable. The supply-response forces may be weak enough around steady state so that long run equilibrium will never be reached. This does not imply that the economy will diverge through time towards zero output and employment, which would happen if wages keep falling and supply does not react. Rather, third world countries typically undergo periods of slow growth interrupted by booms and depressions, the characteristics of the cycle described in this paper.

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