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Summary:
The introduction of the Euro has considerably affected the *de facto* monetary policy autonomy – defined as statistical independence from monetary policy in the key currency areas – in countries outside the European Currency Union. Using a standard open economy framework we argue that *de facto* monetary policy autonomy has significantly declined for countries that dominantly trade with the ECU and slightly increased that dominantly trade with the Dollar-Zone. The predictions of our model find support in the data. We estimate the influence of the Bundesbank/ECB's and the Fed's monetary policies on various country groups. The *de facto* monetary policy autonomy of both non-Euro EU-members and EFTA countries declined with the introduction of Euro. This effect was slightly stronger for the EU member countries than for EFTA countries as our theory predicts. At the same time, the de facto monetary policy autonomy of Australia and New Zealand vis-à-vis the US Dollar has (moderately) increased. This finding also supports our theoretical model.

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Fear of Floating and the External Effects of Currency Unions

1. Introduction

The introduction of the Euro exerted a strong influence on monetary and fiscal policies in the Eurozone countries.[1] Yet, the influence of the Euro on monetary policies does not stop at the borders of these twelve countries. Indeed, there are good theoretical reasons to believe that the rise of the Euro has not only altered the rules of the game on international financial markets but also the decisions of monetary authorities around the world. We will argue that countries that trade significantly more with the Eurozone countries than with the USA now increasingly and more closely align with the monetary policy of the European Central Bank. At the same time, countries that typically trade more with the USA than with Eurozone countries experienced a moderate increase in de facto monetary policy autonomy. We define de facto monetary policy autonomy as independence from monetary policy in the key currency areas.

We develop this logic in a partial equilibrium open-economy framework. Our theoretical argument unfolds in three major steps:

The first step is standard: We adopt a classic rational expectations model, in which monetary policy can be used by the monetary authority to offset the employment effects of an unexpected economic shock.[2] In the second step, we 'open' the economy and allow exchange-rate fluctuations affecting the domestic inflation rate. Monetary policy can reduce exchange-rate affects, but with one policy instrument for two economic goals – stabilization of employment and reduction of the import of inflation – the monetary authorities face a dilemma. This part of our model draws on the "fear of floating" literature (Calvo and Reinhart 2002), which has provided ample evidence for the argument that not only pegged countries but also non-pegged countries lack monetary autonomy because monetary policy is used to stabilize the exchange-rate to a key currency (Shambaugh 2004; Calvo and Reinhart 2002, Frankel et al. 2002). In

[1] While all EU countries are members of the European Currency Union, only twelve of the 25 EU countries have abandoned their national currency and introduced the Euro. Eurozone countries include Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, and Spain. In 2007, Slowenia will become the 13th country of the Eurozone.

[2] Franzese (2002) provides a comprehensive review of the political economic literature of electoral and partisan cycles.

our model the incentive to use soft pegs – that is to stabilize an officially floating currency – results from the inflationary effects of exchange-rate depreciations. A reduction of the real interest rate differential to key currencies leads to a depreciation of the domestic currency and – in turn – to an increase in the prices of imported goods.[3] Since an increase in inflation lowers government support, monetary authorities especially in small open economies have an incentive to stabilize the exchange-rate (Calvo and Reinhart 2002: 391). Accordingly, many countries which are formally floating, "de facto are 'importing' the monetary policy of the major-currency countries." (Frankel et al. 2002: 3)

In the third step, we augment the "fear of floating" literature by allowing for more than one key currency. With competing key currencies, the local currency of the country which reduces its interest rate depreciates against both currencies. The direction of currency outflows determines the relative strength of this depreciation: the domestic currency depreciates more relative to the key currency which attracts a relatively larger inflow of capital. Since the importance of the US Dollar as major currency has declined relative to the Euro, the exchange-rate effect for a country that seeks to offset a decline in consumption, employment and economic growth should now be smaller than before the introduction of the Euro, while the depreciation relative to the Euro should be larger than it was relative to the Deutsche Mark.

We then employ this model to analyze how the emergence of the Euro as a key currency has influenced the *de facto* monetary policy autonomy of outside countries. We show that whether a country's monetary policy autonomy increased or declined depends on the relative value of its imports from the Euro-zone and Dollar-zone. Countries that primarily import goods and services from the Dollar-zone, gain in monetary policy autonomy, since the overall inflationary push of a given change in the real interest differential will decline. The opposite is true for countries that import most goods and services from the Euro-zone. In this case, the inflationary stimulus of a change in the interest differential has increased after the introduction of the Euro. Countries that predominantly import goods and services from the Euro-zone should have observed a decline in their *de facto* monetary policy autonomy, while countries that import mostly from the Dollar-zone should have experienced a small increase in *de facto* monetary policy autonomy.

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3 This holds if corporations pass-through the exchange-rate effect to the consumers. See Shambaugh 2005 for convincing evidence that exchange-rate pass-through is common.

The introduction of the Euro provides the natural (and currently, we believe, the only feasible) test case for our theory.[4] We test the predictions of our model in various ways: First, we study whether non-EMU European countries more closely align their monetary policy to the Euro interest rate implemented by the European Central Bank. Specifically, we analyze the influence of the European Central Bank's monetary policy on the interest rate policies of the three EU members, who did not join the Euro, namely the United Kingdom, Sweden, and Denmark. Second, we demonstrate that the influence of US monetary policy on the interest policy of those three countries has gradually declined since the introduction of the Euro. Third, we compare the Euro's effect on the monetary policy of these three countries to its effect on the monetary policy of EFTA countries (Norway, Switzerland, and Iceland). While the distance of the EFTA countries to the Eurozone's center of gravity is similar to the EU countries', the EFTA countries import relatively less from the Euro-zone (and more from the Dollar-zone) and they are politically less involved with the EMU. Fourth, we provide evidence for our model's prediction that countries which trade far more with the US than with the Euro zone (Australia and New Zealand) have gradually gained in monetary policy autonomy. And fifth, we show that Canada – a country that has maintained a fixed exchange-rate peg with the US Dollar until 2001 – does not experience any significant changes in monetary policy autonomy.

All these tests provide evidence in favor of our model. We find that the Euro decreased monetary policy autonomy in European countries, and arguably more so in the three non-Euro EU countries than in the EFTA countries. At the same time, the influence of the Fed's prime rate on the interest rate of these countries has declined. We also observe a moderate increase in the de facto monetary policy autonomy of Australia and New Zealand. These four empirical thus do not reject our theory. The fifth test-case[5] provides a comparison to a country for which our model makes no predictions, because Canada until at least November 2000 had de facto fixed its exchange-rate to the Dollar and moved in very narrow bands. Therefore, the Bank of

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[4] We thank an anonymous referee for pointing out to us that our theory may be extended to make predictions on changes on countries monetary policy autonomy if one key currency (partly) replaces another key currency. The replacement of the Pound standard by the Dollar standard would be the obvious example. While this seems to be true, the gradual replacement of one key currency by another one takes much longer and is therefore much more difficult estimate than the stepwise increase in the importance of the Euro relative to the D-Mark. Moreover, the decline of the Pound and rise of the Dollar were historically fostered by the two World Wars and the Great Depression, which makes it even more difficult to isolate the effects our model predicts from other influences on monetary policies.

[5] This test was suggested to us by an anonymous referee.

Canada had to use its monetary policy to defend the exchange-rate rather than to stabilize inflation. The Canadian case nevertheless adds to the confidence we have that the results we find are not spurious but indeed systematically related to the introduction of the Euro rather than for example globalization or financial market liberalization.

2. Monetary Policy Autonomy in Open Economies

Fixed exchange-rates and thus currency unions have crucial advantages. They reduce exchange-rate uncertainty, thereby removing transaction costs to international trade and fostering economic growth (Rose 2000).[6] And since removing exchange-rate pegs is costly, the pegging country may borrow monetary policy credibility from the key currency's monetary authority (Lohmann 1992; Keefer and Stasavage 2002). The flipside of pegged exchange rates is the decline in monetary policy autonomy. Since the monetary authority has to defend the peg, it cannot use monetary policies for domestic policy goals such as the stimulation of consumption and investment: "Under pegged exchange-rates and unrestricted capital flows, monetary policies must track closely those prevailing in the country to which the domestic currency is pegged." (Frankel et al. 2002: 2). This logic was first established by Robert Mundell and Marcus Fleming in the early 1960s (Mundell 1961, 1962, Fleming 1962). The trade-off Mundell and Fleming have constituted still fuels modern political economic explanations of monetary, financial and exchange-rate policies (see inter alia, Bernhard, Broz and Clark 2002; Broz and Frieden 2001; Rogoff 1985, Giavazzi and Pagano 1988, Canavan and Tommasi 1997).[7]

The Mundell-Fleming model is often interpreted dichotomously. Countries either peg there currency or they do not; if they choose to peg, they have no monetary policy autonomy while if they do not choose to peg, they have full monetary autonomy. Broz and Frieden (2001: 322) argue that "pegging (…) has costs. To gain the benefits of greater economic integration by fixing the exchange rate, governments must sacrifice their capacity to run an independent monetary policy."

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6 Eichengreen and Leblang (2003) find no significant and robust relation between pegged currencies and economic growth. Bernhard and Leblang (1999) suggest that countries are more likely to peg their currencies if they had a relatively low growth rate before.

7 This model has also informed the theory of optimal currency areas. Accordingly, different jurisdictions are member of an optimal currency area if trade flows between them are relatively important (there is much to gain from the removal of trade barriers) and if business-cycles are highly synchronized (there is little to lose from surrendering monetara policy autonomy). See McKinnon 1961, 1962; Bayoumi and Eichengreen 1996, 1997.

There cannot be any doubt that this dichotomous view is a useful simplification. However, at times it exaggerates the extent to which the choice of an exchange-rate system in open economies determines monetary policy autonomy. Since pegs come with bandwidths which can be fairly generous, monetary authorities maintain some, albeit limited autonomy over monetary policy. Bernhard, Broz and Clark (2002: 695) therefore correctly point out that the monetary authority of the pegging country "is, *to a large extend*, delegating monetary policy to a foreign central bank." (Emphasis added). It is misleading to assume that a peg *completely* removes monetary autonomy.

In recent years, an important new literature[8] has argued that, in the reverse case, monetary authorities claiming that their exchange-rate floats often follow a "soft peg". In this case, monetary authorities pursue an implicit exchange-rate goal and intervene whenever the exchange-rate deviates too much. The main proponents in this literature, Guillermo Calvo and Carmen Reinhart, have identified two reasons why "countries that say they allow their exchange-rate to float mostly do not." (Calvo and Reinhart 2002: 379). The first is that exchange-rate fluctuations reduce the ability of many countries to borrow on global capital markets. High exchange-rate volatility leads to a risk-premium demand from international investors. To avoid such risk-premiums, governments seek to stabilize their currency's exchange-rate to a key currency or basket of currencies. Secondly and – from our perspective – more importantly, many governments stabilize their exchange-rate to key currencies because of what has been dubbed "exchange-rate pass-through" (Hausmann et al. 2001).

