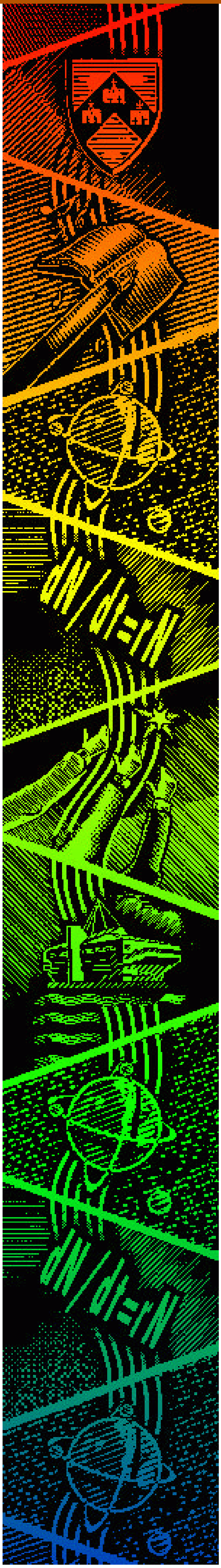

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A Comparison of Menu Costs in Open and Closed Economies with a Mixed Industrial Structure

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ABSTRACT: *In this paper we develop Dixon and Hansen (1997) to allow for two-sector small open economy in which the non-traded sector is monopolistic. The closed economy version of the model generalises Dixon/Hansen to allow for diminishing returns on the traded sector. We compare the short-run impact of menu costs on the economy and also the size of menu costs needed to sustain nominal rigidity in both the open and closed economies. We find that whilst the welfare gains from monetary expansion are of a similar magnitude, nominal rigidity can occur for much smaller menu costs than in the closed economy case. Hence we argue that menu costs and the resultant nominal rigidities are more likely to be important in an open economy.*

Key words: Menu costs, open economy, welfare, monopolistic competition.

JEL: D40, E30, L16, F32.

We would like to thank Claus Thustrup Hansen for his comments. Faults remain our own.

Introduction.

The existing literature on the importance of menu-costs has focused on models of closed economies where all industries are the same[1] (see for example Mankiw 1985, Blanchard and Kiyotaki 1987, Rotemberg 1987, Ball and Romer 1990, 1991). This is clearly restrictive: most important economies are to some extent open, and the structure of industries in them is diverse. The conclusion of this approach was that

> "*The scope for small menu costs to lead to large output effects in our model depends critically on the elasticity of labour supply with respect to the real wage being large enough. Evidence on individual labour supply suggests, however, a small elasticity*." (Blanchard and Kiyotaki 1987, pp. 369).

In Dixon and Hansen (1997) (henceforth DH), we considered the issue of the variation in industrial structure in a closed economy on the importance of menu costs. DH adopted the theoretical framework of the existing menu-cost literature, but extend it to allow for some variety amongst output markets: proportion b were monopolistically competitive, and proportion 1- b were perfectly competitive (where $b \in [0,1]$). The representative sector model is thus the special cases of $b=1$ (monopolistic) and $b=0$ (Walrasian) . Introducing two sectors leads to some very different conclusions: there is an additional dimension of causality in terms of the reallocation of labour between sectors. In particular, DH found that even with a highly inelastic labour supply, the size of menu costs needed to ensure nominal price rigidity could be small and the welfare gains large. For example, following a 5% increase in the nominal money supply the menu costs needed for non-neutrality could be 40 times smaller and the welfare gains more than 100 time larger than in the symmetric case with $b=1$[2].

In this paper we consider a further departure form the standard model: *in addition to allowing for two different types of industry, we also consider the case of a small open economy.* We assume that there are two sectors: the traded good sector which is perfectly competitive and in which the economy and the firms in that sector are

[1] By this, we mean that there is either a single industry, or many industries that are identical.

[2] In fact, with a perfectly inelastic supply and no competitive sector, the menu costs need to be infinite and the welfare gain is zero: in the mixed case the menu costs are bounded and the welfare gain positive, with the possibility that the welfare gain can outweigh the private loss of the firms.

price-takers, and the non-traded sector in which firms are monopolistically competitive. Thus, the parameter b plays a dual role: not only does it reflect the importance of the monopolistically competitive sector, but also the degree of openness (a higher b represents a less open economy, with b=0 representing the perfectly competitive closed economy case of the standard models). Whilst we generalise the approach in the product market, we keep the assumption that the labour market is perfectly competitive. We also allow for a more general technology in the competitive sector than in DH, output being log-linear in employment so that returns can be diminishing as well as constant.

