Booms and Busts

in EMU

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A floating exchange rate combined with a clear inflation target can be a powerful stabilizer even if there are fluctuations in exchange rates that are unrelated to current fundamentals,. Under plausible conditions, most of the stabilisation will occur through the exchange rate, and fundamental shocks will generate considerable medium term exchange rate volatility. The consequences of asymmetric shocks inside EMU are worse than envisaged in early analyses of the EMU project such as Calmfors et al. (1997). Inflation and real interest rate differentials arise which magnify the imbalances and cause boom-bust cycles in the member countries.

1. Introduction

Sweden recently voted no to the euro, but several other countries are facing the choice whether to join EMU in the near future. The traditional starting point for analysis of EMU is the theory of optimal currency areas. According to this scheme of analysis, membership in a monetary union brings efficiency gains on the microeconomic level, but macroeconomic costs associated with the loss of monetary autonomy. When you cannot pursue a monetary policy which is appropriate for the specific country, macroeconomic stability is harder to maintain.

This trade-off between microeconomic gains and macroeconomic losses is often questioned by economists who argue that the value of monetary autonomy is exaggerated in the conventional analysis. Sometimes it is even claimed that the macroeconomic arguments might be in favour of monetary union. The reason why one can come to such a conclusion is exchange rate volatility. In the conventional Mundell-Fleming model, exchange rates respond to fundamental shocks in such a way that they help to stabilize output and inflation. But in reality, exchange rates are very volatile and the uncovered interest parity condition - a key ingredient in conventional macroeconomic models - fails miserably in econometric estimation. With excessive and irrational volatility, a flexible exchange rate may be a source of instability rather than a shock absorber, it is said.

Another argument is that the central banks of small countries with floating rates and supposedly independent monetary policies often move their interest rates in line with their big neighbours. What is the value of an independent monetary policy if, much of the time, you set the same interest rate?

In this paper I use a simple model of the Mundell-Fleming type to make three arguments. First, a model of this type is consistent with the broad stylized facts of international macroeconomics. With imperfect competition in goods markets, non-clearing and non-integrated labour markets, nominal wage rigidity, persistent supply and demand shocks, and some noise in exchange rates, we should expect the high volatility of real and nominal exchange rates and the failure of uncovered interest parity that we observe in the data.

Second, even if there are substantial movements in exchange rates that are unrelated to current fundamentals, a flexible exchange rate coupled with a clear inflation target can be a very powerful stabiliser. Under plausible conditions, most of the stabilisation will occur through the exchange rate rather than the interest rate, so small interest rate differentials do not imply that there is little stabilization.

Third, the consequences of asymmetric shocks in EMU are worse than envisaged in early analyses of the EMU project such as Calmfors et al. (1997). Asymmetric shocks, which are not counteracted by fiscal policy, will lead to inflation differentials and real interest rate differentials between the countries, which magnify the imbalances. The result is boom-bust cycles in the member countries. Persistency of supply and demand shocks adds to the problem and the key factor that makes this a more serious problem in Europe compared to the US is the low labour mobility between European countries.

Inspiration to this paper comes partly from Bergvall (2002a) who examines the stabilizing role of alternative exchange rate systems, and the recent papers by Honohan and Lane (2003) on inflation differentials in EMU and Sinn (2003) on the current problems in Germany.

In the next section I present the theoretical framework that is used in the analysis. In Section 3 I consider the situation outside the monetary union with a floating exchange rate and inflation targeting. Two extreme cases are considered, first when demand and supply shocks are temporary, then the more realistic case when shocks are very persistent. In Section 4 I analyse what happens when the small country joins a large monetary union. A theoretical and empirical comparison of the situations inside and outside EMU is made in Section 5 and the role of fiscal federalism and labour and product market integration are discussed in Section 6. Section 7 concludes.

2. A Mundell-Fleming Model

The perspective taken here is that of a small open economy considering whether to join a large monetary union. Trade with countries outside the monetary union is disregarded in the formal analysis. Since the focus is on asymmetric shocks creating imbalances in the small

country, variables relating to the monetary union are taken to be constant.[1] The theoretical framework is a simple Mundell-Fleming model, intended to be relevant for the medium term, say 1-6 years. To make the arguments as clear as possible, the model is kept simple (disregarding lags etc.) and the period in the model should be thought of as one or two years.

Credit markets are assumed to be perfectly integrated and the uncovered interest parity condition is a key equation in the model.[2] Labour is assumed to be immobile so there are completely separate labour markets. Product markets are characterised by imperfect competition and purchasing power parity (PPP) does not hold. One reason is that goods are differentiated so that prices of goods produced in different countries can deviate from each other. But even if the goods are similar, imperfect information implies imperfect competition and deviations from the law of one price. A key insight from search models of the product market is that imperfect information makes a market, which would otherwise be perfectly competitive, similar to monopolistic competition.

Customer relations are another reason why the medium term price elasticity of exports and imports is modest. When customers respond slowly to changes in costs and prices, relative prices can deviate for substantial periods before there are major effects on market shares.[3] On the empirical level, it has long been well known that there are substantial and persistent deviations from the law of one price even for similar traded goods - see references in Gottfries (1986) and Rogoff (1996).[4]

The model includes an IS-curve (1), an interest parity condition (2), a Phillips curve/aggregate supply relation (3), an expectations scheme (4), and autoregressive shock processes (5)-(7):

$$y_t = \beta(e_t + p^* - p_t) - \gamma(i_t - \pi_{t+1}^e) + d_t \tag{1}$$

$$i_t = i^* + E_t(\Delta e_{t+1}) + u_t \tag{2}$$

$$\pi_t = \pi_t^e + \alpha(y_t - \bar{y}_t) \tag{3}$$

$$\pi_t^e = \pi^0 + \lambda(\pi_{t-1} - \pi^0) \tag{4}$$

$$d_t = \rho_y d_{t-1} + \varepsilon_t^d \qquad\qquad \rho_y < 1 \tag{5}$$

$$\bar{y}_t = \rho_y \bar{y}_{t-1} + \varepsilon_t^y \tag{6}$$

$$u_t = \rho_u u_{t-1} + \varepsilon_t^u. \qquad\qquad \rho_u < 1 \tag{7}$$

i is the nominal interest rate in the small country and i^* is the interest rate in the monetary union. All other variables are in logs; y is production, p is the price *of nontradable goods*, π is inflation $(p_t - p_{t-1})$, π^e is expected inflation, e is the nominal exchange rate (the price of the currency of the monetary union), p^* is the price level in the monetary union, and $\bar{y}$ is the natural level of output.[5]

Some microeconomic foundations for wage and price setting and the effect of the real exchange rate on aggregate demand are given in the appendix. Full dynamic optimization on the demand side would imply that national wealth (net claims on foreigners) would become a state variable and I would have to resort to numerical simulation to solve the model. To keep the model analytically solvable, I simply assume that real spending is a function of a demand shock, d_t, and the expected real interest rate.

I use a simple backward looking specification of expectations (4) where π^0 is the inflation target, which is also the average level of inflation. This specification may be

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[5] The monetary union is large relative to the home country and the prices of tradable and nontradable goods are the same in the monetary union.

criticized for lacking microeconomic underpinnings but the question how to model inflation expectations is a matter of intense research and controversy and there is considerable evidence of a "backward-looking" element in the inflation process (see e. g. Mankiw 2001). This so-called "inflation persistence" problem is dealt with in various ways in the literature on monetary policy. Some authors introduce "rule of thumb" price-setters, Mankiw and Reis (2002) formulate a model where individuals update their information only occasionally, and Ball (2000) considers a model where individuals use optimal univariate forecasts for inflation. To keep the model simple, I postulate the backward-looking expectations scheme (4) with λ as a measure of inflation persistence.