Exchange-rate pass-through has many facets. For instance, in developing countries a depreciation of the domestic currency may lead to an increase in the value of foreign debt to domestic assets (especially where global capital markets prefer denominating debt to a key currency). In such cases, the depreciation of the domestic currency may lead to an increase in the number of illiquid and bankrupt firms (especially banks) (Aghion 2000). In developed countries the effect of a currency's depreciation on the price of imported goods seems to matter more. Monetary authorities are reluctant to let their currency depreciate against the key currencies because they want to maintain domestic price stability.

8 Following the title of an article by Calvo and Reinhart (2002), this literature has been labeled 'fear of floating'.

Over the past few years, abundant empirical evidence has been provided in favor of the "fear of floating" hypothesis. Hausmann et al. (2001: 399) analyze the influence of a change in international prices on domestic prices and find a strong positive effect. Shambaugh (2005) studies the degree to which the devaluation of the domestic currency leads to an increase in the prices of imported goods and finds an almost perfect import price pass-through. Both articles thus lend support to the idea that import prices tend to be set in the producer's currency. As a consequence, currency depreciation pushes inflation upwards. This result is mirrored by recent research of Campa and Goldberg (2005). Distinguishing between short-term and long-term effects of exchange rate pass-through on import prices, they find evidence for both, with the short-term effects being slightly smaller than the long-term effects. Their results also suggest that exchange-rate pass-through is especially high in manufactured goods.

The situation of monetary authorities with floating currencies thus still resembles the Mundell-Fleming trade-off: Central banks face a dilemma between monetary policy autonomy and the desire to avoid import-driven inflation. Yet, the severity of this dilemma does not solely result from the chosen exchange-rate regime but also depends on the size of the country, economic openness, and the extent of exchange-rate pass-through.

Small, open economies import a relatively larger share of their domestic consumption than larger economies. The devaluation of the domestic currency associated with a large exchange-rate pass-through leads to a much larger effect on the inflation rate than a large country would experience in the same situation. Monetary authorities in small open economies have severely limited *de facto* monetary policy autonomy even under a flexible exchange-rate regime. Only large countries issuing key currencies – currencies in which international trade is denominated and capital owners hold their assets – benefit from monetary policy autonomy under flexible exchange-rates.

The "fear of floating" literature provides an extension to the Mundell-Fleming Model rather than a substitute. The main contribution of this increasingly important and influential strand of literature is the notion that monetary policy autonomy of many countries is limited even if they allow their currencies to float. The proponents of a "fear of floating" approach do not argue that the *de facto* monetary policy of floating currencies is lower than the monetary policy autonomy of pegged currencies. Therefore, political economic arguments based on the Mundell-Fleming model are typically still valid but they seem to be overstretched from the perspective of a fear-of-floating framework.

In this article we enrich the fear-of-floating literature and combine it with Alesina at al.'s highly influential work on monetary unions (see Alesina and Barro 2001 and 2002; Tenreyro and Barro 2003) and with Ronald McKinnon's theory on the advantages of large currency areas (McKinnon 1962 and 2004). McKinnon argued the role of key currencies in the global economy *ceteris paribus* depend on the market size of a key currency area, since economic agents tend to favor larger currencies over smaller currencies. Applied to currency unions, this suggests that – everything else being equal – the use of the union's currency by international financial markets is likely to exceed the use of the union members' previous currencies in sum.

The case of the Euro provided support for McKinnon's theory. The importance of the Euro on international financial markets goes beyond the role the Deutsche Mark, French Franc, Dutch Guilder, Spanish Peseta, Italian Lira and smaller currencies jointly had. In fact, the introduction of the Euro brought about competition in the choice of the denomination of bonds, equities, and other financial instruments, which previously had been dominated by the US Dollar. This has resulted in structural changes to international financial markets that have important macroeconomic implications, as well as implications for the monetary policies of countries outside the union (see BIS 2004 and Plümper and Troeger 2006). In the next section, we will provide a formal model which demonstrates under what conditions and how the establishment of a currency union influences the monetary policy of outside countries.

3. Exchange-Rate Regimes, De facto Monetary Policy Autonomy and Currency Unions

We develop our formal model in three steps. In the first step, we adopt a standard textbook version of a rational expectations model of monetary policy with non-partisan governments. Various variants of this model have been suggested in the late 1980s (Cukierman and Meltzer 1986; Rogoff and Sibert 1988; Persson and Tabellini 1990). We follow Persson and Tabellini (2000) and Obstfeld and Rogoff (1998) in assuming that monetary policy is a political instrument, which can be used to offset the unfavorable impact of economic shocks on consumption.

In the second step, we transfer the model into an open economy framework, allowing for capital-flows and exchange-rate effects. This subsection incorporates the common wisdom that the potential for capital flows reduces the efficacy of monetary policy. We find that monetary policy becomes a more costly political instrument if agents can transfer capital into other currencies, as the devaluation of the domestic currency will lead to higher prices of imported goods and thus to higher inflation. This effect increases with the ratio between the consumption of imported goods to the consumption of domestic goods. The model is consistent with the finding that small open economies are less likely to use monetary policy than large closed economies to offset economic shocks or shelter the domestic economy.

The third step discusses the influence of a monetary union on the direction of capital flows and exchange-rate effects. In brief, the relative size of the currency affects the direction of capital flows, because capital owners have a preference for currencies that are in high demand. We implicitly discuss the logic of external effects of currency unions in a three-country model, where one government uses monetary policy to offset an economic shock (country *1*), while the other countries remain unaffected by the shock and maintain stable monetary policies. Accordingly, the capital owners of the first country have a choice between two "safe haven currencies". The direction of capital flows influences the exchange-rate between all three currencies. We will show that stimulating monetary policy is most likely if the country affected by the shock has relatively moderate imports from the country issuing the flight currency. Hence, active monetary policy becomes less likely if capital flows are re-directed to the prime trading partner – as was the case for the European countries that remained outside the Euro-zone after the establishment of the European Monetary Union.

The Basic Framework: Monetary Policy in a Closed Economy

Our model draws on Giavazzi and Pagano's analysis of the anti-inflationary effects of pegged currencies (Giavazzi and Pagano 1988; see also Obstfeld and Rogoff 1996: 648-653). The model is based on a government loss function where both, suboptimal consumption and inflation enter quadratically

$$\mathfrak{L}_t = \left(\bar{C} - C_t\right)^2 + a\,\pi_t^2 \quad . \tag{1}$$

$\bar{C}$ denotes optimal consumption which by definition cannot fall below the actual level of consumption C_t. a is a constant weighting the government's cost of inflation relative to that of suboptimal consumption.[9] Agents rationally expect the inflation

[9] We do not discuss partisan politics here. Note however, that the model is open to allow for a weighting parameter α that varies between parties and across countries. By simply assuming that right parties have a higher α than left parties, we can develop this model to explain partisan differences along the lines suggested by Hibbs (1987). We also do not control for

rate π^e, which is a function of the natural rate of unemployment and the expected monetary policy

$$\pi_t^e = E(\pi|\theta) = E(r^e|\theta) = \pi_{t-1} + E(\Delta r^e|\Delta\theta), \tag{2}$$

where θ represents the natural rate of unemployment and r^e represents the expected monetary policy (expected interest rate) in the absence of an exogenous shock. For simplicity reasons and without loss of generality, we standardize so that $\pi^e - r^e \mid \theta = 0$. Following conventions, E denotes the expectation term. In a two-period model inflation is thus

$$\pi_t = \pi_{t-1} - \kappa \frac{\Delta r}{\Delta\theta} \tag{3}$$

where $\kappa > 0$ is a constant. In this framework, agents adjust their behavior taking all available information into consideration. If governments react more elastically to changes in the natural rate of unemployment when facing an upcoming election, voters will anticipate the electoral business cycle. In turn, monetary policy can create output growth and employment only if the interest rate cut surprises the economic subjects. If economic subjects correctly anticipate monetary policies, monetary authorities have an incentive to set monetary policy according to the non-accelerating inflationary rate of unemployment (NAIRU) (Mankiw 2001; Ball and Mankiw 2003). Thus, the optimal monetary policy stabilizes inflation at acceptable levels while the unemployment rate approaches its natural rate. This does not mean, however, that monetary policy autonomy is useless. Governments may still use it to respond to unexpected economic shocks. Augmenting the government's loss function (equation 1) by the notion of expected inflation and unexpected shocks we get

$$\mathfrak{L}_t = \left[\left(\pi_t - \pi_t^e \right) - C_t + \bar{C} - \varepsilon_t \right]^2 + a\pi_t^2 \tag{4}$$

In equation 4, unanticipated inflation is politically costly, since it sharpens random income redistributions and degrades the allocation signals in relative prices. Equation

partisan effects in the empirical section because partisan influences on monetary policies are uncorrelated with the various stages of European monetary integration we are interested in.

4 includes a term for an idiosyncratic unexpected economic shock to the domestic economy (ε_t), which provides rational (i.e. non-opportunistic and non-partisan) incentives for monetary policy differences across countries. As in equation 1, the term *a* weighs the political cost of inflation relative to that of suboptimal consumption. Lower values of *a* provide governments with higher incentives to use monetary policy. But even if *a* is large many governments use monetary policy to (partly) offset economic shocks (ε_t), with *a* only determining the extend to which governments do so – though whatever the government does, an economic shock will reduce its support. The optimal choice of monetary policy – i.e. the first order condition for optimal inflation – implies to set

$$\frac{\partial \mathfrak{L}_t}{\partial \pi_t} = 2\left[\left(\pi_t - \pi_t^e\right) - C_t + \bar{C} - \varepsilon_t\right] + 2a\pi_t = 0 \quad , \tag{5}$$

which after some simple transformation results in

$$\pi_t = \frac{C_t - \bar{C} + \pi_t^e + \varepsilon_t}{1+a} \quad . \tag{6}$$

Accordingly, optimal inflation is higher if agents expect higher inflation, as well as if the shock is severe, and if actual consumption is closer to optimal consumption. Governments can rationally stabilize employment by responding to unexpected exogenous shocks of size ε. When governments do not bring monetary policies in line with the exogenous shock, consumption decreases while inflation remains constant. Yet, this is not necessarily in the government's interest. Since both consumption and inflation enter the loss function quadratically, the government is better off if inflation increases moderately and consumption declines moderately rather than either inflation increases strongly or consumption declines in the size of the shock. In other words: the best reaction is to partly offset the economic shock. The exact extent to which the government offsets exogenous shocks depends on the weight *a* (the lower a, the more governments react to exogenous shocks). If $a = 0$, governments completely eliminate the impact of the shock on consumption and if $a = \infty$ the monetary authority will not react at all. As equation 3 reveals the use of monetary policy (thus cutting the interest rate) in any case increases inflation: $\partial \pi_t / \partial r_t < 0$.