In a closed economy with all industries monopolistically competitive, output can only increase with competitive labour markets insofar as the labour supply increases. If the labour supply is inelastic, then this means that real and nominal wages must rise significantly. Hence, output rises are only possible in the present of significant menu costs, leading to the pessimism of the above quote. In the case of a closed economy with a mixed industrial structure as in Dixon and Hansen (1997), there is a reallocation effect: as wages rise, the competitive sector price rises relative to the (fixed) monopolistic sector price, allowing monopolistic sector output to rise with modest menu costs even when the labour supply is inelastic. Furthermore, there is a clear first order welfare gain in reallocating from the competitive to the monopolistic sector (since this reduces the deadweight loss caused by the restriction of output in the monopolistic sector).

In the open economy, there is an additional dimension: not only do we have an additional sector, but also its price is tied down by the law of one price and furthermore the possibility of trade means that the domestic consumption can differ from production. In the presence of menu costs, nominal output prices are fixed in the open economy case, so that the upward pressure on nominal wages is much less and hence the menu costs needed to keep prices unchanged in the monopolistic sector are smaller. Nominal wages will need to rise in order that the total labour supply increases: however, any such rise will lead to a reallocation from the competitive sector as its output decreases. This enhanced reallocation effect can lead to larger increases in welfare even taking into account the loss in foreign currency reserves necessary to finance a balance of trade deficit.

If we compare the open economy to the equivalent closed economy, we find that the magnitude of menu costs required is always smaller and generally significantly so (less than 10%). The welfare gains are roughly of the same magnitude as in the closed economy case, sometimes a little larger sometimes a little smaller. However, what we are interested in is the relative magnitude of the menu costs (private loss) to the welfare gains. Since the private loss is so much smaller and the welfare gains about the same, the ratio of welfare gain is in general much larger in the open economy case. For some parameter values, the private loss is zero in the open economy case and strictly positive in the closed case: hence the *ratio* is infinitely larger in the open economy.

The paper is organised in the following manner. In section 1 we outline the basic model; in section 2 we consider the equilibrium in the closed and open economies when prices are perfectly flexible. In section 3 we ask the question of the effect of an increase in the money supply given that menu costs are sufficient to mean that the monopolistic price is unchanged. In section 4 we consider the private loss to monopolistic firms of maintaining a fixed price (a measure of the minimum size of menu costs necessary to maintain prices) and the welfare gain that results if prices are fixed. Section 5 provides an explicit comparison of the closed and open economy cases (Proposition 3). Section 6 explores the magnitudes for different parameter values, enabling us to compare the case of a representative sector closed economy (b=1), the case of a mixed closed economy (DH with $0<b<1$) and an open economy.

1. The model

In this section we outline the basic building blocks of the model, the firms, the households and markets in which they interact.

1.1. Households

There is a continuum of households $i \in [0,1]$. They derive utility from consumption of leisure and of two different types of goods: the goods produced in the monopolistic sector, the consumption of which is denoted by C^M, and the good produced in the competitive sector, the consumption of which is denoted by C^C. Formally

(1.1) $$U\left(C_i^M, C_i^C, l_i\right) = \frac{\left(C_i^M\right)^b \left(C_i^C\right)^{1-b}}{b^b (1-b)^{1-b}} - \frac{g}{g+1} l_i^{\frac{g+1}{g}}$$

where $$C_i^M = \left(\int_{j=0}^{1} c_{ij}^{1-m} dj \right)^{\frac{1}{1-m}}$$

and μ is the elasticity of substitution between any two goods produced in the monopolistic sector. The utility of leisure is represented by the second term in the utility function, which is formally the disutility of labour (l). The parameter g represents the wage elasticity of labour supply while its inverse value is the marginal disutility of work.

The consumer price index is given by

$$P = \left(P^M\right)^b \left(P^C\right)^{1-b}$$

where $$P^M = \left(\int_{j=0}^{1} p_j^{\frac{m-1}{m}} dj \right)^{\frac{m}{m-1}}$$

The budget constraint of household i is:

$$P^M C_i^M + P^C C_i^C \leq W l_i + p_i \equiv I_i$$

where W is the nominal wage, which is assumed to be the same in the two sectors (that is, there is perfect labour mobility between the two sectors). Total consumption is given by

$$C = C^M + C^C$$

The demand for money is assumed that some transaction technology determines the relation between aggregate spending of the households and money balances

$$M = \int_{i=0}^{1} I_i di$$

Maximizing utility and assuming that all households are identical yields aggregate consumption and labour supply:

(1.2) $$C^C = (1-b)\frac{M}{P^C}$$

(1.3) $$C^M = b\,\frac{M}{P^M}$$

(1.4) $$l = \left(\frac{W}{P}\right)^{g}$$

(1.5) $$c_j = \left(\frac{p_j}{P^M}\right)^{\frac{-1}{m}} \mathrm{C}^{\mathrm{M}}$$

The first two equations state that a constant share of income is spent on the competitive good and on the goods supplied by the monopolistic sector's firms. The third equation states that labour supply is function of the real wage and of the parameter γ, the elasticity of labour supply. (1.5) gives the demand for firm *j* as a function of p_j,, given the decision about the total consumption of the aggregate monopolistic good, C^M**.**

1.2. Firms

All firms take the nominal wages *W* and sectoral prices P^C and P^M as exogenous. However firms in the competitive sector are price-takers while the firms in the monopolistic sector are free to set their own price[3]. The production function of all firms in the monopolistic sector is characterised by constant returns to scale whereby the output is normalised to be equal to employment. Therefore we have

$$X^M = L^M$$

Profit maximization for the monopolistic firm *j* yields the following condition for P_j.