The demand shock, d, represents "animal spirits", pension reforms, and other factors affecting aggregate demand. The aggregate supply shock is a shock to the natural level output caused by changes in technology, labour supply, or structural changes in the labour market.[6] All shocks are allowed to be autoregressive. For notational convenience, the autoregressive parameter is assumed to be the same for the demand and the supply shock.

The shock to the interest parity condition, u, can represent irrational movements in the exchange rate due to bubbles, noise traders etc. but it could also reflect completely rational variations in confidence. If, for some reason, there is increased uncertainty concerning future monetary and fiscal policy, international investors will require a higher risk premium when lending to the country. The result will be either a higher interest rate or a depreciated exchange rate.[7] In the following, I use the term "confidence shock" for this shock.

Note that if the exchange rate is expected to be unchanged and there is no confidence shock the interest rate will be the same as abroad and the real exchange rate, which is consistent with output being at its natural level, is:

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[6] Standard supply side shocks (technology, labour supply etc.) are shocks to potential output. Oil price increases and tax changes may affect the price level without much effect on potential output. Such shocks are disregarded here. Central banks often allow such factors to cause temporary deviations of inflation from the target; sometimes they use price indices which exclude them.

[7] Formally we can imagine that a shift to a more inflationary monetary policy regime occurs with some small probability and that investors estimate this probability based on political variables outside the model. Then we will see variations in the risk premium even if there is no actual change of regime in the sample period. Such a "peso problem" can cause variations in u_t even if investors are risk neutral.

$$e_t + p* - p_t = \frac{1}{\beta}\left(\bar{y}_t - d_t + \gamma i*\right).$$ (8)

When shocks occur, relative price changes are necessary in order to maintain macroeconomic balance and the magnitude of the necessary adjustment of the real exchange rate depends on the parameter β. In order to get an idea how large β may be we have to consider the effect of the real exchange rate on imports and exports. The price elasticity of imports is relatively low. First, many imported goods are not produced in the home country. Cars are not produced in Denmark, Norway or Finland, and bananas are not produced in Sweden. For such goods, import demand is simply market demand for the product. If, for example, consumers have Cobb-Douglas preferences the price elasticity of import demand will be unity and the share of nominal expenditure spent on imported goods will be constant. In cases when there are domestic producers, customer relations and supply constraints limit medium term changes in their market shares. If domestic producers have a relatively small share of the market, the price elasticity of imports will still be close to the price elasticity of market demand. In fact, the price elasticity of import demand is often found to be around to unity in empirical studies (Goldstein and Kahn 1985).

On the export side, we would expect a larger elasticity.[8] But as discussed above, product differentiation and customer relations limit the price elasticity over the medium term. Conventional estimates of the medium term price elasticity of exports are around 1.5-2 but they are likely to suffer from downward bias as discussed in Gottfries (2002). We must also take account of the fact that there is less than full pass-through (pricing to market) so only a fraction of a change in the real exchange rate (measured in terms of nontradables or unit labour costs) feeds through into the relative price of tradables.[9]

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[8] Suppose, for example, that domestic producers have a market share of 10 percent in the domestic and foreign markets and as a result of depreciation of the home currency their market share increases 20 percent, to 12 percent. For given market demand at home and abroad, exports will increase 20 percent and imports will decrease 2.2 percent.
[9] For Swedish and international evidence, see Lundin (2003).

In the appendix I formulate a simple model with imperfect competition and constant expenditure share for imports where β can be calculated as

$$\beta = -E_{XP} E_{PV} \frac{X}{Y}. \qquad (9)$$

E_{XP} is the price elasticity of exports, E_{PV} is the elasticity of the export price with respect to variable cost, and X/Y is exports relative to GDP. In previous work I found that $E_{XP} \approx -3$ and $E_{PV} \approx 0.4$ for Sweden (Gottfries (2002)). Since the export share is about one quarter in value added terms (excluding the import content in exports) we get $\beta = 3 \times 0.4 \times 0.25 = 0.30$.[10] Thus, if domestic demand falls by an amount corresponding to 5 percent of GDP, a real depreciation in the order of 17 percent (5/.30) is required in order to maintain output at its natural level. If, instead, we consider a large country such as the US with an export share around 10 percent we get a lower value for β, so larger real exchange rate movements are necessary in order to maintain macroeconomic balance.

3. Floating Exchange Rate and Inflation Target

Now consider the situation outside the monetary union. I assume that the objective of the central bank is low average inflation and output close to the natural (flex price) level. The central bank has no desire to counteract changes in output caused by changes in technology or labour supply and it does not care about changes in the consumer price index associated with necessary relative price adjustments. To achieve its objective, the central bank adopts an inflation target π^0 in terms of the price of nontradable goods.[11] Since the price level in the monetary union is assumed to be constant, π^0 may be thought of as the difference between

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[10] This number for β is in the range found in empirical work with aggregate data. Bergvall (2002a) estimates the effect of the real exchange rate on aggregate demand and finds elasticities in the range 0.2-0.5.

[11] One may object that most central banks formulate an objective in terms of the consumer price index. The practical difference should not be very large, however, because the medium term impact of the exchange rate on the consumer price level seems to be small.

the inflation target in the home country and that in the monetary union. The instrument of monetary policy is the interest rate.

I focus on a situation when monetary policy outside the monetary union has the same average level of credibility as monetary policy inside.[12] To keep the model simple, I assume that the central bank can observe the shocks and react to them, and thus keep actual inflation equal to the target $\pi_t = \pi^0$ in every period. In such a regime, equation (4) implies that $\pi_t^e = \pi^0$ and (3) implies:

$$\pi_t = \pi^0 + \alpha(y_t - \bar{y}_t) = \pi^0. \tag{10}$$

Inflation targeting implies that production is kept at its natural level $y_t = \bar{y}_t$. Substituting the aggregate demand relation (1) we get

$$\gamma(i_t - \pi^0)i_t - \beta(e_t + p* - p_t) = d_t - \bar{y}_t. \tag{11}$$

The left hand side is a linear combination of the real interest rate and the real exchange rate and may be thought of as a monetary conditions index.[13] This monetary conditions index is set in such a way as to balance supply and demand shocks. In order to solve for the exchange rate, use (11) to substitute for i_t in the interest parity condition (2) and $p_t = p_{t-1} + \pi_t$:

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[12] As discussed above, confidence shocks may be interpreted as temporary fluctuations in credibility. It is very hard to see why credibility should be an argument for forming monetary unions, at least if the union involves countries on a similar level of development. If country A has a more credible monetary policy than country B it must be because country A has a better institutional framework for monetary policy (a more independent central bank, a clearer goal for monetary policy etc.). Then it makes more sense for country B to copy the monetary policy framework of country A than to give up monetary policy in order to get a credible regime. For this reason, Calmfors et al. (1997) saw little reason why there would be a long run credibility gain – and lower interest rates - if Sweden joined the EMU. Still, the credibility argument and the associated interest rate differential have remained popular in the debate over the costs and benefits of joining the EMU.