This setup resembles the workhorse model for monetary policy and it has often been used by political economists (Persson and Tabellini 1990, 2000, Obstfeld and Rogoff 1996: 648-652). In what follows, we leave the beaten tracks and augment the model in a way which allows the discussion of monetary policies in open economies – that is, in the next step we open the economy by introducing capital flows and exchange-rate effects.

Monetary Policy in Open Economies

The argument that governments in small open economies have lower incentives to offset the effect of exogenous shocks is well established in political economic research. In short, if a government relaxes monetary discipline while having to deal with an exogenous shock, it will not only stimulate the domestic economy but also provide an incentive for capital exports (which is matched by an increase in the imported goods and services). Hence, the stimulating effect of "cheap money" is partly absorbed abroad and this part is larger the smaller the domestic economy is relative to the rest of the world. In other words, monetary policy is less efficient the smaller and the more open the domestic economy is. We can easily add this insight to our model.[10] Without loss of generality, it is most convenient to model the inflationary push of lax monetary policy as a consequence of the exchange-rate effect multiplied by economic openness. This view is consistent with empirical evidence. For instance, David Romer (1993) finds robust support for the hypothesis that more open countries tend to have lower inflation rates.

Allowing for exchange-rate effects of monetary policy draws the attention back to inflation, which in open economies depends on domestic monetary policy and on the exchange-rate. Specifically,

$$\pi_t^1 = \pi_{t-1}^1 - \kappa \frac{\Delta r}{\Delta \theta} - \Delta z_{1,2} \left(X^{21} / Y^1 \right), \qquad (7)$$

[10] For simplicity reasons and without lack of generality, our model compares closed economies to open economies. In reality, however, governments command over so many capital controls that capital account openness is better described as discrete variable. The effects that our model describes will be smaller if a country partly opens its capital account. This implies that some changes can offset each other. For example, our model predicts that in the 1990s the Dollar became a less important key currency for Australia and New Zealand. At the beginning of that period, however, both countries liberalized their capital account, which increases the influence of the US Dollar on Australia's and New Zealand's Dollar.

where *1* and *2* denote two countries, $z_{1,2}$ is the exchange rate between the currencies of country *1* and country *2*, $\Delta z_{1,2}$ measures the change in the exchange-rate from period t-1 to period t. The term in the brackets denotes exports of country *2* to country *1* divided by the GDP of country *1*.

$$\frac{\partial \pi_t^1}{\partial \Delta z_{1,2}} = -\left(X^{2,1}/Y^1\right) < 0. \tag{8}$$

Equation 8 states that devaluations of the domestic currency – due to an increase in the money supply or an interest rate cut – leads to inflationary pressure. We can close our model, because, if we ignore short-run fluctuations and stochastic trends, the real exchange-rate is a function of inflation and the interest rate in countries *1* and *2*. Thus,

$$\Delta z_{1,2} = \frac{r_t^1 - \pi_{t-1}^1}{\lambda\left(r_t^2 - \pi_{t-1}^2\right)} \tag{9}$$

where $\lambda > 0$ is a constant that reflects the economic agents risk assessment of the two currencies. Equation 9 states that the exchange-rate between two countries *ceteris paribus* follows the real interest differential. The real interest rate does not need to be equal in both countries, since disequilibrium in the capital account can be equalized by disequilibrium in the current account. Hence, the country with the lower real interest rate will be a capital exporter and run a current account deficit. Again, this result is consistent with the empirical literature (Obstfeld and Rogoff 1996: 25-27). Inserting equation 7 into the government's loss function we get:

$$\begin{aligned} \mathfrak{L}_t^1 = & \left(\pi_{t-1}^1 - \kappa\frac{\Delta r^1}{\Delta\theta^1} - \frac{\Delta z_{1,2} X^{2,1}}{Y^1} - \pi_t^{1e} - C_t^1 + \bar{C}^1 - \varepsilon_t^1\right)^2 \\ & + a\left(\pi_{t-1}^1 - \kappa\frac{\Delta r^1}{\Delta\theta^1} - \frac{\Delta z_{1,2} X^{2,1}}{Y^1}\right)^2 \end{aligned} \tag{10}$$

Obviously the inflation rate and thereby the utility of monetary policy for the government not only depend on domestic settings like optimal consumption but also on the exchange rate effects of domestic monetary policy.[11] If we now recall from the rational expectation versions of the Philips curve literature that inflation rates are basically a function of monetary policy and the exogenously given natural rate of unemployment, then the smaller the country is and the more the country imports from the key currency area, the less likely the government is to use monetary policy to offset economic shocks. For these reasons, governments in small countries place a higher value on avoiding exchange-rate effects and shy away from active monetary policy.

Developing our model in this direction and taking partial derivatives from the governments' loss function (equation 10) with respect to exchange rate adjustments, we observe an increase in government losses if the domestic currency depreciates:

$$\frac{\partial \mathfrak{L}_t^1}{\partial \Delta z_{1,2}} = -\frac{2X^{2,1}}{Y^1}\left(\pi_{t-1}^1 - \kappa\frac{\Delta r^1}{\Delta\theta^1} - \frac{\Delta z_{1,2}X^{2,1}}{Y^1} - \pi_t^{1e} - C_t^1 + \overline{C}^1 - \varepsilon_t^1\right) - \frac{2aX^{2,1}}{Y^1}\left(\pi_{t-1}^1 - \kappa\frac{\Delta r^1}{\Delta\theta^1} - \frac{\Delta z_{1,2}X^{2,1}}{Y^1}\right) < 0 \qquad (11)$$

As equation 11 suggests, even though a reduction of the interest rate increases consumption, it becomes less desirable in the presence of exchange-rate adjustments. If the government cuts interest rates, capital outflows increase. As a result, the domestic currency loses value and rising prices of imported goods add to inflation.[12] Again, our model is consistent with empirical evidence (see Shambaugh 2005).

Systemic Effects of Currency Unions

At this point, our argument starts to become slightly more complicated. To analyze the external effects of currency unions in a comparative statics approach, we need to considerably increase the number of countries in our model. In fact, we will need one country to analyze (still called 1) and three additional countries (dubbed 2, 3 and 4). These four countries are necessary as two countries have to agree on a currency union (without loss of generality we assume that countries 3 and 4 agree on a union), while

11 The final loss function where we also insert equation 9 into 10 and derive the optimal monetary policy can be found in the appendix.

12 The same holds true if governments prefer to raise money supply rather than lowering the interest rate. In this case, agents expect an increase in the inflation rate, which in turn weakens the domestic currency. The result is similar to the effect of reducing the interest rate: domestic consumption declines and inflation increases, because imported goods become more expensive. We therefore exclusively focus on interest-rate cuts.

country 2 is a competing key currency area. This setting nicely resembles a situation in which country 1 is the UK, country 2 the USA, country 3 Germany and country 4 France.

Consistent with the empirical evidence, our model assumes that everything else being equal, capital owners tend to hold assets in "large" currencies (Solans 1999; McKinnon 2004). This gave the US dollar a convenient position as the dominant international currency and assured additional seignorage income to the Federal Reserve Bank.[13] With the introduction of the Euro, the European currency proliferated as a second international currency (BIS 2004; Chinn and Frankel 2005). In early 2004, approximately 40 percent of total trans-border assets were held in Euro – up from a historical low of 13 percent in 1984 for the two dominant Euro-zone currencies, D-Mark and French Franc, together. The Euro has eroded many of the barriers that segmented the European market and gave rise to a unified market comparable in size to the one denominated in US dollars (Plümper and Troeger 2006).[14]

The new position of the Euro affects the behavior of capital owners in case of an asymmetric economic shock in a country not belonging to the Euro-zone. Though the BIS does not report the geographical composition of bank's cross-border positions, the role of reserve currencies on the international asset market is likely to have a regional bias. While the Dollar is stronger in Latin America and demand for the Yen is higher in East Asia, the share of the Euro in cross-border bank positions in Europe exceeds 50 percent. It thus seems safe to argue that the Euro has become the main currency for European capital owners storing their assets in a foreign currency because their home country uses monetary policy to offset an economic shock.

These changes on global capital markets affect capital flows between currencies (not necessarily between countries) and thereby exert an influence on the exchange rate. Since this argument lies at the heart of our model, let us make the underlying logic clear. Suppose a world of three currencies (refer to them as Pound, Dollar, Euro), in which capital owners of one currency (the Pound) search for more attractive assets when interest rates plunge. In principle, a drop in the interest rates may imply a shift from the bond market and from short-term assets to the stock exchange. Yet, a cut in one country's short term interest rates also propels some assets into short-term assets denominated in other currencies and especially in key currencies known to be

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13 Porter and Judson (1996) estimate that approximately 50-70 percent of the US currency is held abroad – granting roughly 20 billion Dollars of seignorage to the US Treasury.

14 This also holds true for the denomination of international contracts in traded goods and the denomination of bonds, where the Euro outstripped the Dollar already in 1999. For more details, see Galati and Tsatsaronis 2001; BIS 2004.

"safe havens". Accordingly, the capital-owners in our example could shift their assets to either of the two other currencies or they could choose any combination of the two currencies. Assume Pound-owners transferred their money exclusively into the Dollar, thus refusing the Euro as safe haven. In this case the Pound would depreciate against the Dollar *and* the Euro, but the Pound depreciation against the Dollar would be stronger than against the Euro. In other words, the direction of asset flows after a reduction in the real interest rate differential affects the relative strengths of the exchange-rate effect in a system of currencies.

This example resembles the state of global finance before the introduction of the Euro. The Dollar was the most attractive "safe haven" when a country significantly reduced its domestic interest rate. In this period, whenever there was an exogenous shock in one country, its currency depreciated more towards the Dollar than it depreciated towards the D-Mark, the French Franc or other minor reserve currencies. In turn, the Dollar not only appreciated vis-à-vis the currency of the country which adjusted its interest rate to lower demand; the US currency to a lesser extent also appreciated towards all other currencies. When capital-owners perceive both alternatives as being equally attractive, thus transferring about equally sized parts of their capital into the Dollar and the Euro, the depreciation of the Pound to the Dollar becomes smaller, while the depreciation of the Pound to the Euro becomes larger.