(1.6) $$\frac{W}{p_j} = 1 - m$$

In the competitive sector there are constant or diminishing returns with:

[3] It is the essence of monopolistic competition that the firm takes the industry/sectoral price as given (in this case P^M), whilst it sets its own price p_j. From (1.5) the firm's own price elasticity is 1/μ

(1.7) $$X^C = \frac{\left(L^C\right)^a}{a}$$

where $a \in (0,1]$. This generalises Dixon and Hansen (1997) where a=1. From (1.7) when a<1, the demand for labour in the competitive sector is:

(1.8) $$L^C = \left(\frac{W}{P^C}\right)^{\frac{-1}{1-a}}$$

When a=1, output is demand determined, since the labour demand curve is infinitely elastic.

2. Macroeconomic Equilibrium without menu costs.

In section 2 we examine the equilibrium in the case where prices are perfectly flexible. This represents the starting point for when we analyse the case of menu costs. First we will consider the closed economy case, then the open economy.

2.1. Macroeconomic equilibrium in a closed economy.

In this section we will briefly outline the closed economy model. The exposition will be brief, since the model follows DH except for generalising it by allowing for α<1. Given the symmetric structure of the model the prices of all monopolistic goods p_j are equal to P^M. Hence, (1.6) becomes

(2.1) $$\frac{W}{P^M} = 1 - m$$

Solving for equilibrium (see Appendix I), we find that the relative price of monopolistic and competitive goods is given by:

(2.2) $$\frac{P^M}{P^C} = \left\{ (1-m)^{-1-g(1-a)} \left[\frac{b}{a(1-b)}(1-m)+1 \right]^{1-a} \right\}^{\frac{1}{g(1-b)(1-a)+1}}$$

with the absolute price level given by.

(2.3) $$P^C = \left\{ (1-m)^{-bag} \left[\frac{b}{a(1-b)}(1-m)+1 \right]^{a} \right\}^{\frac{1}{g(1-b)(1-a)+1}} a(1-b)M$$

Total employment is:

(2.4) $$l = \left\{ (1-m)^{gb} \left[\frac{b}{a(1-b)}(1-m)+1 \right]^{g(1-b)(1-a)} \right\}^{\frac{1}{g(1-b)(1-a)+1}}$$

with employment in the competitive sector:

(2.5) $$L^C = \left\{ (1-m)^{gb} \left[\frac{b}{a(1-b)}(1-m)+1 \right]^{-1} \right\}^{\frac{1}{g(1-b)(1-a)+1}}$$

Note that *relative* employment is given by:

(2.6) $$\frac{L^M}{L^C} = \frac{b}{a(1-b)}(1-m)$$

Total consumption (which we use to measure GNP) is:

(2.7) $$C = \frac{1}{a(1-b)} \left\{ (1-m)^{b(1+g)} \left[\frac{b}{a(1-b)}(1-m)+1 \right]^{-b-a(1-b)} \right\}^{\frac{1}{g(1-b)(1-a)+1}}$$

The effect of imperfect competition in the monopolistic sector is captured by the μ term: the case of the first-best Walrasian economy, where both sectors price at marginal cost, occurs when μ=0. When μ>0 leads to two effects when compared with the Walrasian case:

a) *The sectoral misallocation allocation effect*: too much labour is allocated to the competitive sector with respect to the perfect competition case (i.e., μ=0), as indicated by equation (2.6).

b) *The activity effect*. The level of total employment and consumption is lower (equations (2.4) and (2.7)).

The model simplifies to DH when we set α=1. Allowing for α<1 tends to reduce the relative size of the competitive sector, by increasing the severity of diminishing returns to labour.

2.2. Macroeconomic equilibrium in an open economy setting

In this section the model is extended to allow for international trade. The competitive sector produces a good traded on the international market, with the domestic price determined by the domestic currency value of the international price $P^c=eP^*$. The exchange rate is assumed to be fixed, which means that the domestic currency price of the traded good is fixed. The monopolistic sector produces a non-traded good. The economy is small, in that P* is exogenously determined on the world market. There is only one asset, non interest bearing money, so that the current account and the trade balance are the same. We assume that a specie-flow mechanism is present (think of money as gold), and distinguish between two analytical time horizons. In the *short-run* the current account can be non-zero (money flows in (out) if there is a surplus (deficit) on the current account). In the *long-run* the current account is zero, and the money stock is constant.