[13] See Ball (1999) for an open economy model where the policy rule can b expressed in terms of a monetary conditions index.

$$\frac{1}{\gamma}\left[\beta(e_t + p* - p_{t-1}) + d_t - \bar{y}_t + (\gamma - \beta)\pi^0\right] = i* + E_t(\Delta e_{t+1}) + u_t. \tag{12}$$

To find the solution for the exchange rate, I guess that the solution has the form:

$$e_t = p_{t-1} - p* + A + B(d_t - \bar{y}_t) + Cu_t \tag{13}$$

where A, B and C are unknown coefficients. Then the expected future exchange rate is

$$E_t(e_{t+1}) = p_t - p* + A + B\rho_y(d_t - \bar{y}_t) + C\rho_u u_t \tag{14}$$

and the expected change in the exchange rate is

$$E_t(\Delta e_{t+1}) = \pi^0 + B(\rho_y - 1)(d_t - \bar{y}_t) + C(\rho_u - 1)u_t. \tag{15}$$

Substituting into (12) we can verify that the unknown coefficients are:

$$A = \frac{\gamma}{\beta}i* + \pi^0, \quad B = -\frac{1}{\beta + \gamma(1 - \rho_y)}, \quad C = \frac{\gamma}{\beta + \gamma(1 - \rho_u)}. \tag{16}$$

Thus we have the solution of the model in the case of inflation targeting:

$$e_t + p* - p_{t-1} = \frac{\gamma}{\beta}i* + \pi^0 - \frac{1}{\beta + \gamma(1 - \rho_y)}(d_t - \bar{y}_t) + \frac{\gamma}{\beta + \gamma(1 - \rho_u)}u_t \tag{17}$$

$$E_t(\Delta e_{t+1}) = \pi^0 + \frac{1 - \rho_y}{\beta + \gamma(1 - \rho_y)}(d_t - \bar{y}_t) - \frac{\gamma(1 - \rho_u)}{\beta + \gamma(1 - \rho_u)}u_t \tag{18}$$

$$i_t - i^* = \pi^0 + \frac{1 - \rho_y}{\beta + \gamma(1 - \rho_y)}(d_t - \bar{y}_t) + \frac{\beta}{\beta + \gamma(1 - \rho_u)}u_t \ . \tag{19}$$

The implications of the model depend very much on the degree of persistence of the shocks. In order to clarify this, it is useful to examine two extreme cases: when shocks are completely transitory and when they are very persistent.

Temporary Shocks

If all shocks are completely temporary $\rho_y = \rho_u = 0$ and

$$e_t + p^* - p_t = \frac{\gamma}{\beta}i^* - \frac{1}{\beta + \gamma}(d_t - \bar{y}_t) + \frac{\gamma}{\beta + \gamma}u_t \tag{20}$$

$$E_t(\Delta e_{t+1}) = \pi^0 + \frac{1}{\beta + \gamma}(d_t - \bar{y}_t) - \frac{\gamma}{\beta + \gamma}u_t \tag{21}$$

$$i_t - i^* = \pi^0 + \frac{1}{\beta + \gamma}(d_t - \bar{y}_t) + \frac{\beta}{\beta + \gamma}u_t \tag{22}$$

where I used the fact that $p_t = p_{t-1} + \pi^0$. When there is a positive (net) demand shock, the central bank raises the interest rate, and the currency appreciates; the two effects are of equal magnitude and both help to maintain stable production. A confidence shock (positive u) implies a depreciation of the exchange rate but the central bank compensates for this by raising the interest rate so that output is kept stable. In spite of the noise that is present in the exchange rate, monetary policy is able to maintain macroeconomic stability.

In practice, though, one may argue that the case for maintaining an independent monetary policy is much weaker than it appears in this simple model. Monetary policy affects the economy with a *lag*. Empirical studies typically find that it takes about a year for

the full effect on output to occur.[14] If shocks are temporary, there is a considerable risk that the effects of policy arise *after* the shock has disappeared. This is a reason to be sceptical about the usefulness of an independent monetary policy.

Furthermore, confidence shocks may create considerable imbalances between different sectors even if overall macroeconomic balance is maintained. If the currency depreciates due to lack of confidence this creates large profits in the tradable sector while, at the same time, the high interest rate leads to contraction of domestic sectors such as construction.

In the light of equations (21) and (22), tests of the UIP condition may be taken as confirmation that most movements in the exchange rates are unrelated to fundamentals. According to the model, fundamental supply and demand shocks imply that the interest rate is high when the currency is strong and expected to depreciate. Confidence shocks have the opposite effect: the interest rate is high when the currency is temporarily depreciated and thus expected to appreciate. In fact, many studies have found the "wrong" sign of the coefficient for the interest rate when testing UIP; in practice, a high interest rate is a sign that the currency will appreciate rather than depreciate.[15]

Thus, we are lead to conclude that most movements in exchange rates are due to confidence shocks and only a small share is due to fundamentals. Confidence shocks are a nuisance for monetary policy as well as for firms trading in international markets and a major advantage of joining a monetary union is that irrational movements in exchange rates are eliminated. The case for joining a monetary union appears to be strong.

But this reasoning is based on the assumption that shocks are temporary. The conclusions will be quite different if we take shocks to be very persistent and this case is examined below.

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[14] The most convincing evidence of such a lag comes from estimated VAR models where innovations in the policy instrument (money, monetary base or the interest rate) are interpreted as exogenous policy shocks. An early study along these lines was Blanchard (1989); for a recent overview, see Christiano-Eichenbaum-Evans (1999).

[15] These tests typically consist of estimating regressions of the type $e_{t+1} - e_t = \alpha + \beta\left(i_t - i_t^*\right) + \varepsilon_{t+1}$ and testing whether β is equal to unity.

Persistent Shocks

The business cycle is not a sinus curve which automatically returns to the mean after a given time. As emphasised by Romer (2001), business cycles vary considerably in size and length. In fact, many macroeconomic variables appear to be non-stationary but stationary in differences. This is an important insight from the last 20 years of empirical research on macroeconomic time series. Often, it is hard to say whether variables are really non-stationary or stationary around some deterministic trend, but if there is reversion to the mean it is often so slow that one cannot reject non-stationarity. This applies to production but also to consumption, real and nominal exchange rates, and many other variables.[16] Since observed variables are ultimately driven by supply and demand shocks it seems plausible to think of the underlying supply and demand shocks as also being very persistent.[17]

If we think of what lies behind supply and demand shocks, a high degree of persistence also seems plausible. One intended effect of a pension reform would typically be to increase the national savings rate and this necessarily translates to a persistent decrease in domestic demand. On the supply side, a structural change in the labour market will affect the natural rates of employment and output; again we would expect this change to be very persistent.

Countries do not export the same goods and exogenous changes in terms of trade in the world market may also be included in the demand shock. If we had included countries outside the monetary union and allowed for differences in the exposure to exchange rates and demand from countries outside the monetary union, we would have had another source of shocks to aggregate demand.[18] In both cases, data tells us that the shocks tend to be quite persistent.

We may also consider less fundamental reasons behind demand and supply shocks. There appear to be large swings in consumption and investment associated with moods and "animal spirits". In some periods there is a lot of optimism and when some firms

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[16] For example, Alexius and Nilsson reject stationarity of the real exchange rate (long run PPP) for 11 out of 13 OECD countries.

[17] In fact, this is the idea in "common trends" models which take observed variables as being linear functions of unobserved common trends.