The model developed so far can easily be augmented to allow a concise representation of the effects of currency unions on the monetary policy in third countries. For this purpose, we have to change the simplifying treatment of the impact of changes in the real interest differential on the exchange-rate. Recall from equation 7 that inflation is affected by the exchange-rate. A depreciation of the domestic currency implies an increase in the inflation rate.

Now assume that monetary authorities of country 1 for whatever reasons reduce the interest rate.[15] The change in country 1's monetary policy brings the system into disequilibrium. Since the government of country 1 reduces the interest rate, country 1 becomes a capital exporter. In line with the empirical evidence presented in the preceding subsection, the direction of capital outflows from country 1 is determined by the relative country size and the strength of the size bias (Mundell 1964). For our

[15] For convenience reasons, we assume that all capital accounts and current accounts have been balanced and all interest rates were identical prior to the shock.The argument does not depend on this assumption, but solely makes the mathematics more tractable.

argument, the strength of the size bias is not important. However, our argument depends on its existence.

To determine the impact of an asymmetric economic shock on four countries which maintain a flexible exchange-rate regime, we need to model the investors' size bias explicitly. A simple mathematical account for exchange-rate fluctuations in the presence of size effects is

$$\begin{aligned} \Delta z_{1,2} &= \frac{r_t^1 - \pi_{t-1}^1}{\lambda\left(r_t^2 - \pi_{t-1}^2\right)} \times \frac{\left(N-2\right) Y_2^{(1+b)}}{Y_2^{(1+b)} + Y_3^{(1+b)} + Y_4^{(1+b)}} \\ \Delta z_{1,3} &= \frac{r_t^1 - \pi_{t-1}^1}{\lambda\left(r_t^3 - \pi_{t-1}^3\right)} \times \frac{\left(N-2\right) Y_3^{(1+b)}}{Y_2^{(1+b)} + Y_3^{(1+b)} + Y_4^{(1+b)}} \\ \Delta z_{1,4} &= \frac{r_t^1 - \pi_{t-1}^1}{\lambda\left(r_t^4 - \pi_{t-1}^4\right)} \times \frac{\left(N-2\right) Y_4^{(1+b)}}{Y_2^{(1+b)} + Y_3^{(1+b)} + Y_4^{(1+b)}} \end{aligned} \tag{12}$$

where $z_{1,i\neq 1}$ measures the exchange-rate effects between the currencies of country 1 and the other 3 countries induced by monetary policy changes in country 1. $0 \leq b \leq \infty$ accounts for the size bias. If $b = 0$, investors use all currencies according to country size, if $b > 0$ investors overweigh larger currencies in their portfolio. Equation 14 suggests that a crisis-ridden country's exchange-rate with large reserve currencies devaluates slightly more than the country's exchange-rate with smaller reserve currencies. Again, there is considerable evidence for such a safe haven effect. For instance, the currencies of countries most heavily affected by the Asian crisis, South Korea, Indonesia, and Thailand (Radelet and Sachs 1998; Kaminsky and Reinhart 1999; Hausken and Plümper 2002) lost approximately 80 percent of their pre-crises value against all major currencies, but the drop vis-à-vis the dollar was significantly larger. Accordingly, the Dollar appreciated vis-à-vis all other major reserve currencies.[16] Therefore, the assumption that we make here seems to be valid.

We now can reconsider the part of equation 10 which sets government support losses in relation to currency depreciation in Country 1. Let

$$\tilde{\mathfrak{L}}_t^1 = \left(\ldots - \frac{\Delta z_{1,2} X^{2,1}}{Y^1} \right)^2 + a \left(\ldots - \frac{\Delta z_{1,2} X^{2,1}}{Y^1} \right)^2 \tag{13}$$

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16 In this respect, the Asian Crisis is not an isolated case. Japanese economists have at times analyzed 'inertia' in the use of the Dollar as means for the store of wealth. See Ogawa and Sasaki 1998.

be the partial exchange-rate effect on government losses. Hence, inserting equations 12 into 13 and simplifying the equation gives

$$\tilde{\mathfrak{L}}_t^1 = (1+a)\left[\begin{array}{l}\left[-\frac{X^{2,1}\left(r_t^1-\pi_{t-1}^1\right)}{Y^1\lambda\left(r_t^2-\pi_{t-1}^2\right)}\times\frac{(N-2)Y_2^{(1+b)}}{\sum_{i=2}^4 Y_i^{(1+b)}}\right]^2+\left[-\frac{X^{3,1}\left(r_t^1-\pi_{t-1}^1\right)}{Y^1\lambda\left(r_t^3-\pi_{t-1}^3\right)}\times\frac{(N-2)Y_3^{(1+b)}}{\sum_{i=2}^4 Y_i^{(1+b)}}\right]^2+\\ \left[-\frac{X^{4,1}\left(r_t^1-\pi_{t-1}^1\right)}{Y^1\lambda\left(r_t^4-\pi_{t-1}^4\right)}\times\frac{(N-2)Y_4^{(1+b)}}{\sum_{i=2}^4 Y_i^{(1+b)}}\right]^2\end{array}\right] \quad (14)$$

Equation 14 might look inconvenient but it just describes the sum of all partial effects. With respect to the total loss in support for the government in country 1, both equations provide us with unsurprising results: the support losses are larger 1) the smaller country 1 is relative to the other countries, 2) the more open its economy, 3) the larger the interest rate cut and 4) the more elastically voters will react to changes in inflation (the larger α).

In addition, equation 14 has some interesting properties which we have not yet discussed: if country 1's imports from countries 2-4 are identical, then government losses are higher the less equal the sizes of countries 2-4 are. In the same vein, losses are smaller, the less goods and services country 1 imports from the largest currency. These results of the model find support in the empirical literature. Ariel Burstein et al. argue that import prices are highly correlated with the exchange-rate of the key currency even if we control for consumers' demand elasticity (Burstein et al. 2002).

Without loss of generality, we may assume that countries 3 and 4 form a currency union. Equation 14 then simplifies to

$$\tilde{\mathfrak{L}}_t^1 = (1+a)\left[\left[-\frac{X^{2,1}\left(r_t^1-\pi_{t-1}^1\right)}{Y^1\lambda\left(r_t^2-\pi_{t-1}^2\right)}\times\frac{(N-2)Y_2^{(1+b)}}{Y_2^{(1+b)}+Y_{\overline{34}}^{(1+b)}}\right]^2+\left[-\frac{X^{\overline{34},1}\left(r_t^1-\pi_{t-1}^1\right)}{Y^1\lambda\left(r_t^{\overline{34}}-\pi_{t-1}^{\overline{34}}\right)}\times\frac{(N-2)Y_{\overline{34}}^{(1+b)}}{Y_2^{(1+b)}+Y_{\overline{34}}^{(1+b)}}\right]^2\right], \quad (15)$$

where $\overline{34}$ denotes the currency union between country 3 and country 4. This finally allows us to obtain the net external effect of the establishment of a currency union on country 1 by subtracting equations 14 and 15 from each other:

$$\Delta\tilde{\mathfrak{L}}_t^1(CU)=(1+\alpha)\left[\begin{array}{l}\left[-\frac{X^{2,1}\left(r_t^1-\pi_{t-1}^1\right)}{Y^1\lambda\left(r_t^2-\pi_{t-1}^2\right)}\times\frac{(N-2)Y_2^{(1+b)}}{Y_2^{(1+b)}+Y_{\overline{34}}^{(1+b)}}\right]^2+\left[-\frac{X^{\overline{34},1}\left(r_t^1-\pi_{t-1}^1\right)}{Y^1\lambda\left(r_t^{\overline{34}}-\pi_{t-1}^{\overline{34}}\right)}\times\frac{(N-2)Y_{\overline{34}}^{(1+b)}}{Y_2^{(1+b)}+Y_{\overline{34}}^{(1+b)}}\right]^2\\-\left[-\frac{X^{2,1}\left(r_t^1-\pi_{t-1}^1\right)}{Y^1\lambda\left(r_t^2-\pi_{t-1}^2\right)}\times\frac{(N-2)Y_2^{(1+b)}}{\sum_{i=2}^4 Y_i^{(1+b)}}\right]^2-\left[-\frac{X^{3,1}\left(r_t^1-\pi_{t-1}^1\right)}{Y^1\lambda\left(r_t^3-\pi_{t-1}^3\right)}\times\frac{(N-2)Y_3^{(1+b)}}{\sum_{i=2}^4 Y_i^{(1+b)}}\right]^2\\-\left[-\frac{X^{4,1}\left(r_t^1-\pi_{t-1}^1\right)}{Y^1\lambda\left(r_t^4-\pi_{t-1}^4\right)}\times\frac{(N-2)Y_4^{(1+b)}}{\sum_{i=2}^4 Y_i^{(1+b)}}\right]^2\end{array}\right] \quad (16)$$

We find that the interest rate differential to country 2 becomes less important for country 1. This suggests that the influence of the US central bank on monetary policy in non-EMU European countries has declined. At the same time, the joint impact of countries 3 and 4 (after they had joined a currency union) exceeds the aggregated impact of the two countries when they issued two separate national currencies. Accordingly, monetary policy in non-EMU European countries follows the European Central Bank's monetary policy more closely than it had been the case with the influence of German monetary policy prior the introduction of the Euro. However, equation 16 is not strictly negative. More precisely, it is negative for countries which import more from the currency union $\left(\overline{34}\right)$ than from country 2. However, equation 16 becomes positive if country 1's imports from country 2 exceed its imports from the currency union members. In addition, the smaller countries 3 and 4 had been before the union, the smaller the external effects of currency unions. The more country 1 imports from country 2 (countries 3+4), the higher the probability that the creation of the currency union increases (decreases) monetary policy autonomy of country 1.

Discussion and Hypotheses

At least at a first glance, the model developed in this section seems relatively complicated. However, these complications added to a simple open economy model are fully justified as our model allows the derivation of multiple hypotheses, all of which should be open to rigorous empirical tests.

In respect to the *de facto* monetary policy autonomy of open economies our model makes the following *ceteris paribus* predictions: First, monetary authorities in smaller countries are less likely to use monetary policy for domestic political purposes (i.e. to stimulate the economy or offset economic shocks). Second, *de facto* monetary policy autonomy is smaller the higher the ratio of imports to GDP. Third, *de facto* monetary policy autonomy declines in the ratio between the imports from the key currency area and GDP. And fourth, *de facto* monetary policy autonomy declines with the degree of exchange-rate pass-through (the extent to which import prices increase when the domestic currency depreciates). Clearly, these hypotheses can be stated in the probability to which governments choose an exchange-rate peg. Accordingly, governments are more likely to fix the exchange-rate to a key currency (or a currency basket), when the country is relatively small and open, when the country imports a relatively large share from a key currency area and when import corporations tend to increase prices if the domestic currency depreciates.