The equilibrium condition for output in the monopolistic sector is that output equals demand (as in the closed economy):

$$L^M = C^M = b\frac{M}{P^M} \tag{2.8}$$

In the competitive sector, however output is supply determined from (1.8), with the gap between output and domestic consumption (1.2) being met by imports or exports. Only in the long-run does current account balance require that domestic demand and supply are equal. The current account surplus S is given by[4]:

[4]In this model we are adopting a very simple approach to the monetary side of the economy: money is the only asset, all profit income is distributed domestically, there are no foreign earnings.. Hence the trade balance and CA coincide.

(2.9)
$$S = eP^* \frac{\left(L^C\right)^a}{a} - P^C C^C$$
$$= eP^* \frac{\left(L^C\right)^a}{a} - (1 - b)M$$

The equilibration of the current account occurs through the adjustment of the domestic money supply. Hence $S = \Delta M$ so that (2.9) can be viewed as a difference equation, with the "long-run" solution M* being current account balance (S=0). In the long-run, the economy behaves effectively as a closed economy with domestic production and consumption of the traded good being equal (see (2.9)).

We assume that there is no sterilising of monetary flows by the central bank. The central bank foreign currency reserves are R (in terms of foreign currency), and they change with the current account: $\Delta R = eS$. In the absence of sterilisation, changes in foreign exchange exactly follow changes in the domestic money supply (indeed, we could set e=1 and consider domestic and foreign currency to be "gold").

Since the closed economy model is static, in order to compare the closed and open economy versions of the model, we will concentrate entirely on the short run impact effect. This seems reasonable in that menu costs are seen as a source of short run nominal rigidity. Also, our underlying model of the firm and consumer is essentially static: the dynamics in the open economy comes solely through the specie flow mechanism. However, when evaluating the welfare effects of a monetary shock in an open economy we will take into account the impact effects on the reserves[5].

3.1. The effect of a monetary expansion on wage and employment in the closed economy

In this section, we consider the effect of a monetary expansion on the economy under the assumption that menu costs are large enough to prevent monopolistic firms from adjusting their prices. Following the literature, we assume that the initial state of the economy is the frictionless equilibrium described in section 2. We will replicate the results of DH for the closed economy, but allowing for α to vary. We can find the

[5] We could make the model pseudo-dynamic by requiring that the menu costs need to equal the present value of discounted profits lost. However, this exercise would add little of interest to our results.

change in P^C as a function of the change in W and M by exploiting the fact that in equilibrium consumption and production in the competitive sector are equal (see Appendix II).

(3.1) $$p^c = (1-a)m + a$$

where $$w = \frac{dW}{W}; m = \frac{dM}{M}; p^c = \frac{dP^C}{P^C}$$

The elasticity of the nominal wage with respect to the money supply is formally obtained from the labour market clearing condition (see Appendix III).

(3.2) $$V_{wm} = \frac{w}{m} = \frac{1 + g(1-a)(1-b)}{g[1-a(1-b)] + \dfrac{a(1-b)}{b(1-m)+a(1-b)}}$$

Note that ζ_{wm} is increasing in α and γ, and $\zeta_{wm} \geq 0$. Hence from (3.1) the elasticity of P^C with respect to money supply is:

(3.3) $$\frac{p^c}{m} = 1 + a(V_{wm} - 1)$$

Clearly, an increase in the money supply increase the competitive price. If α=1 the elasticity collapses to the value found by Dixon and Hansen[6]. If β=1 the elasticity of the wage is equal to $1/\gamma$. When β=0, the elasticity is equal to unity. That is, following a monetary expansion the wage would increase by the same percentage as the money supply and as would P^C (see equation (3.3)). In other words when β=0 money is neutral.

The change in total employment is obtained from total differentiation of the labour market clearing condition

(3.4) $$gl[w-(1-b)p^c] = L^M m + \frac{1}{a-1} L^C (w - p^c)$$

where the LHS is the change in labour supply, and the first and the second term on the RHS are, respectively, the labour demand response in the monopolistic and the competitive sector. L^C and L^M are the long run equilibrium values of employment in the two sectors.

Consumption and production in the competitive sector may increase or decrease. It will increase only if the price of the competitive good increases less than the money supply, i.e. if $V_{wm}<1$. From (3.2) this happens when:

(3.5) $$g > \frac{1-m}{b(1-m)+a(1-b)}$$

It follows that the bigger α the smaller γ needs to be for a monetary expansion to cause an increase in L^C (when α=1 we have the DH case). If the inequality in (3.5) is reversed, then the competitive sector output is crowded out by the increase in the monopolistic sector. We summarise the results in Proposition 1

PROPOSITION 1 *In a closed economy, an increase in money supply that is small enough to prevent price changes in the monopolistic sector leads to:*

(a) nominal wage level increases;
(b) total employment and real wages increase;
(c) employment in the monopolistic sector and consumption of the monopolistic goods increase
in proportion to the money increase;
(d) the value of g relative to the values of a, b and μ determines whether employment in the
competitive sector and consumption of the competitive good decreases or increases.