[18] This reason for imbalances is emphasised by Honohan and Lane (2003).

and consumers spend they generate business and increased optimism for other firms and consumers. When firms go bankrupt they bring other firms and financial institutions with them. Thus there are reinforcing factors, which amplify booms and recessions, and it seems plausible that these processes can go on for some time if they are not halted by fiscal or monetary policy.

Thus it seems much more plausible that ρ_y is close to unity than that it is close to zero. To highlight the role of persistence, consider the limit case when $\rho_y \to 1$.[19] Then equations (17)-(19) become:

$$e_t + p* - p_t = \frac{\gamma}{\beta} i* - \frac{1}{\beta}(d_t - \bar{y}_t) + \frac{\gamma}{\beta + \gamma(1 - \rho_u)} u_t \qquad (23)$$

$$E_t(\Delta e_{t+1}) = \pi^0 - \frac{\gamma(1 - \rho_u)}{\beta + \gamma(1 - \rho_u)} u_t \qquad (24)$$

$$i_t - i* = \pi^0 + \frac{\beta}{\beta + \gamma(1 - \rho_u)} u_t. \qquad (25)$$

If the inflation target is the same as the inflation rate in the monetary union $(\pi^0 = 0)$ and there are no confidence shocks, changes in the nominal exchange rate are unpredictable, the nominal and the real exchange rate are random walks, and they are perfectly correlated. In a Keynesian world with much volatility in demand and little volatility in supply we will observe considerable exchange rate volatility, but little variation in inflation and output.[20] As discussed in Section 2, a plausible value of β implies that there will be considerable variation in the real and nominal exchange rate.

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[19] Formally, demand and supply cannot be independent random walks but variations in national savings rates can be very persistent. I look at the case when $\rho = 1$ only to highlight the role of persistence.

[20] If we add a conventional money demand equation we may note that the interest rate is constant and thus the real money supply will be proportional to output.

If we add confidence shocks we can explain the perverse results sometimes obtained in tests of the UIP relation. As before, the central bank will react to lack of confidence by increasing the interest rate and this will generate a negative correlation between the interest rate differential and the expected appreciation of the exchange rate.[21]

Alexius (2001) and Meredith and Chinn (1998) find that the uncovered interest parity hypothesis fairs better when tested for long-term financial investments. Typically the coefficient for the interest rate differential gets the right sign, but it is smaller than unity. This is exactly what we would expect if demand and supply shocks are more persistent than confidence shocks.

With highly persistent demand and supply shocks, the above model is consistent with the observed high volatility, unpredictability, and persistence of nominal and real exchange rates, and the close correlation between them. Also, it is consistent with substantial deviations from the "law of one price" for tradable goods and the observation that prices of different goods inside a country are more correlated than prices of similar goods sold in different countries (Engel and Rogers 1996).

An interesting observation is that when shocks are very persistent, stabilisation of real shocks occurs primarily via the exchange rate; the interest rate is used mainly to counteract what is seen as irrational or excessive exchange rate movements.

With persistent shocks and some variation in confidence, the model is consistent with major stylized facts in international macroeconomics. It also implies that a flexible exchange rate and a clear inflation target help to maintain macroeconomic stability. Lags in the implementation and effects of policy have been disregarded, but if shocks are highly persistent this is much less of a problem. Then policy will be useful even if the effect takes some time.

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[21] This argument has some similarity with that of McCallum (1994) in that the central bank reacts to shocks to the UIP relation, but his model is different and based on interest rate smoothing. Fama (1984) pointed out that a small or negative coefficient in test of UIP means that the variance of the "risk premium" is larger than the variance of the expected change in the exchange rate. When exchange rate changes are (almost) unpredictable, this condition is easy to satisfy (see discussion in Alexius (2002)).

But to see exactly the value of having an independent monetary policy we must compare to the situation when the small country joins the large monetary union and this is the topic of the next section.

4. Membership in the Monetary Union

The common currency simplifies for business trading with other countries in the union. Firms can avoid costs for exchanging currencies and uncertainty about the value of the euro relative to the home currency. Thus one should expect a positive effect on trade with other members of the monetary union. Early studies point to increases in trade in the order of 10 percent due to EMU (Micco, Stein and Ordonez (2003), Flam and Nordström (2003)). For a small open economy such as Sweden, this would imply that exports and imports, which today constitute about 40 percent of GDP, would increase by an amount corresponding to 4 percent of GDP. Increased exchange of goods and services would bring gains from increased specialization, economies of scale etc. More trade and increased comparability of prices should induce some equalisation of prices in some markets.

But a Volvo is not the same thing as a BMW even if they are both purchased with euros. Customer relations and established networks are important in many markets and this will not change because we use euros. There will be some increase in trade and competition along the borders etc. but price differences caused by differences in productivity, wages and taxes will not disappear because of the common currency.

Calmfors and Johansson (2002) have argued that nominal wage flexibility should increase when a country joins a monetary union. But nominal wage rigidity seems to be pervasive in developed countries with low inflation rates, so we should expect considerable nominal rigidity to remain.

Thus I will use the same model to analyse what happens when the small country joins the monetary union, but we can think of the parameter values as being somewhat different. When the country is inside the monetary union $e_t = 0$ and $i_t = i^*$, and average inflation is assumed to be zero

$$\pi_t = \lambda \pi_{t-1} + \alpha \left[d_t - \gamma(i^* - \lambda \pi_t) + \beta(p^* - p_t) - \bar{y}_t \right]. \tag{26}$$

Using the fact that $p_t = p_{t-1} + \pi_t$ we can solve for the inflation rate:

$$\pi_t = \frac{\alpha(\beta p^* - \gamma i^*)}{1 + \alpha\beta - \lambda\alpha\gamma} + \frac{\alpha}{1 + \alpha\beta - \lambda\alpha\gamma}(d_t - \bar{y}_t) + \frac{\lambda}{1 + \alpha\beta - \lambda\alpha\gamma}\pi_{t-1} - \frac{\alpha\beta}{1 + \alpha\beta - \lambda\alpha\gamma}p_{t-1} \tag{27}$$

If shocks to demand and supply are temporary $\rho_y = 0$ and there is no inflation persistence $\lambda = 0$ we will have some temporary variations in output and inflation. As discussed above, it is not clear that those variations could be effectively countered by monetary policy outside the monetary union. But in the case of persistent shocks we get prolonged periods with high or low inflation relative to the average in the monetary union. Inflation persistence (λ) magnifies the imbalances arising from asymmetric shocks. The real interest rate becomes low in an inflationary boom and high in a deflationary recession.[22] But periods of high inflation will not last forever; when prices have increased enough, the process is reversed because the export industry loses market shares. The result is boom-bust cycles with periods of high and low inflation.

In the previous section I argued that high persistence of demand and supply shocks is plausible, consistent with the facts, and helps to resolve the UIP puzzle. Such persistence also adds to the severity of the problems in the monetary union. As discussed in Section 2, real exchange rate adjustments are necessary when there are persistent changes in demand and supply, and in a monetary union these adjustments can only occur via inflation differentials. In fact, inflation differentials are the adjustment mechanism in a monetary union, but with inflation persistence we are likely to get overshooting, with booms followed by busts, and conversely.

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[22] This mechanism was pointed out by Walters (1986) in the case of fixed exchange rates and is discussed by Svensson (1994) in the context of the ERM crisis.