Since the above hypotheses have been derived from other models and since these hypotheses are consistent with the empirical evidence, our analyses focus on the novel predictions of our model:

Hypothesis 1: *The creation of a monetary union influences monetary policy autonomy of non-members (see eq. 11).*

Furthermore, the establishment of a union's currency influences monetary policy autonomy of non-members the more the larger the gain in importance of the union's currency on global financial markets relative to the sum of the union-members' previous currencies.

Hypothesis 2: *The influence of other key currencies on the monetary policy of third countries gradually declines in the presence of a size bias when a currency union is established (see eq. 15-16).*

The dependency of third parties' monetary policy on the monetary policy of the non-union's key currency (the Dollar) declines, while its dependency on the union's key currency (the Euro) increases. In the aggregate, third parties may well gain or lose in monetary policy autonomy. They will gain (lose) if they import more (less) from the Dollar area than from the Euro area. In other words, third parties will lose *de facto* monetary policy autonomy if the largest share of their imports comes from the countries that have joined the monetary union.

Hypothesis 3: *The establishment of a union's currency reduces (increases) monetary policy autonomy of non-members if the non-members import more (less)* *from the union's currency area than from other key currency areas (see eq. 15-16).*

4. Research Design

The theoretical argument presented in the previous section implies that the establishment of a currency union has effects on the monetary policy of countries outside the union. These externalities are more pronounced in countries that obtain a relatively large share of their imports from the unions' currency area. In turn, the impact of other key currencies on monetary policies in third parties declines.

Variables, Data Sources and Operationalization

As dependent variables we choose the change in the "actual instrument used by most central banks to impose their policy – the short-term interest rate" (Obstfeld et al. 2004; Frankel et al. 2002; and Shambaugh, 2004). In particular, we study the determinants of the discount rate (the rate at which the central banks lend or discount eligible paper for deposit by banks) and the lending rate (the rate that usually meets the short- and medium-term financing needs of the private sector).

The sample consists of, we believe, all countries to which our theory usefully applies including Canada which is a borderline case. The sample is small, but one has to bear in mind that the countries of the European Monetary Union naturally disqualify for testing our theory. Furthermore, test cases must satisfy a list of conditions: First, they must have implemented a floating exchange-rate system or use wide bandwidths if they have pegged their currency, because pegged countries with narrow bandwidths need to use their monetary policy for stabilizing the exchange-rate to their anchor currency. If this is not the Euro (the US dollar in the case of Canada) the introduction of the common European currency should have no effect on *de facto* monetary policy autonomy. Therefore, we do not expect to find an observable influence of the emergence of the Euro on Canada's monetary policy. Second, countries should not have experienced a period of hyperinflation between 1980 and 2005 as this would be difficult to deal with in the estimation. Third, countries should have had a responsive government (democracy) through the entire period, since the utility function we have assumed is otherwise unlikely to be valid. Specifically, monetary authorities in autocratic regimes do not necessarily bother about imported inflation. And fourth, countries should be relatively open to imports, because countries with a low ratio of imports to GDP do not need to care about imported inflation. Finally, we also believe that Japan disqualifies, since the decade of deflation in Japan made the country's monetary policy immune against imported inflation for much of the last fifteen years. This leaves us with four groups of test cases:

In the first group we have the EU members that have abstained from implementing the Euro: the UK, Denmark, and Sweden. Since these countries receive most of their imports from the Eurozone countries, our theory predicts the strongest decline in de facto monetary policy autonomy.[17] We use these countries to test hypotheses 1 and 2 in a first set of tests.

The second group consists of EFTA countries. Norway, Switzerland, and Iceland import less than the EU countries from the Eurozone, but imports from Eurozone countries still exceed imports for the USA.[18]

The third group includes New Zealand and Australia. These two countries both have a relatively low trade openness but import more goods from the US than from the Eurozone.[19] We should not expect a strong effect of the Euro on monetary policy in these two countries but since we should expect an increase in monetary policy autonomy, New Zealand and Australia allow a direct test of hypothesis 3.

All forementioned countries either allow their currencies to float or have implemented a de facto peg with broad bandwidths. The last country in our sample is different. Until November 2000, Canada had de facto pegged its Dollar to the US dollar and employed very narrow bandwidths in which exchange-rate fluctuations are allowed (+/-2%). Since then, the Bank of Canada uses a forecasting model to set its prime interest rate, which is still basically in line with the Fed's monetary policy.[20] For almost the entire period under observation, the Canadian monetary authorities needed to use their monetary policy to defend the parity against the US dollar.[21] For

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[17] The three EU countries import on average over the period under observation 50 percent of all imports from the Euro-zone and only 8 percent from the US.

[18] The three EFTA countries import about 40 percent from the EMU and about 8 percent from the US.

[19] Australia and New Zealand import on average 20 percent from the US and 13 percent from the EMU.

[20] The Bank of Canada decides on eight pre-set dates whether or not to change their key interest rate (the overnight rate). The Bank follows an inflation target (currently of two percent) and uses an economic projection based on a model of the Canadian economy, an analysis of the information from monetary and credit aggregates, interest rate credit spreads and changes in credit access, and information on the interest rate expectations of participants in financial markets for decision-making.

[21] Canada traditionally imports most of its goods and services from the US (more than 65 percent on average) whereas only a negligible small share is imported from the Euro-zone (about 6 percent). Therefore, even if Canada would have implemented a more flexible

these reasons, we should expect to find no effect of the Euro introduction on the de facto monetary policy autonomy in Canada. However, Canada provides a good 'the dog that did not bark' test for our theory as we can contrast the findings for the other group of countries to a country in which we should be unable to observe a systematic effect.

We analyze discount rate adjustments in the cases of the Scandinavian countries (Denmark and Sweden) as well as Iceland and lending rates in the cases of Great Britain, Switzerland, Norway, New Zealand, Australia and Canada. Because information on both interest rates is available for Germany and the US, it was possible to regress discount rates on discount rates and lending rates on lending rates. Though lending rates are on average somewhat higher than discount rates, we were unable to detect a systematic effect in the regression analysis which is not surprising since we first difference all time series. Under these conditions, we were unable to observe parameter heterogeneity between the two subsets of countries. All data on interest rates stem from Global Financial Data, Inc. Our results are robust regarding the operationalization of the central bank interest rate.[22]

Table 1 displays the summary statistics of the nominal central bank interest rates for the countries in our sample.

	Mean	Maximum	Minimum	Std. Dev.	Obs.	Period
discount rates						
GER	4.44	8.8	2.00	1.88	302	1980:1 – 2005:2
USA	5.89	14.0	0.75	3.00	302	1980:1 – 2005:2
DNK	6.33	13.0	2.00	2.89	302	1980:1 – 2005:2
SWE	6.47	12.0	1.00	3.51	302	1980:1 – 2005:2
ICE	14.87	40.0	4.10	9.73	302	1980:1 – 2005:2
lending rates						
GER	7.39	11.9	3.00	1.92	302	1980:1 – 2005:2
USA	9.13	21.5	4.00	3.52	302	1980:1 – 2005:2
UK	8.70	17.0	3.50	3.64	302	1980:1 – 2005:2
NOR	9.85	15.5	3.75	3.17	302	1980:1 – 2005:2
SWI	5.10	6.95	3.19	1.00	302	1980:1 – 2005:2
AUS	12.07	20.5	7.7	3.56	302	1980:1 – 2005:2
CAN	9.18	22.75	3.75	4.01	302	1980:1 – 2005:2
NZL	12.24	20.5	6.5	4.13	302	1980:1 – 2005:2

Table 1: Summary Statistics of Central Bank Interest Rates

exchange-rate system the implementation of the EMU would have had no effect on its the monetary policy autonomy.

22 We used simple sample split methods and more complex interaction effect specifications to test the dependency of our results on the type of interest rates reported by the central banks. We found no systematic effect. Results can be obtained from the authors upon request.

Since daily data is not available for our control variables, we study monthly data. The first year of observation is of limited importance; changes in the first considered data-point do not alter the results much. If we use a later starting point, the influence of the Dollar on monetary policy in the countries in our sample becomes slightly higher. If anything, this would improve the significance of our findings.

We use the real interest rate (rather than the nominal interest rate) in the regression analysis.[23] The reason is a theoretical one: for international investors, the nominal interest rate is meaningless. No one would buy a bond for which the issuing government pays an interest rate of 20 percent the bond is denominated in a currency which loses 50 percent of its value per year. Accordingly, the relatively high interest rate in Iceland does not mean that investment in the Icelandic Krona is attractive. Rather, investors also consider Iceland's high inflation rate. Along similar lines, central banks set nominal interest rates, but they do so by calculating the real interest rate difference to other currencies.[24]

Our theory predicts a larger impact of the monetary policy set in the EMU the more important the Euro as an international save haven currency becomes. This implies that the impact of the Euro-zone interest rate policy on the monetary policy in outsider countries is not stable over time. To adequately model this slope heterogeneity we construct interaction effects between the EMU interest rate (the US interest rate) and period dummies. Since the Euro was phased-in, our specification distinguishes five time periods. At July 1st 1990, the EMU countries fully liberalized capital accounts vis-à-vis each other and enforced their monetary policy coordination. In January 1994, central banks of the EMU began to coordinate and harmonize interest rate policies more closely. At the same time, the European System of Central Banks was legally introduced. In January 1999, the EMU countries fixed their exchange-rate and introduced the Euro. Finally, in January 2002 the Euro became

[23] The monthly inflation rate is taken from the World Development Indicators provided by the World Bank.

[24] Comments on previous versions of this paper have suggested that central banks control the nominal rather than the real interest rates. Their argument resembles a commonly made assumption according to which unions cannot bargain for real wage increases but only for nominal wage increases. Though this argument makes intuitively sense for unions it is for two reasons far less appealing for central banks. The first reason is theoretical: central banks can if necessary adjust the interest rate on a daily basis, thus carefully adjusting monetary instruments to changes of the inflation rate. In other words, the central bank does not need to formulate nominal interest rate targets but can adjust monetary policy according to the inflation rate. The second reason is mainly empirical: While real wage increases are largely independent of the inflation rate, the interest rate and the inflation rate are highly collinear, indicating that with unions being unable to negotiate real wage increases, the central bank is able to target real interest rates.

the only means of payment in all EMU countries. We expect to find an increasing influence of the EMU's interest rate on monetary policy in other countries after 1994, that is with the beginning of interest-rate harmonization. Since monetary policy coordination between 1990 and 1994 remained a stated goal rather an actual policy we would be surprised to find a growing influence of the EMU's monetary policy at this early stage of European monetary integration.