Proof: (b) can be shown by substituting (3.1) and (3.2) into the LHS or RHS of equation (3.4). (c) derives from (2.8) and (d) from (3.5). ■

As far as point (a) is concerned, which follows from (3.2), there are basically two reasons for nominal wages to increase: firstly the increased demand for output of the monopolistic sector causes the labour demand to increase thereby increasing wages; secondly the price increase in the competitive sector increases the price index *P* inducing the households to claim higher wages.

[6] i.e. $z_{wm} = \frac{1-bm}{gb(1-bm)+1-b}$

3.2. The Impact effect of a monetary expansion on wage and employment in an open economy

With flexible prices the underlying "long-run" equilibria of the open and closed economies are the same in real terms. This is because the assumption of balanced trade in the open economy leads to the condition that domestic production and consumption of the competitive good are equal, as in a closed economy. However with menu costs and a fixed exchange rate, the short-run equilibrium can be different, since the current account can be non-zero with the production and consumption of the internationally traded good diverging. The crucial difference between the closed and open economy is that the aggregate price index P is now fixed, since the law of one price fixes P^C in addition to P^M which is treated as fixed due to menu costs. The elasticity of wage with respect to money supply becomes (see Appendix IV)

(3.6)
$$E_{wm} = \frac{\beta(1-\mu)(1-\alpha)}{(1-\alpha)\gamma\left[\beta(1-\mu)+\alpha(1-\beta)\right]+\alpha(1-\beta)} \geq 0$$

Clearly, for $\beta<1$, this term differs from ζ_{wm}., and is decreasing in α. For $\beta=1$ we have a closed economy and hence $E_{wm}=\zeta_{wm} = 1/\gamma$.

Since E_{wm} is generally strictly positive, the level of labour demand in the export sector will in general *decrease* in response to an increase in the money supply. However, there are 3 special cases where it does not fall:

1) when the labour supply is perfectly elastic ($\gamma\to\infty$);
2) when $\beta=0$, which corresponds to removing the monopolistic sector from the economy. Without this sector there is no channel through which the monetary policy can affect the level of employment (see equation (1.8)) and, in the long run, the level of consumption.
3) when $\alpha=1$ (in this case, though, employment in the competitive sector falls, as explained below).

(3) is the open economy equivalent of the closed economy DH case. It follows from the fact that when α=1 then $P^C=W=eP^*$ and hence W can not change. This implies that even in the short run the labour supply is constant. Using (1.4) the labour supply can be rewritten as follows

$$l = \left(\frac{eP^*}{P^M} \right)^{bg}$$

where all the variables that determine the labour decisions of the households are fixed. Obviously this finding holds whatever assumption is made about the behaviour of the firms producing the non traded goods. In fact since W is fixed there is no incentive for them to change P^M.

As far as the monopolistic sector is concerned employment increases in response to a money supply shock. This follows from the assumed rigidity of P^M as was the case in the closed economy version of the model. This implies that, when α=1, employment in the export sector decreases. In fact total labour supply is constant and labour demand in the competitive sector is not fully met.

PROPOSITION 2. *In the open economy with a fixed exchange rate, the impact effect of an increase in money supply are:*

- *a) consumption of both goods increases proportionately to the increase in money supply;*
- *b) employment in the monopolistic sector increases proportionately to the increase in money supply;*
- *c) employment decreases in the export sector if $b>0$ and it is constant if $b=0$;*
- *d) the current account is negative;*
- *e) foreign currency reserves decrease;*
- *f) increase in total employment, nominal and real wage if the returns to scale are diminishing (i.e., $a<1$);*
- *g) constant total employment, nominal and real wage if the returns to scale are constant (i.e., $a=1$), even in absence of menu costs.*

Proof: (a) follows from (2.8) and (1.2); (b) stems from (2.8); (c) follows from (1.8) and (3.6); (d) and (e) are derived from (a), (c), and (2.9); (f) is obtained from (1.4) and (3.6); (g) is (3) above. ■

4. Private loss and welfare gain in the closed and in the open economy

In the section 3 we saw what the effects where of a monetary *expansion conditional upon the monopolistic price being constant*, presuming that the size of menu costs was sufficient for firms to forbear a change in price. In this section we look at the losses that the monopolistic firms incur by not adjusting prices. These losses can be seen as the size of menu costs needed for price rigidity in the monopolistic sector. The private loss is then compared to the welfare gain obtained through a monetary expansion. Again, we look both at he closed economy (with $\alpha \leq 1$) and compare it to the open economy case.