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5. Comparing stability inside and outside

The most important prediction of the analysis is that there will be larger deviations from the natural level of output inside the monetary union. Outside, shocks are stabilised; inside the imbalances are amplified by the common monetary policy. Year to year volatility of output need not be larger, but there will be long periods during which output is above or below the natural level. As a consequence, there will be persistent inflation differentials within the monetary union.

Obviously, the model presented here is very simplified. By allowing the central bank to respond to all shocks it gives an exaggerated picture of the potency of monetary outside the monetary union. But the main conclusion should be quite robust theoretically. Even if we would introduce some unobservable shocks and control errors - the qualitative conclusion will be the same as long as the central bank can respond to some shocks. When real shocks are very persistent it seems plausible that the central bank does have ability to counteract them.

One case when the conclusion may be overturned is if there are substantial confidence shocks (u_t) and the central bank is unable to counteract them. Obviously, day to day volatility in the exchange rate cannot be counteracted by monetary policy, but such volatility can hardly threaten macroeconomic balance either. But the central bank should be able to detect longer term mispricing of the exchange rate, which threatens macroeconomic stability.[23]

A backward-looking Phillips curve was assumed because of its simplicity and apparent consistency with observed inflation persistence. But the main mechanism does not rely on inflation persistence. With forward-looking pricing à la Taylor-Calvo, it will still be the case that periods of high demand will be associated with high inflation and low real interest rates in the monetary union. The main difference is that inflation would stop immediately when the boom ends, so the problems would be less severe.

We now have data for the first four years of monetary union in Europe and we may ask whether the outcome so far supports or contradicts the analysis. The main difficulty

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[23] In a more elaborate model, Nyberg (2003) shows that the central bank should care more about the exchange rate the more persistent confidence shocks may be.

that we face when we try to test the main prediction is the problem of measuring the natural level of output. With persistent shocks that affect the natural level of output, and persistent deviations from the natural level inside the union, trend extrapolations will be a crude measure of potential output. Estimates of the natural rate of unemployment are notoriously unreliable.[24]

In view of this measurement problem it may be more useful to look at inflation. First, price stability is a policy objective in itself, and second, variations in inflation are an indication that output is, or has been, deviating from the natural level (c. f. equation (3)). What is problematic according to my analysis is persistent deviations in inflation from target. For this reason I have calculated average inflation rates during the first four years of EMU for the euro countries and five countries with floating exchange rates and explicit inflation targeting (*Table 1*). I use two measures of inflation: the consumer price index and the GDP deflator. The consumer price index is relevant for consumers but the GDP deflator is more relevant for domestic producers. As an indication of domestic imbalance (see equation (3)) prices of domestic production may be more relevant than consumer prices, which are affected by indirect taxes, oil prices, exchange rates, and import prices.

We see immediately that inflation differs more between countries inside the EMU, particularly if we measure inflation using the GDP deflator. By this measure, the difference between the highest and lowest inflation in EMU is 4.2 percent; the corresponding difference for the inflation targeting countries is 1.4. As a consequence, real interest rates differed from 3 percent for Germany to minus one for Ireland.

Two countries appear to have been particularly affected by the common monetary policy in this period: Ireland and Germany. Some key data or these countries are shown in Table 2.

As Ireland joined the monetary union, the interest rate was cut from 6 to 3 percent and this, together with a sinking euro, fuelled the boom that was already underway.

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[24] From 1995 to 2003 wages in Germany grew on average 1.5 percent annually, inflation (GDP deflator) was 0.9 percent, average GDP growth was 1.3 percent, and unemployment was high. With downward nominal wage rigidity as in Holden (1994, 2003) and Akerlof-Dickens-Perry (1996) it is possible that the German economy has been on the flat part of the long run Phillips curve for a long time. In such a situation, data for actual output contains very little information about potential output.

In the first five years 1999-2002, Ireland has had 7 percent wage increase per year and 4.5 percent inflation compared to 2 percent wage and price increases for the euro area. The real interest rate has been negative 5 of the last 6 years and property prices have soared.

In Germany, the downturn that started in 2001 has been magnified by a too high interest rate and a rising euro. As Germany went into a crisis, the euro rose some 20 percent against the dollar. The European Central Bank is not cutting its interest rate much because some other countries, such as Ireland, have relatively high inflation. Germany has a number of specific problems, including those in former East Germany, but the situation is not made better by having a too high interest rate. Wage growth and inflation have been very low in Germany so there was ample room for expansionary demand management, but expansionary monetary policy has not been possible because Germany has lost control over monetary policy.

These imbalances have not gone unnoticed. Economists watching developments in the euro area have noticed them (Gaynor et. al. 2002). Honohan and Lane (2003) describe the imbalances in Ireland:

 "What went wrong for Ireland and is it a harbinger of the likely prospects for the accession countries? We argue that, in addition to domestic factors, EMU itself has contributed to the surge in Irish inflation. EMU did remove a potentially effective instrument of policy restraint (nominal exchange rate adjustment). Furthermore, by lowering nominal and real interest rates, EMU added an important demand fillip, especially manifested in soaring house prices. And the inflationary impulse, exceptionally strong for Ireland, that was generated by euro weakness in the early years of the system might well have bee offset by an appreciation of the Irish pound within the wide EMS band that was in effect from 1993-1998."
and Sinn (2003) writes about Germany:
"... the euro is causing adjustment problems for Germany and is constraining Germany's economic policy. This situation shows surprising parallels with that of Japan."
These statements are not statements against the euro, but observation what has happened in Ireland and Germany.

The Taylor rule is a well known rule of thumb for monetary policy. It says that the interest rate should depend on inflation and the output gap and a key element in the Taylor

rule is that the coefficient on inflation should be substantially larger than unity. The intuition is that if inflation has increased, it is likely inflation expectations have also increased. In order to get a contraction of aggregate demand, the nominal interest rate must rise more than inflation so that the expected *real* interest rate increases.

The coefficient for inflation in the Taylor Rule is typically set between 1.5 and 2.5. Since the inflation differential between Ireland and Germany has been almost 4 percentage points, the inflation differential alone would have motivated a 6-8 percentage point interest rate differential between the two countries. If we would take account of the output gap (which is hard to measure) we would get an even bigger difference. A recent application of the Taylor rule made by economists at the Swiss Banking Group UBS suggested that Ireland should have had an interest rate of 6-7 percent while Germany basically needed a zero interest rate (Sunday Telegraph 24 August 2003).

Is it meaningful to apply the Taylor rule to countries within a monetary union? Well, Germany is still Germany and Ireland is still Ireland even if they use the same currency. We may look at inflation, unemployment and growth in these countries and ask approximately what interest rate would have been set under a floating exchange rate. Admittedly, this is a very hypothetical exercise, but it does give us some indication of just how wrong the common interest rate is for these countries. The answer is that it is very wrong.

6. Fiscal Policy, Labour Mobility, and Product Market Integration

When the suitability of Europe as a currency area is discussed, comparisons are often made with the United States. Two differences have typically been highlighted: fiscal federalism and labour mobility. Recent discussions have put more focus on product market integration. How important are these three factors and the differences between the US and Europe?