This econometrical set-up follows Chow (1960). He suggested a test for structural changes in time series. In brief, his procedure allows estimating different slopes for different periods in the time-series. The test itself then establishes whether the coefficients before and after the cut-off point are statistically different. We include such a test in form of a simple Chi^2-test to show that the impact of the Euro-zone interest rate on the interest rate of EU non-EMU countries has significantly changed between the theoretically established time-periods.

To account for the trade argument derived in the theoretical part we take monthly trade data from the IMF's Direction of Trade Statistics to compute the relative import shares from the Eurozone and from the US. The import weights control for our theoretical arguments according to which countries follow the ECB's monetary policy more closely the higher their imports from the Eurozone. Our results stay largely robust if we do not weight the monetary policy of central banks issuing key currencies.[25]

In addition, we control for the growth of GDP and the level of the real interest rate in the countries under observation as well as for the German and US growth rates and changes in the exchange rate to both key currencies. Moreover we add the unemployment rate of the countries under observation to the battery of explanatory variables. All economic variables come from the World Development Indicators of the World Bank (2005) and the monthly exchange rates come from Global Financial Data, Inc. The inclusion of additional variables aims at controlling business-cycle influence of monetary policy. We thus include controls which are likely to influence the central bank interest rate. Since these controls are unlikely to be correlated with the periodization of European monetary integration, the exclusion of controls is possible in principle. However, this statistically appropriate procedure would render the results less convincing and thus we estimate our model with a full battery of controls.

[25] The stability of the results for trade-weighted and un-weighted data is also due to the fact that the countries under observation all import more than 50 per cent of all their imports from the Eurozone and less than 20 per cent from the US.

The empirical approach we choose to model the relationship between the monetary policy of the key currencies and the interest policy of the nine countries under observation is a combination of first differenced monthly real interest rate data and a GARCH (Generalized Autoregressive Conditional Heteroskedasticity) specification to control for time dependent error variance and serial correlation. Interest rates are usually driven by stochastic processes, that is: they have a single unit root. Unit roots render the estimated coefficients of time series models in levels inefficient and can even lead to spurious regression results (Granger and Newbold 1974). It is therefore recommended to either co-integrate the time-series or to take the first differences.[26] While Wu and Zang (1997) show that levels of interest rates are typically trended and at least close to non-stationarity, our co-integration tests indicate that the dependent and independent interest rate series are not co-integrated and do not fluctuate around a long-term equilibrium trend. Even if that was not the case, co-integration relationships are unlikely to be identical across the countries in our sample. This finding prevents co-integration analysis and leaves us with differencing the time series to generate sound estimation results. In doing so, our specification not only mirrors the common practice in the field (Obstfeld et al. 2004, Shambaugh 2004). Since we are interested in short-term adjustments rather than in long-term effects, differencing also nicely reflects out theory. We look at immediate reactions of monetary authorities in the outsider countries to monetary policy changes of the European Central Bank.

Yet, even after eliminating serial correlation we observe time-dependent error variances. The variance of the dependent interest rates reveals autoregressive conditional heteroskedasticity, thus violating one of the Gauss-Markov assumptions of linear regression models. Not controlling for variance heterogeneity would render estimates inefficient and therefore potentially unreliable (Wooldridge 2003: 416; Plümper et al. 2005). For this reason, we run Panel-GARCH models, which do not only estimate the usual mean equation of linear models but also specify a variance equation. While the conditional mean function estimates the expected values of the endogenous variable with respect to our theoretically inspired exogenous variables (the German and US interest rate, domestic unemployment, growth etc.), the variance equation controls for time-dependency of the endogenous variable's variance by regressing the variance of the endogenous variable on the lagged values of the squared residuals (ARCH-term) plus the lagged values of the forecasted variance (GARCH-term). Controlling

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[26] We were unable to detect any co-integration equations with the usual Johansen tests.

for serial correlation by first differencing the monthly interest rates and eliminating time dependency of the error variance by employing a GARCH specification produces white noise residuals and leaves us with an unbiased and efficient estimation results.

5. Empirical Analysis

In this section, we test the three main hypotheses derived from the formal model using the case of the European Monetary Union, which we believe offers the only feasible test for our hypotheses about the external effects of currency unions.[27]

We perform two sets of tests. In the first set, we test hypothesis 1 and 2 based on a sample of countries in which we are most likely to be able to separate the effect of the European currency union from noise in the data: the three EU members that have abstained from joining the European Monetary Union. A failure to observe the effects our theory predicts would thus immediately lead to a rejection of the theory. We use these three countries to analyze the growing influence of the Euro in comparison to the historic influence of the D-Mark (as the pre-Euro European key currency) and in contrast to the declining influence of the US Dollar (hypotheses 1 and 2).

In the second set of tests we compare the effect the introduction of the Euro had on countries which are affected the most to three groups of other countries. The first group consists of EFTA countries which are about as close to the Eurozone as the EU members, but import slightly less from the Eurozone than the UK, Denmark and Sweden.[28] While this variation is small, it should be large enough to make a notable statistical difference. Our theory therefore predicts a slightly smaller decline in monetary policy autonomy of Switzerland, Norway, and Iceland. The second 'control group' comprises of New Zealand and Australia. Both countries import slightly more

[27] Robert Franzese suggested that since our argument is based on exchange-rate pass-through, monetary policy of all countries depends on the real exchange-rate to all other countries unless a pair of countries does not trade with each other. Thus, a currency union between – say – Honduras and Guatemala would have an influence on monetary policy in other countries. This indeed follows from our theory but it also follows that the effect of changes in the real interest differential on the inflation rate in the importing country would rise at an immeasurable small amount. Honduras and Guatemala are small countries. Therefore, their exports and their exchange-rate also have a very small influence on inflation in other countries. Since monetary authorities do not change their prime interest rate in continuous steps (say from 4.13 to 4.15 percent) but typically change interest rates in discrete steps of 0.25 percent (or multiples thereof), we are unlikely to be able to observe these effects even if they existed.

[28] The three EU countries that did not join the EMU import on average more then 50% of their goods and services from the Euro-area whereas the three EFTA countries (Switzerland, Iceland and Norway) on average only import 40% from the countries forming the European Monetary Union.

goods and services from the US than from the Eurozone. We should therefore expect a very small increase in monetary policy autonomy. Specifically, our theory predicts a small decline in the influence of the US dollar' interest rate and a negligible, probably insignificant, increase in the correlation between the Euro base rate and monetary policy in these countries. Finally, we use Canada as third and last control case. Since Canada maintained an exchange-rate peg with narrow bands over the period we analyze, our theory predicts no or an unsystematic influence of the Eurozone's monetary policy. If we find no systematic effect for Canada, we can be more certain that the systematic effects we observe in the other analyses were actually brought about by the introduction of the Euro (rather than by any other change in world finance). We report and discuss both sets of tests in turn.

Testing Hypotheses 1 and 2: The Euro and Monetary Policy in Britain, Denmark and Sweden

The theoretical model predicts an increase in the extent to which the three EU countries that did not join the Monetary Union actually adjust their monetary policy to the Eurozone's monetary policy. We measure the increasing institutionalization by the time cuts explained above. In addition the effect should be more pronounced if we use the import shares from the Eurozone as weights. Table 2 lists the regression results for the impact of D-Mark/Euro interest rate on the interest rates of the EU countries that abstained from joining the Monetary Union in the GARCH(1,1) specification. We report three models in two versions each (unweighted and trade weighted). Model 1 solely includes the variables of our main interest, without controlling for the US dollar's influence on the monetary policy in the UK, Denmark, and Sweden. Models 1a and b thus provide a first test of hypothesis 1. Models 2a and b add the US base interest rate and therefore tests hypothesis 2. These two models also provide a robustness check for hypothesis 1. In models 3a and b we include the battery of controls which we have discussed in section 4.

Table 2 about here

The results in table 2 support our theoretical model – or more precisely they do not reject hypotheses 1 and 2. Changes in the key currency's interest rate have the assumed significant and positive effect on the decision of the EMU-outsiders in the sample to adjust their interest rates equally. This holds true for the whole period under observation. Most noteworthy is that the effect increased significantly after the EMU central banks had harmonized their interest rates in 1994. Before 1994 the three countries under observation largely pursued an autonomous monetary policy, which was only at times influenced by the monetary policy in the US. The D-Mark base rate had no systematic influence of the British, Swedish, and Danish monetary policy before 1994, when the EMU central banks harmonized their monetary policy. Since then, the influence of the Euro had been stronger than the influence of the D-mark, while the Dollar has completely lost its systematic impact on the monetary policy of the three countries in our sample.

Since 1999, a 1 percent change in the EMU interest rate was followed by at least an increase of 0.35 percent points in the three EU countries that did not take part in the Monetary Union. With each step of closer integration of the Monetary Union the monetary policy of the outsider countries decreased further. Since 2002, the association has risen above 0.50 percent. This could be interpreted as if the three countries that did not enter the European Monetary Union became half-member at least in terms of the pursued monetary policy. The Chi squared tests show that the coefficients increased *significantly* over the three periods after 1994. Hence, the influence of the key currency on the monetary policy of EMU outsiders is positively related to the size of the key currency area. As predicted, monetary policy autonomy – the main reason for abstaining from the union – decreases even in countries that abstained from joining the union.

These results are robust to the inclusion of the US monetary policy (models 2a-3b). More importantly, we find some evidence lending support to our hypothesis 2, but the results are rather mixed depending on whether we compare the post-94 influence of the Dollar to the influence the Dollar had in the eighties or to its influence in the early nineties. Comparing the 94-99, the 99-02 and the 02-05 coefficients to the 90-94 coefficient indeed supports hypothesis 2. However, if we compare the influence the Dollar had on the three countries in our sample to its influence during the eighties we find no systematical difference. We do not want to safe hypothesis 2 here, but the lack of clear decline in the influence of the US monetary policy could be caused by the lack of contemporaneousness in the countries' shift from Keynesian to monetarist monetary policies. We therefore suggest comparing the post-94 influence of the Dollar to the Dollar's influence between 1990 and 1994. This comparison reveals a clear decline in the influence the Fed's interest rate has on the monetary policy choices of the central banks in our sample. In addition, we will later see that the effect of the Dollar was apparently more pronounced in other countries.