A The closed economy

Following DH we approximate the loss/revenue ratio for an individual monopolist given that it expects the other monopolists not to adjust, using a second order Taylor expansion around the initial equilibrium. This yields[7]

(4.1) $$\frac{dp_c}{RV} \approx \Phi_c = \frac{1}{2}\left(\frac{1}{m} - 1\right) V_{wm}^2 m^2$$

Φ_c is therefore a measure of the size of menu costs needed for price rigidity in the closed economy.

The consequences of a monetary expansion for welfare are derived using a second order Taylor expansion on the utility function around the initial equilibrium. Hence the response of welfare to an increase in money supply equals (see Appendix V)

[7] For its derivation see Dixon and Hansen (1997), p.12

(4.2)

$$\frac{dU_c}{C} \approx \Omega_c = \left[b + a(1-b)(1-V_{wm})\right]m - \frac{1}{2}b(1-b)\left[a(1-V_{wm})-1\right]^2 m^2$$
$$-g\left[b(1-m)+a(1-b)\right]\left\{\left[b + \left[a(1-b)-1\right](1-V_{wm})\right]m + \frac{1}{2}\left[b + \left[a(1-b)-1\right](1-V_{wm})\right]^2 m^2\right\}$$

<u>B The open economy</u>

In the open economy the loss/revenue ratio is

$$\text{(4.3)} \qquad \frac{dp_o}{RV} \approx \Phi_o = \frac{1}{2}\left(\frac{1}{m}-1\right)E_{wm}^2 m^2$$

Since the production function for the monopolistic sector has not changed, (4.3) has the same form as (4.1).

Note that in the open economy the elasticity E_{wm} is decreasing in α, so that loss/revenue is decreasing in α

$$\frac{\P\Phi_o}{\P a} \leq 0$$

The welfare gain function has two different forms according to whether the competitive production function exhibits constant returns to scale (α=1) or diminishing returns to scale (α<1) (see Appendix VI). When α<1, the welfare gain function is

(4.4)

$$\frac{dU_o}{C} \approx \Omega_o = m - g\left[b(1-m)+a(1-b)\right]\left(E_{wm}m + \frac{1}{2}E_{wm}^2 m^2\right) + (1-b)\left(\frac{a}{a-1}E_{wm}-1\right)m + \frac{a(1-b)}{2(a-1)^2}E_{wm}^2 m^2$$

whilst for α=1 we have:

$$\text{(4.5)} \qquad \frac{dU_o}{C} \approx \Omega_o = mb\ m$$

It should be noted that (4.4) and (4.5) account for the decrease in foreign currency reserves that is induced by a monetary shock (see Proposition 2 (e)). So while in (4.2) only consumption and labour response are considered, in (4.4) and (4.5) the response of the real value of the foreign currency reserves (*R/P*) relative to real GNP is added (see

Appendix VI). When α<1 the second order approximation of the response of *R/P* relative to real GNP is given by

$$\frac{dR}{PC} = (1-b)\left(\frac{a}{a-1}E_{wm} - 1\right)m + \frac{a(1-b)}{2(a-1)^2}E_{wm}{}^2 m^2 \quad (4.6)$$

where e*dR* is the change in net export, or, equivalently, the change in foreign currency reserves (valued in terms of the home currency) induced by an increase in money supply. When α=1, we have

$$e\frac{dR}{PC} = m(mb-1) \quad (4.7)$$

Both expressions are negative and indicate that foreign currency reserves diminish when the money stock increases. In the long-run the reduction in the foreign exchange reserves exactly equals the initial increase in the money supply (since current account balance requires M=M*). Note that (4.7) holds as long as β<1. For β=1, in fact, there is no consumption of the traded good and hence no outflow of foreign currency.

5. The consequences of a monetary shock in closed and open economies: a comparison

The key difference between the open and the closed economy is the behaviour of the competitive sector price. In the open economy it is fixed in nominal terms by PPP; any difference between domestic demand and supply is met by imports/exports. In the closed economy it moves freely to equate domestic supply and demand. We will now trace through consequences of a monetary shock in these two settings.

Comparing the elasticity of wages with respect to the money supply in the closed economy (3.2) with the open economy (3.6) we have for all parameter values

$$V_{wm} \geq E_{wm} \quad (5.1)$$

When β<1 the inequality is strict, so that the wage response to an increase in money supply is higher in the closed economy than in the open. This difference reflects the fact that in the open economy the price of the (traded) competitive good is fixed. Since the price in the monopolistic sector is assumed to be rigid in both cases, it follows that the price index increases in the closed economy whilst it is unchanged in the open. Hence nominal wages increase solely to accommodate the increased demand for labour coming from the monopolistic sector. The two elasticities coincide when β is equal to 1, when the competitive sector is absent.