Fiscal Federalism:

The federal budget is much larger in the U. S. than in the European Union and federal taxes imply an automatic redistribution between growing and contracting states, which does not exist in Europe. Sala-i-Martin and Sachs (1992) and Bayoumi and Masson (1995) found that

the federal budget offsets 30-40 percent of income changes in individual US states. On the other hand, most European states have relatively large public sectors and high taxes compared to the U. S. and therefore the automatic stabilizers are typically stronger in Europe than in the U. S. Unless we believe in complete Ricardian equivalence, fiscal policy could, in theory, perform a similar stabilizing role as the federal budget does in the United States.

On the other hand, fiscal stabilisation of "shocks" is not always desirable. One purpose of a pension reform would be to increase the national savings rate and this necessarily translates to a decrease in domestic demand. If investment opportunities improve, it does make sense to exploit them, and to finance some of the new investment by borrowing abroad.

Even if stabilisation is desirable, and fiscal policy can do the job much of the time, there are likely to be periods when fiscal policy is not very successful, and sometimes fiscal policy is a source of shocks because changes in the fiscal stance are motivated by politics rather than economics. Maybe there existed some feasible fiscal policies for Ireland and Germany, which, if pursued, had helped them to avoid the current imbalances. Did the governments in Ireland and Germany pursue those policies? Obviously, the answer is no.

In the case of Germany, the problems with the stability pact must be seen in the context of general macroeconomic developments. A consequence of large welfare states and automatic stabilizers is that government deficits are quite cyclical in the European countries. A recession implies lower tax revenues and much of the cost of rising unemployment falls on the government. Whether such deterioration is desirable is less clear. If government finances are in order, swings in the deficit are not a problem but help to stabilise the economy. But when government finances are weak, increasing deficits may create uncertainty about the sustainability of government finances and this may have negative effects on consumption and investment. Giavazzi and Pagano (1990, 1996) argue that in such situations, fiscal policy may even have the opposite effect to what it has in conventional Keynesian models. The effect of fiscal policy is hard to judge in a specific situation, but what does seem clear is that fiscal policy is an unreliable tool when government finances are already weak.

The stability pact is often criticized for putting to harsh constraints on fiscal policy. It should be remembered, however, that the stability pact was not intended as a day-

by-day regulation of fiscal policies in the member countries of the EMU. The philosophy in the Maastricht Treaty was that the member countries would be capable of pursuing suitable fiscal policies for their countries. The rules concerning deficits and debt levels were only intended as minimum requirements preventing serious mismanagement of government finances. The fact that so many countries have ended up being constantly constrained by these rules shows that the view taken in Maastricht was too optimistic. Fiscal policy is not always managed in the best way and it does not always suffice to stabilise the economy.

The Labour Market

In their classical study of regional adjustments in the US, Blanchard and Katz (1992) showed that much of the adjustment to job losses in U. S. states takes the form of workers moving between states. Labour mobility is much smaller between European countries so an important adjustment mechanism is lacking in Europe. A less well-known result in the study by Blanchard-Katz is that very little of the adjustment to regional shocks occurs via wages. Wages do not fall much in depressed states. A plausible interpretation is that the U. S. labour market is reasonably well integrated so that firms must pay similar wages to keep their best workers.

The situation in Europe is very different. With almost no labour mobility between countries, wages can differ substantially, and there can be long periods during which wages rise faster in one country. This difference between the US and Europe is illustrated in *Figure 1*, where the upper panel shows the distribution of US states with respect to *total* wage increases over the 1998-2002 period. The figure shows that 11 states had a 15 percent wage increase, 9 states had a 14 percent wage increase and so on. On the low side, Michigan had a 10 percent wage increase and on the high side Massachusetts had a 20 percent wage increase. The lower panel shows the corresponding distribution for the euro area. Germany and Italy had 9 percent wage increase over the period, while Ireland had a 28 percent wage increase, followed by Portugal with 21 percent. Greece (22 percent) is not included since they joined EMU later. The US and the euro area have similar size in terms of population. The US is divided into 51 states and the euro area is divided into 12 countries. If the economic structures were similar in the two areas, we would expect the averaging effect to bring wage

increases in European countries closer to each others compared to US states. In fact, the difference between the highest and the lowest wage increase is twice as large for the euro area.

An argument which has often been made in the Swedish discussion is that membership in the monetary union would imply a new discipline for wage setters. Once we would join the monetary union, wage setters would realise that wages need to rise "in pace with Europe". There are two problems with this argument. First, and as shown above, adjustments of relative wage and price levels are necessary and for this reason wage increases "in pace with Europe" is not a sustainable norm in a monetary union. Such a norm may work for a while, but it is likely to break down when a big asymmetric shock occurs. Second, evidence on "inflation persistence" in the Phillips curve suggests that wage and price setters are relatively backward looking and hence they are unlikely to take account of potential future cost crises. An overheated labour market leads to wage increases as firms bid for workers independent of its long run consequences and warnings by the government.

Product Market Integration

In his paper "The Purchasing Power Parity Puzzle" Rogoff (1996) concluded that:

> *"International goods markets are highly integrated, but not nearly as integrated as domestic goods markets. This is not an entirely comfortable conclusion, but for now there is no really satisfactory alternative explanation of the purchasing power parity puzzle."*

My analysis is completely different. Imperfect competition in product markets is a key element in the model, but no claim has been made that international markets are fundamentally different from domestic markets. Products are differentiated and customer relations are important in the home market too. But prices of German cars are likely to be more closely correlated than the prices of Volvos and BMWs because German car makers have to pay similar wages to their workers.[25]

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[25] For example, Engel and Rogers (1996) examine disaggregated consumer price indices for cities in the US and Canada. They show that relative price levels between cities in the same country vary much less than relative prices between cities situated in different countries.

7. Conclusion

The model presented here is clearly stylised. By allowing the central bank to respond to all shocks it gives an exaggerated picture of the potency of monetary policy outside the monetary union. But the qualitative conclusions are likely to be robust theoretically and the model is consistent with a number of basic macroeconomic facts such as the persistence of movements in output and consumption, large and persistent movements in real and nominal exchange rates, close correlation between real and nominal exchange rates, lack of predictability of the exchange rate except in the long run, and inflation persistence. Since a model with imperfect competition fits these facts much better than models with perfect competition and PPP (or only small deviations from PPP) it seems more relevant to use for policy analysis.

The main new insight, drawing on work by Honohan and Lane (2003), is that the problems caused by asymmetric shocks are worse than we foresaw before EMU started. In studies such as Calmfors et. al. (1997), the main focus of the analysis was on the risk of shocks and how to stabilise demand shocks at some given sticky price. What we failed to foresee was the consequences when asymmetric shocks are *not* stabilised: inflation differentials that magnify the imbalances.

Key ingredients in the analysis are lack of labour market integration, so wages can differ substantially between countries, imperfect competition in goods markets, making relative price adjustments necessary, and persistent supply and demand shocks. High persistence of shocks is plausible, consistent with the facts, helps to resolve the uncovered interest parity puzzle for floating exchange rates, and leads to persistent imbalances inside the monetary union.

One money does not make one perfect market - but one money works better if there is already one labour market. In the absence of a high degree of labour market integration, the common interest rate may lead to boom-bust cycles in the member countries. There is no such thing as a perfect exchange rate system. Confidence shocks are a conundrum under floating exchange rates. Undeniably, there is noise in exchange rates; but a floating exchange rate and a clear inflation target may still be a powerful pair that maintains macroeconomic balance.