Moreover, by adding the US interest rate to the right hand side of the estimation model we also show that the increase in the correlation between the Euro interest rate and the base rate in the three countries of our sample just results from increased integration of financial markets. For instance, the greater alignment of monetary policies between the ECB's rate and non-Euro countries could have been caused by the world-wide reduction in barriers to capital flows and the subsequent increase in global financial integration. However, only our model predicts a declining role of the Dollar as the key currency area. The financial market integration explanation would generally predict in increase in the correlation between monetary policies of open countries. That we find no increase and possibly even a decline influence of the US monetary policy thus in our view indicates that our theory is superior to theories based on financial market integration. This is not to suggest, however, that financial market integration does not exert a constraining influence on monetary policies.

Figure 3 visualizes the relative strengths of both the D-Mark/Euro's and the Dollar's influence on monetary policy in the 3 non-EMU EU countries. We display coefficients (straight lines) and confidence intervals (dotted lines) from model 3b in table 2.

Figure 1 about here

Figure 1a highlights the increasing effect of the interest rate set in the Euro-zone after 1994 and also shows that the confidence intervals become much narrower after 1990 and that the effect turns significant from 1994 onwards – the confidence bands do not cross the zero line any more. The effect of the US interest rate is much closer to zero throughout the whole period. The Dollar influenced monetary policies of the countries in our sample only in the early 1990s, when the D-Mark lost parts of their anchor function due to the unification turbulences in German monetary policy.

Adding economic control variables and country fixed effects to the battery of explanatory variables (see models 3a and 3b) has almost no effect on size and sign of the parameters of main interest. Only the coefficient for the impact of ECB monetary policy before 1990 changes the sign but remains insignificant indicating a relatively large monetary policy autonomy of the non EMU countries vis-à-vis the German interest rate policy. It is also important to note that the controls added very little to the explanation, which, however, does not mean that these factors do not affect monetary policy in the countries of our sample at all. One has to keep in mind that we are solely analyzing short-term adjustments. We added the control variables not because we believe that changes in the unemployment rate lead to immediate adjustments of the base interest rate, but rather because we believe that most readers expect us to control for these variables even though they come from literatures that pretty much deal with level effects. In our view, it is therefore more surprising that we find an effect of unemployment at all, rather than that this effect is so small. Yet, the positive and slightly significant effect of US growth and the negative and statistically significant effect of unemployment indicate business cycle effects for monetary policy setting. Increasing unemployment drives governments to cut back main interest rates to stimulate the economy and induce growth and employment.

Weighting the impact of the EMU interest rate policy by import shares from the Eurozone (models 1b, 2b, and 3b) does not alter the results significantly. This is perhaps due to the fact that all three countries imported a constant share of about 50 per cent of goods and services from Eurozone countries. However, we can observe a slight increase in the trade weighted effects of the ECB's monetary policy after 1994 as compared to the unweighted parameters. This mirrors the prediction of our theoretical model.

Finally, the estimation of the variance equation reveals the necessity of controlling for autoregressive conditional heteroscedasticity. Both, the ARCH 1 and the GARCH 1 terms remain positive and significant in all models we ran. Obviously, interest rates are not only highly volatile over time, the variance at time t also depends on the variance at t-1. Ignoring this fact would have rendered estimates inefficient and most likely biased. Since the sum of the ARCH and the GARCH terms fall short of unity; our estimates conform to the stability condition for ARCH models.[29] After having taken first differences and controlled for ARCH, the remaining residuals are white noise.

Revisiting hypothesis 2 and testing hypothesis 3: Country Groups in Comparison

We now look beyond the Eurozone's closest neighbors and evaluate the effect of the Euro on monetary policy in additional countries. These additional analyses serve three purposes: First, analyzing additional countries may be considered as robustness

[29] Values greater than one could again lead to spurious estimates since the ARCH process would be explosive.

check. Second, we now look at countries which trade more with the US and less with the Euro-zone. Therefore, we should be able to find a stronger influence effect of the Euro introduction on the correlation between the US Dollars base rate and the monetary policy of third countries. The additional cases thus shed more light on hypothesis 2. Finally, the analysis of the US Dollar's influence on monetary policy in New Zealand and Australia provides a test of hypothesis 3.

Table 3 reports 4 identical models for the four country groups included in our analysis.

table 3 about here

Model 4 is almost identical to model 3b. The sole difference is that model 4 does not estimate a slope for the theoretically unimportant period between 1990 and 1994. The results are robust to this moderate change.

Model 5 estimates an identical model for the sample of the three EFTA countries. Our theory predicts a slightly lower influence of the ECB base interest rate and a slightly higher remaining influence of the US Dollar interest rate as well as a rising influence of the Euro base rate and a decline influence of the Dollar's base rate. We find that the monetary authorities in EFTA countries increasingly use the Euro as anchor currency and indeed the Euro's influence seems to be slightly lower. At the same time, the influence of the Dollar stays about constant or declines slightly. Overall, the EFTA countries behave similarly to the three EU members. The differences between those groups are in line with our theory but they are moderate.

According to our theory, the differences between those two country groups and the group analyzed in model 6, Australia and New Zealand should be by far larger. We observe an increasing but instable influence of the Euro and a declining influence of the US Dollar on monetary policy in Australia and New Zealand. As theoretically predicted, the influence of the Euro increased less than we observed for two European groups, while the influence of the Dollar declined more strongly. Again, the results do not unequivocally support our theory, but they are basically in line with the predictions and do not allow to reject our hypotheses. One has to bear in mind that we are analyzing short term adjustment, and that we should not expect clean and polished results.[30] If we interpret the results cautiously in the light of hypothesis 3, then we find some moderate support. The influence of the Dollar on monetary policy

[30] For example, delayed adjustments enter our estimation as noise.

weakened with the introduction of the Euro. The Euro, however, does not exceed an equally strong influence as the Dollar had on Europe's antipodes.

Finally, we can also compare these results to the Canadian case. As we have explained above, our theory does not make predictions for Canada since Canada had de facto pegged its Dollar to the US Dollar. Thus, we do not expect an influence of the Euro's monetary policy and a very strong influence of the US Dollar over all periods. The results reported in model 7 are basically in line with these predictions. Monetary policy in the Eurozone does not seem to influence the decisions of the Bank of Canada, which remains in general straight in line with the Fed's monetary policy. Though the Bank of Canada has increased its de jure monetary autonomy vis-à-vis the Dollar at the turn to the new century, this additional freedom does not yet show up in its decisions.

Overall Discussion

We believe that the tests of hypotheses 1 to 3 and the comparison across the four country groups by-and-large support our theory. Our model makes important correct predictions: the model correctly predicts the relative strengths of the Euro's and the Dollar's influence on monetary policy on three or if we consider Canada on four country groups, we find support for hypothesis 1 and 2 if we look at the EU countries and the EFTA countries and for hypothesis 3 if we look at Australia and New Zealand. The Euro's influence on monetary policy in third countries exceeds the Dollar's influence when these countries import more from the EMU than from the USA and vice versa. In addition, the Dollar's influence on monetary policy in European countries has by-and-large vanished since the introduction of the Euro, but the US interest rate still exerts a dominant influence of Canada's monetary policy.

Yet, at least at first sight some estimated coefficients seem to be slightly off the theoretical expectations of our model. First, we cannot observe a significant increase in the influence of the Euro on monetary policy in Australia and New Zealand. This being true, one has to keep in mind that our model makes weak predictions as to whether we should expect such an effect, because Australia's and New Zealand's imports from the Eurozone countries are small in comparison to both their total imports and their GDP. Significant inflationary pressures from a potential decline of these countries real exchange-rate with the Euro thus cannot be large. Therefore, we do not consider this as being an issue or even falsifying our model.

Second, the Dollar's influence on third countries' monetary policy in the 1980s was comparably low and perhaps lower than our model would lead us to expect. Two factors, however, disturb the picture in 1980s: First: the Scandinavian countries especially but also Australia and New Zealand maintained relatively high capital controls through the 1980s.[31] Denmark, for example, removed restrictions on foreign exchange accounts on the 1st October 1988, Sweden on the 1st of July, Norway followed on the 8th December 1989 (Miniane 2004 table 7). Until these restrictions were fully removed, the countries maintained larger monetary policy autonomy, since capital controls reduce the elasticity of the exchange-rate to changes in the interest-rate differential with the key currency area.[32] And second, during the 1980s all monetary policy autonomies started a strict macroeconomic stabilization policy, thereby bringing inflation under control. This widespread policy shift to monetarism, however, hardly took place simultaneously (Iversen and Soskice 2006). The USA's and Germany's turn to monetarism occurred in 1982, New Zealand and Australia implemented a soft version of monetarism in 1985 and the Scandinavian countries did not follow before 1986/87. As macroeconomic stabilization programs were implemented at different points in time, we should expect a relatively low convergence of monetary policies in the turbulent 1980s. With the abolition of capital controls and the shift to anti-inflationary policies in the late 1980s the conditions for our model were satisfied. Since then, monetary authorities responded to the possibility of imported inflation by stabilizing the exchange-rate to their important trading partners.

Hence, if we focus on the years since 1990, the *de facto* monetary policy autonomy of countries outside the European Monetary Union was indeed affected by the introduction of the Euro (unless the outside countries had pegged their currency to another currency as in the case of Canada). This effect is especially pronounced in countries that import the largest share of goods and services from the Euro-zone like the three EU members (Denmark, Sweden and the UK) that abstained from joining the European Monetary Union and the EFTA countries. In other words, monetary policy autonomy of countries with flexible exchange rate systems is influenced by the monetary policy of their main trading partners and by the desire of the central bank

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31 We use new data on capital account restrictions collected by Jacques Miniane (2004). In comparison to Dennis Quinn's data (Quinn 1997) the Miniane data allows to identity the years in which countries liberalize their capital accounts. This data also has the advantage of being highly collinear with Philip Lane's and Gian Milesi-Ferretti's measure of FDI assets and liabilities to GDP (Lane and Milesi-Ferretti 2001).

32 See footnote 10 for an additional discussion.

to avoid inflation. According to our analysis, there is also strong evidence that the influence of the US Dollar on countries which allow their exchange-rate to float has declined due to the emergence of the Euro as strong contender.

6. Conclusion

The ability of governments (and independent central banks) to set the prime interest rate according to the macroeconomic situation of the country is conditioned upon the degree of international monetary interdependence. The more important international trade and international production chains become, the more vulnerable countries are to exchange-rate volatility. For this reason, governments increasingly seek to reach two goals with one instrument: monetary policy shall ensure stable employment *and* stable exchange rates.