Note that for β=0, the elasticity in the open economy is 0 while in the closed economy is equal to 1. Though these outcomes may appear opposite, they actually state the same thing; i.e., monetary policy can not affect the level of employment. For employment in the competitive sector to be constant wage rigidity is needed in the open economy because the price of the traded good is fixed (see equation (1.8)). On the contrary wage flexibility is needed in the closed economy because the price of the competitive good increases in response to a money shock (see equation (3.3)). Nonetheless while consumption can not increase in the closed economy it will in the open through a deficit in the balance of trade.

Note that since $V_{wm} \geq E_{wm}$, from (4.1) and (4.3):

$$\Phi_o \leq \Phi_c \tag{5.2}$$

The above inequality stems from the fact that the increase in W caused by an increase in M is smaller in an open economy, so that the gap between the optimal ratio W/P^M and the actual value of W/P^M after a money stock increase is smaller. Hence the loss/revenue ration is smaller in the open economy case.

Since P^M is fixed and the monopolistic sector's good is not internationally traded, employment in the monopolistic sector and consumption of its goods increase in the open economy in the same way as they do in the closed economy. However, consumption of the competitive good increases more in the open economy because its price is fixed, whilst P^C is increasing in the closed economy. Employment in the competitive sector always decreases in the open economy, since eP^* is fixed and W increases. In the closed economy employment in the competitive sector can be either increasing or decreasing depending on γ. However if there is a reduction this is always smaller than in the open economy. In fact the change in L^C in the open economy is given by

(5.3) $$dL_o^C = L^C \frac{1}{a-1} E_{wm} m$$

and in the closed economy by

(5.4) $$dL_c^C = L^C (1 - V_{wm}) m$$

using (3.2) and (3.6) it can be shown that

(5.5) $$(1 - V_{wm}) > \frac{1}{a-1} E_{wm}$$

This implies that if there is a reduction in L^C in response to an expansive monetary policy this is smaller in the closed than in the open economy. Note that (5.3) and (5.4) imply that the size of the change in employment in the competitive sector depends directly on the technology (α) in the open economy while it does not in the closed one.

Since the employment in the monopolistic sector increases equally in the two economies, it follows that total employment, and therefore real wage, increase more in the closed economy.

PROPOSITION 3. *Following a monetary shock, the short run equilibrium in the closed economy has with respect to the short run equilibrium of the open economy where eP^* is fixed, the following features:*

(a) higher nominal wage;
(b) larger private loss;
(c) equal employment level in the monopolistic sector and equal consumption level of the monopolistic sector's goods;
(d) higher employment level in the competitive sector;
(e) lower level of consumption of the competitive sector's good;
(f) higher total employment and real wage levels;
(g) lower total consumption.

Proof: (a) follows from (5.1); (b) stems from (5.2); (c) follows from (2.8) and (1.3); (d) derives from (5.5); (e) follows from (3.3), (3.2), (1.2); (f) stems from (c), (d), and (1.4); (g) stems from (c) and (e). ■

6. A numerical example

The Table on next page shows the consequences of an increase by 5% of the money supply in terms of welfare gain and private loss for different parameter values. The last two columns show the ratios

$$\Psi_c = \frac{\Omega_c}{b\Phi_c}$$

$$\Psi_o = \frac{\Omega_o}{b\Phi_o}$$

which are used to compare welfare gain with private costs in the two settings. The numerator is the total welfare gain; the denominator the private cost. Note that the private cost is weighted by β, since only a proportion β of industries incur the private cost. Hence Ψ_i indicates how large the welfare gain is relative to the private cost.

If we compare the private loss in columns Φ_c and Φ_o then as expected the menu costs needed for price rigidity are larger in the closed economy than in the open one for any given value of the parameters where $\beta<1$. Indeed, in the case of $\alpha=1$ the private loss is zero in the open economy case. As α increases, both Φ_c and Φ_o decrease, reflecting the diminishing marginal productivity in the competitive sector.

If we compare the two columns Ω_c and Ω_o, we can see that the welfare gain is consistently larger in the open economy, though the difference is not remarkable. It is slightly increasing in α in the closed economy (when $\gamma>0$, constant when $\gamma=0$) and increasing in α in the open economy ($\gamma=0$, 0.2) or slightly decreasing ($\gamma=2$) . As a consequence the ratio between welfare gain and private loss relative to GNP is always larger in the open economy.

Note that for any value of γ, when $\alpha=1$ welfare in the open economy case is increasing whilst no private loss occurs. Hence the ratio of private loss to welfare gain is infinite. Since total employment and real wage are fixed, the welfare improvement is in this case obtained simply by shifting labour from the competitive sector to the monopolistic sector, i.e. by producing more of the high value and less of the low value good. This reverses the misallocation caused by the mark-up in the monopolistic sector, although only at the cost of a loss in currency reserves.