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Table 1. Inflation and interest rates inside and outside EMU. Averages 1999-2002.

|	Inflation			Interest rate	Real interest rate		
	Hourly earnings	GDP deflator	CPI		GDP deflator	CPI	
Euro Countries:							
Germany	2.1	0.8	1.4	3.7	2.9	2.3	
France	3.9	1.2	1.4	3.7	2.5	2.3	
Austria	2.6	1.2	1.8	3.7	2.5	1.9	
Belgium	2.5	1.5	1.9	3.7	2.2	1.8	
Finland	4.0	1.7	2.1	3.7	3.0	1.6	
Luxembourg	3.1	-	2.2	3.7	-	1.5	
Italy	2.3	2.3	2.4	3.7	1.4	1.3	
Netherlands	3.5	3.5	3.0	3.7	0.2	0.7	
Spain	3.2	3.7	3.1	3.7	0.0	0.6	
Portugal	4.5	4.0	3.3	3.7	-0.3	0.4	
Ireland	6.5	4.6	4.2	3.7	-0.9	-0.5	
Max-min	*5.4*	*3.8*	*2.8*	*0.0*	*3.8*	*2.8*	
Inflation targeting countries:							
Sweden	2.9	1.3	1.6	3.8	2.5	2.2	
New Zealand	3.2	1.8	1.9	5.7	3.9	3.8	
Canada	2.1	1.9	2.3	4.3	2.4	2.0	
GBR	4.1	2.3	2.0	5.1	2.8	3.1	
Australia	3.7	2.7	3.3	5.2	2.5	1.9	
Max-min	*2.0*	*1.4*	*1.7*	*1.9*	*1.5*	*1.9*	

Notes: Inflation and interest rates are averages for the period. Source: OECD Main Economic Indicators.

Table 2. Ireland and Germany in the First Years of Monetary Union

	1997	1998	1999	2000	2001	2002	2003	**1999-2003**
Ireland:								
wage growth	5.9	0.7	5.5	8.4	9.0	7.0	5.0	**7.0**
inflation	4.1	6.2	4.1	4.3	5.3	4.9	4.0	**4.5**
interest rate	6.1	5.4	3.0	4.4	4.2	3.3	2.3	**3.4**
interest - inflation	2,0	-0,8	-1,1	0,1	-1.1	-1.6	-1.7	**-1.1**
GDP growth	10.9	8.8	11.1	10.0	6.0	6.0	3.2	**7.3**
Germany:								
wage growth	0.0	1.0	1.4	2.0	2.2	1.5	2.4	**1.9**
inflation	0.7	1.1	0.5	-0.3	1.4	1.6	0.8	**0.8**
interest rate	3.2	3.5	3.0	4.4	4.2	3.3	2.3	**3.4**
interest - inflation	2.5	2.4	2.5	4.7	2.8	1.7	1.5	**2.6**
GDP growth	1.4	2.0	2.0	2.9	0.6	0.2	0.3	**1.2**

Notes: Wage growth: percentage change in the wage rate of private/business sector. *Inflation:* percentage change in GDP deflator, used to measure inflation from the point of view of producers. *Interest rate:* short term. Interest minus inflation measures the expected real interest rate if you expect the same inflation as last year. Numbers for 2003 are OECD projections. Source: OECD Economic Outlook database. The table is adapted from Gottfries (2003).

Figure 1. The Disparity of Wage Increases in Europe Compared to US States

Wage Increases in US States 1998-2002

Wage Increases in Euro Countries 1998-2002
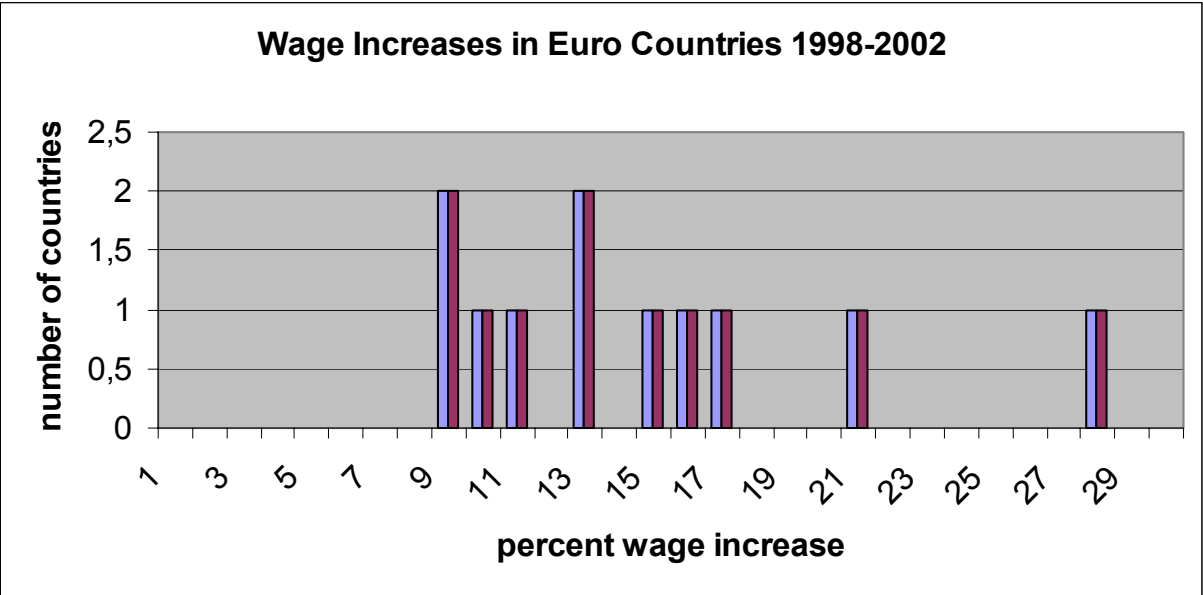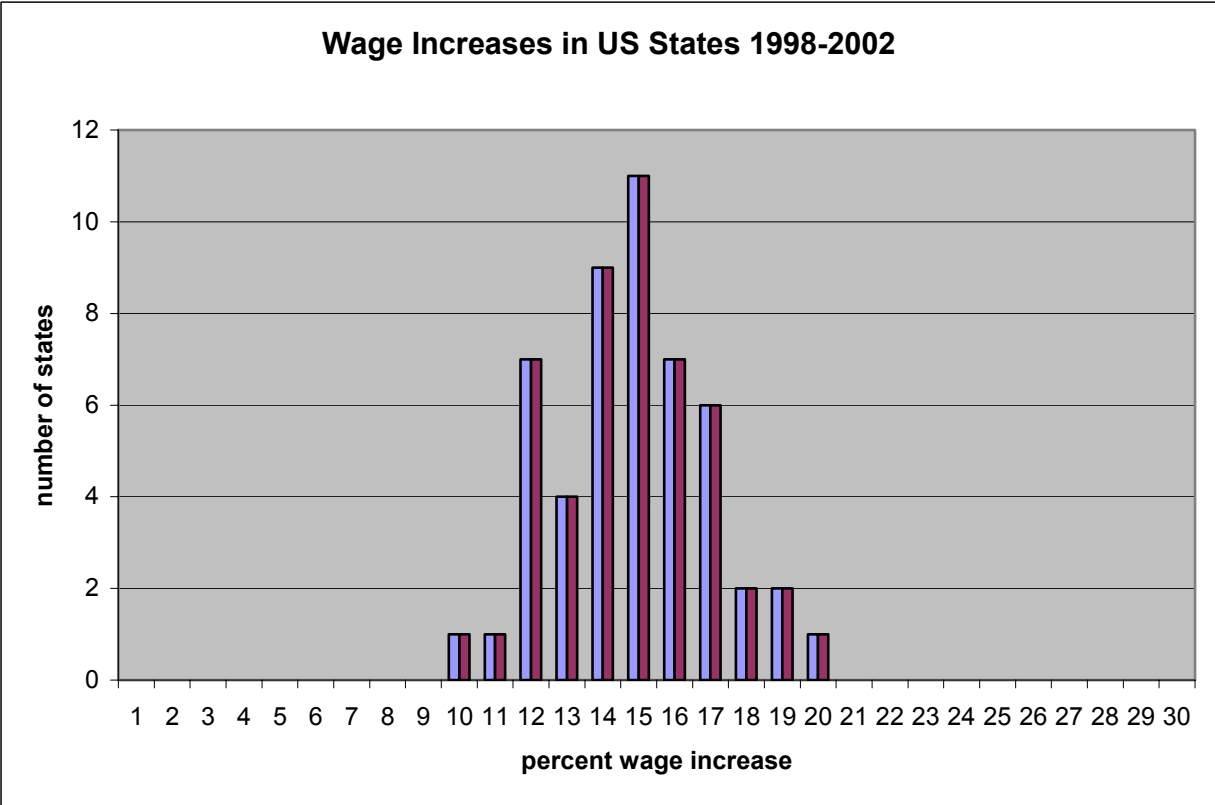
Sources: US: Average annual pay in the private sector from Bureau of Labor Statistics.
Europe: Hourly earnings from OECD, Main Economic Indicators.