As an illustration, Figure 1 shows the open and closed economy welfare gain and private loss functions for γ=0.2 and μ=0.5 as β increases. All schedules are upward sloping. Hence the closer the economy is to the symmetric industrial structure (β=1) the bigger are welfare gain and private loss. The open economy welfare gain function (OWG) lies constantly above the corresponding closed economy curve (CWG) in the same way as the open economy private loss schedule (OPL) lies beneath the closed economy private loss curve (CPL). The distance between the two welfare gain functions reaches a peak as β approaches 1 before collapsing to zero when β=1. Similarly the difference between CPL and OPL becomes large for high values of β.

In Figure 2, γ=2: here the difference between OWG and CWG tends to fade away, while CPL becomes decreasing in β (Figure 2). In general, increases in γ tend to shift the private losses schedules to the right reducing the level of menu costs needed for price rigidity. Increases in α shift the private loss curves to the right as well, while the only way they affect the welfare gain schedules is by increasing the maximum gap between OWG and CWG.

7: Conclusion

In this paper, we have extended DH in two directions: first we have allowed for a more general technology in the competitive sector, so that there can be diminishing returns; second we have opened upo the economy to allow for trade in the competitive sector good. We have then compared the behaviour of the open and the closed economy versions of the model.

The original interest in menu costs was to explain nominal rigidities. The fundamental issue was how large did menu costs need to be in order to lead to nominal rigidities and how large was the welfare gain likely to be relative to the menu costs? The initial literature used a representative sector closed economy model with a perfectly competitive labour market. The conclusion of this literature was somewhat negative: menu costs would need to be large relative to welfare gains unless the labour supply were unrealistically high. One possible response was to drop the assumption that labour markets are competitive (as in Ball and Romer (1990)). In this paper we have kept the comeptitive labour market, but instead open up the economy. We have found that in an open economy menu costs can be small relative to the welfare gains even with a low or zero labour suppply elasticity. The reason for this is two-fold: first, as in DH there is a reallocation effect; second, there is an additional open economy feature that the traded good price is fixed in nominal terms by the law of one price. Both of these features lead to a larger scope for menu costs in explaining nominal rigidities.

There are of course further extensions of the model that can be developed. Most interesting would be to develop an explicitly dynamic setting and a richer dynamic financial structuree e.g. bonds, modelling capital mobility). Whilst these developments are of course desirable, they would change the model in such a way that a direct comparison with the existing literature is not possible.

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Table 1 - Conseq uences of m=5%

1a) γ=0

β	μ	α	Ω_c	Ω_o	Φ_c	Φ_o	Ψ_c	Ψ_o
1	μ	any	0		∞		0	
0.5	0.5	1	1.1797	1.2500	0.2813	0	8.3889	∞
		0.75		1.2708	0.3472	0.0035	6.7950	732.000
		0.5		1.2813	0.5000	0.0313	4.7188	82.000
		0.25		1.3126	1.1250	0.2813	2.0972	9.3333

1b) γ=0.2

β	μ	α	Ω_c	Ω_o	Φ_c	Φ_o	Ψ_c	Ψ_o
1	0.25	any	0.7813		9.3750		0.0833	
0.5		1	0.5436	0.6250	0.8318	0	1.3069	∞
		0.75	0.5414	0.6628	1.0086	0.0194	1.0735	68.4333
		0.5	0.5371	0.6644	1.3667	0.1350	0.7859	9.8426
		0.25	0.5230	0.6552	2.3992	0.7416	0.4360	1.7671
0.5	0.5	1	1.1889	1.2500	0.2127	0	11.1806	∞
		0.75	1.1874	1.2674	0.2499	0.0030	9.5045	856.750
		0.5	1.1850	1.2695	0.3262	0.0217	7.2659	117.000
		0.25	1.1785	1.2697	0.5590	0.1338	4.2163	18.9833

1c) γ=2

β	μ	α	Ω_c	Ω_o	Φ_c	Φ_o	Ψ_c	Ψ_o
1	0.25	any	1.2031		0.0938		12.8333	
0.5		1	0.5902	0.6250	0.1519	0	7.7730	∞
		0.75	0.5863	0.6338	0.1913	0.0059	6.1292	216.333
		0.5	0.5817	0.6236	0.2337	0.0172	4.9776	72.4259
		0.25	0.5766	0.6150	0.2871	0.0387	4.0166	31.7449
0.5	0.5	1	1.2219	1.2500	0.0450	0	54.3056	∞
		0.75	1.2183	1.2549	0.0571	0.0010	42.6968	2429.50
		0.5	1.2139	1.2500	0.0703	0.0035	34.5278	720.000
		0.25	1.2090	1.2451	0.0882	0.0093	27.4161	267.833