Appendix. Market Structure, Wages, Prices, Exports, and the Real Exchange Rate

Wage and Price Setting and the Phillips Curve

Product markets are characterized by monopolistic competition. There is a large (fixed) number of firms indexed i. Some firms produce nontradables and some produce for the export market. To simplify, I assume that domestically produced tradables are not consumed at home. The production function is the same for all firms:

$$Y_i = AN_i \tag{A1}$$

where A is productivity and N_i is employment in firm i. Demand facing firm i is

$$Y_i = \left(\Phi - \varphi \frac{P_i}{P_m} \right) D \tag{A2}$$

where P_i is the price charged by firm i. The relevant market price, P_m, and market demand, D, are taken as exogenous by the individual firm. To model wage setting, I use a simple efficiency wage model where turnover cost depends on the relative wage set by the firm and on the level of employment relative to the labour force: $cW(W_i/W)^{-\sigma}(N/L)^{\delta} N_i$. Thus profit of firm i is written as:

$$P_i Y_i - W_i N_i - cW\left(\frac{W_i}{W}\right)^{-\sigma}\left(\frac{N}{L}\right)^{\delta} N_i = \left[P_i - \frac{W_i}{A} - c\frac{W}{A}\left(\frac{W_i}{W}\right)^{-\sigma}\left(\frac{N}{L}\right)^{\delta} \right]\left(\Phi - \varphi\frac{P_i}{P_m}\right)D. \tag{A3}$$

The first order conditions with respect to the wage and price imply optimal wage and price:

$$\hat{W} = (c\sigma)^{\frac{1}{\sigma+1}}\left(\frac{N}{L}\right)^{\frac{\delta}{\sigma+1}} W, \tag{A4}$$

and

$$\hat{P} = \frac{\Phi}{2\varphi} P_m + \frac{1}{2} V_i \tag{A5}$$

where V_i is variable cost: $V_i = \frac{W_i}{A} + c\frac{W}{A}\left(\frac{W_i}{W}\right)^{-\sigma}\left(\frac{N}{L}\right)^{\delta}$. Using lower case letters to denote logs and allowing for the actual wage of the representative firm to depend on the *expected* wage level we get[26]

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[26] Firm have correct information about employment but may have incorrect expectations about the wage level. This is a shortcut for a more elaborate model with explicitly predetermined wages.

$$w = w^e + \alpha_0 + \alpha(n - \ell) \tag{A6}$$

where $\alpha_0 = \ln(c\sigma)/(\sigma+1)$ and $\alpha = \delta/(\sigma+1)$, or, equivalently:

$$w = w^e + \alpha(n - \bar{n}) \tag{A7}$$

where $\bar{n}$ is the natural level of employment: $\bar{n} = \ell - \alpha_0/\alpha$. In the market for nontradables, all firms charge the same price, so

$$P = \frac{\varphi}{2\varphi - \Phi} V \tag{A8}$$

and

$$p = \ln\left(\frac{\varphi}{2\varphi - \Phi}\right) + v = \ln\left(\frac{\varphi}{2\varphi - \Phi}\right) + w - a + \ln\left(1 + c\left(\frac{N}{L}\right)^\delta\right). \tag{A9}$$

Assuming, as above, that firms have correct expectations about technology and employment, but may have incorrect expectations about wages, we get $p - p^e = w - w^e = \alpha(n - \bar{n})$. Since $y = a + n$ we can write

$$p = p^e + \alpha(y - \bar{y}) \tag{A10}$$

where $\bar{y} = a + \bar{n}$ is the natural level of output.

Exports, the Real Exchange Rate, and Aggregate Demand
Exporting firms are assumed to be small in the foreign market and set the same price

$$P_x = \frac{\Phi}{2\varphi} EP^* + \frac{1}{2} V, \tag{A11}$$

where EP^* is the foreign price of tradable goods expressed in domestic currency. For later reference, note that the elasticity of the export price with respect to variable cost is $E_{PV} = \dfrac{V}{2P_x}$. Aggregate exports are then

$$X = \left(\Phi - \varphi \frac{P_x}{EP^*}\right) Y^*, \tag{A12}$$

where Y* depends on the number of exporting firms and world demand, both of which are taken as exogenous. The price elasticity of exports is $\text{E}_{XP} = -\dfrac{\varphi Y * P_x}{EP * X}$. Using (A8) we can write exports as a function of the real exchange rate:

$$X = \left(\frac{\Phi}{2} - \frac{\varphi}{2}\frac{V}{EP*}\right)Y* = \left(\frac{\Phi}{2} - \frac{2\varphi - \Phi}{2}Q^{-1}\right)Y*, \tag{A13}$$

where $Q = EP*/P$. Let Z denote the nominal value of domestic spending and assume that consumers have Cobb-Douglas preferences between nontradables and tradables and spend a fraction λ on foreign goods. Then we get aggregate demand for domestic output as

$$Y = (1-\lambda)\frac{Z}{P} + \left(\frac{\Phi}{2} - \frac{2\varphi - \Phi}{2}Q^{-1}\right)Y*. \tag{A14}$$

The elasticity of aggregate demand with respect to the real exchange rate is:

$$\beta = \frac{dY}{dQ}\frac{Q}{Y} = \frac{(2\varphi - \Phi)Y*}{2QY} = \frac{\varphi Y * P_x}{EP * X}\frac{(2\varphi - \Phi)P}{2\varphi P_X}\frac{X}{Y} = \frac{\varphi Y * P_x}{EP * X}\frac{V}{2P_X}\frac{X}{Y} = -\text{E}_{XP}\,\text{E}_{PV}\frac{X}{Y}. \tag{A15}$$

Assuming that real spending Z/P is a function of a demand shock and the expected real interest rate and taking a log linear approximation, we get the IS curve in the text.