This paper advances our understanding of the role of currency unions for monetary policy autonomy in neighboring countries. In particular, the exchange rate goal becomes relatively more important for a country, the larger its imports from potential safe haven currencies, because a reduction in the key interest rate tends to have larger exchange-rate effects with the currency in which capital-owners store their assets. Since currencies *ceteris paribus* are less risky stores of value the larger they are, the creation of a currency union diverts international capital flows if the union's currency is used as a reserve currency. For countries with relatively large imports from the union, the *de facto* monetary policy autonomy therefore declines with the introduction of a currency union.

This novel perspective on monetary policy autonomy is supported by the data. Nowadays, the prime interest rate of West European countries follows more closely the monetary policy agreed upon by the European Central Bank. The impact of monetary policy in the Euro-zone on monetary policy in the UK, Sweden, Denmark, Norway, Switzerland, and Iceland is at least twice as strong as it was before the introduction of the Euro, while the influence on the US interest rate on monetary policy in Europe has gradually declined. The Euro replaced the US Dollar as the main reserve currency since the impact of the US monetary policy on the six countries under observation declined while the influence of the Euro-zone grew.

Our findings speak to the extensive literature dealing with the choice of an exchange-rate regime. While there can be no doubt that the choice of an exchange-rate system is dominantly influenced by the trade-off between monetary policy autonomy on the one hand and the desire to stabilize the exchange-rate to other countries, we have shown that the latter aspect in this trade-off may become more important for monetary policy authorities if other monetary policy authorities surrender their autonomy by joining a monetary union. Indeed, our analysis shows that monetary authorities are more likely to follow the monetary policy of a currency union than the monetary policy of smaller key currencies. At the margin, these changes also affect the probability with which outsiders join the monetary union. The more the monetary authority follows the interest rate policy of the central bank of the monetary union, the lower the costs of abandoning the own currency. Our analysis therefore suggests that in the future political scientist should include policy spillovers in the analysis of the choice of a monetary policy regime.

Across Europe, we observe a growing discussion on the delayed introduction of the Euro. In our perspective, this results from an increasing awareness of policy-makers that the costs of joining the union – the decline in monetary policy autonomy – are smaller than they had previously thought. If additional countries and especially Great Britain join the Eurozone, the Euro will grow even stronger and may eventually surpass the US Dollar as leading international reserve currency (Chinn and Frankel 2005). If this happens, more and more countries will use their monetary policy to stabilize their exchange-rate with the Euro and the role of the Dollar on international financial markets gradually declines.

Appendix: Derivation of Optimal Monetary Policy

Inserting equation (9) into (10) gives the final loss function of the government:

$$\begin{aligned}\mathfrak{L}_t^I = &\left(\pi_{t-1}^I - \kappa\frac{r_t^I - r_{t-1}^I}{\Delta\theta^I} - \frac{\left(r_t^I - \pi_{t-1}^I\right)}{\lambda\left(r_t^{II} - \pi_{t-1}^{II}\right)}\frac{X^{II,I}}{Y^I} - \pi_t^{Ie} - C_t^I + \bar{C}^I - \varepsilon_t^I\right)^2 \\ &+ a\left(\pi_{t-1}^I - \kappa\frac{r_t^I - r_{t-1}^I}{\Delta\theta^I} - \frac{\left(r_t^I - \pi_{t-1}^I\right)}{\lambda\left(r_t^{II} - \pi_{t-1}^{II}\right)}\frac{X^{II,I}}{Y^I}\right)^2\end{aligned} \quad \text{(A1)}$$

Derivation of the first order condition for optimal monetary policy in an open economy:

$$\frac{\partial \mathfrak{L}_t^I}{\partial r_t^I} = 2\left(-\frac{\kappa}{\Delta\theta^I} - \frac{X^{II,I}}{\lambda Y^I\left(r_t^{II} - \pi_{t-1}^{II}\right)}\right)\left(\pi_{t-1}^I - \kappa\frac{r_t^I - r_{t-1}^I}{\Delta\theta^I} - \frac{\left(r_t^I - \pi_{t-1}^I\right)}{\lambda\left(r_t^{II} - \pi_{t-1}^{II}\right)}\frac{X^{II,I}}{Y^I} - \pi_t^{Ie} - C_t^I + \bar{C}^I - \varepsilon_t^I\right)^2 \qquad \text{(A2)}$$
$$+2a\left(-\frac{\kappa}{\Delta\theta^I} - \frac{X^{II,I}}{\lambda Y^I\left(r_t^{II} - \pi_{t-1}^{II}\right)}\right)\left(\pi_{t-1}^I - \kappa\frac{r_t^I - r_{t-1}^I}{\Delta\theta^I} - \frac{\left(r_t^I - \pi_{t-1}^I\right)}{\lambda\left(r_t^{II} - \pi_{t-1}^{II}\right)}\frac{X^{II,I}}{Y^I}\right)^2 < 0$$

after some (not always simple) transformations we get the optimal monetary policy:

$$r_t^I = \frac{1}{\left[(1+a)\left(X^{II,I}\Delta\theta^I + \kappa\lambda Y^I\left(-r_t^{II} + \pi_{t-1}^{II}\right)\right)\right]} \times$$
$$\left[(1+a)\kappa r_{t-1}^I Y^I \lambda\left(r_t^{II} - \pi_{t-1}^{II}\right) + \Delta\theta^I \begin{pmatrix} -\pi_t^{Ie} r_t^{II} Y^I \lambda - r_t^{II} Y^I \lambda \varepsilon_t^I + \bar{C}^I Y^I \lambda\left(r_t^{II} - \pi_{t-1}^{II}\right) + \pi_t^{Ie}\pi_{t-1}^{II} Y^I \lambda \\ +\pi_{t-1}^{II} Y^I \lambda \varepsilon_t^I + C_t^I Y^I \lambda\left(-r_t^{II} + \pi_{t-1}^{II}\right) + X^{II,I}\pi_{t-1}^I + a X^{II,I}\pi_{t-1}^I \\ +\pi_{t-1}^I r_t^{II} Y^I \lambda + a\pi_{t-1}^I r_t^{II} Y^I \lambda - \pi_{t-1}^I \pi_{t-1}^{II} Y^I \lambda - a\pi_{t-1}^I \pi_{t-1}^{II} Y^I \lambda \end{pmatrix}\right] \qquad \text{(A3)}$$

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Dependent variable: changes of real interest rates of non-EMU EU countries (Den, Swe, UK)	Model 1a Un-weighted	Model 1b Trade weighted	Model 2a Un-weighted	Model 2b trade weighted	Model 3a Un-weighted	Model 3b trade weighted
Mean Equation:						
Intercept	-0.047**	-0.42*	-0.041*	-0.039*	-0.430**	-0.427**
	(0.022)	(0.022)	(0.022)	(0.022)	(0.177)	(0.177)
Level of Real Interest Rate	0.021***	0.019**	0.019**	0.018**	0.043***	0.042***
(DNK, SWE, UK)	(0.008)	(0.008)	(0.008)	(0.008)	(0.012)	(0.012)
Δ Real Interest Rate	0.017	0.042	0.060	0.087	0.023	0.048
Germany, 80-90	(0.105)	(0.109)	(0.108)	(0.113)	(0.111)	(0.115)
Δ Real Interest Rate	0.088	0.080	0.045	0.038	0.033	0.029
Germany/Euro-zone, 90-94	(0.079)	(0.077)	(0.081)	(0.079)	(0.081)	(0.079)
Δ Real Interest Rate	0.267***	0.271***	0.243***	0.247***	0.240***	0.244***
Euro-zone, 94-99	(0.090)	(0.091)	(0.092)	(0.092)	(0.091)	(0.091)
Δ Real Interest Rate	0.355***	0.359***	0.356***	0.355***	0.326***	0.326***
Euro-zone, 99-02	(0.107)	(0.103)	(0.106)	(0.103)	(0.103)	(0.101)
Δ Real Interest Rate	0.540***	0.634***	0.494***	0.615***	0.585***	0.597***
Euro-zone, 02-05	(0.097)	(0.098)	(0.099)	(0.103)	(0.108)	(0.101)
Δ Real Interest Rate			-0.054	-0.049	-0.070	-0.067
USA, 80-90			(0.049)	(0.044)	(0.049)	(0.046)
Δ Real Interest Rate			0.132**	0.125**	0.148***	0.139**
USA, 90-94			(0.058)	(0.057)	(0.057)	(0.055)
Δ Real Interest Rate			0.068	0.066	0.070	0.068
USA, 94-99			(0.052)	(0.048)	(0.052)	(0.049)
Δ Real Interest Rate			0.024	0.018	0.033	0.025
USA, 99-02			(0.021)	(0.021)	(0.020)	(0.021)
Δ Real Interest Rate			0.027*	0.013	0.016	0.009
USA, 02-05			(0.016)	(0.020)	(0.016)	(0.020)
Exchange rate towards					0.034*	0.032
DM/EURO					(0.020)	(0.020)
Exchange rate towards					0.013	0.014
US$					(0.019)	(0.019)
Growth					0.0004	0.0001
(Den, Swe, UK)					(0.009)	(0.009)
Growth					-0.001	-0.001
Germany/Eurozone					(0.006)	(0.006)
Growth USA					0.037***	0.037***
					(0.011)	(0.011)
Unemployment					-0.033***	-0.032**
(Den, Swe, UK)					(0.013)	(0.013)

Table 2 (part 1): Pooled GARCH First Differences Models.
Dependent Variable: Change in Real Interest Rates of Non-EMU EU Countries.

Dependent variable: changes of real interest rates of non-EMU EU countries (Den, Swe, UK)	Model 1a Un-weighted	Model 1b Trade weighted	Model 2a Un-weighted	Model 2b trade weighted	Model 3a Un-weighted	Model 3b trade weighted
FE Sweden					-0.008	-0.010
					(0.045)	(0.045)
FE UK					0.283*	0.277*
					(0.146)	(0.146)
Chi^2-test difference of emu-coef 80-90=99-02 (p>Chi^2)	5.10	4.47	3.85	3.10	4.07	3.33
	(0.024)	(0.035)	(0.049)	(0.078)	(0.044)	(0.068)
Chi^2-test difference of emu-coef 90-94=99-02 (p>Chi^2)	4.03	4.62	5.40	5.89	4.99	5.31
	(0.045)	(0.032)	(0.020)	(0.015)	(0.026)	(0.021)
Chi^2-test difference of emu-coef 90-94=02-05 (p>Chi^2)	13.00	19.55	12.34	19.68	16.85	19.66
	(0.0003)	(0.000)	(0.0004)	(0.000)	(0.000)	(0.000)
Chi^2-test difference of emu-coef 94-99=02-05 (p>Chi^2)	4.27	7.40	3.44	7.08	5.94	6.75
	(0.039)	(0.007)	(0.064)	(0.008)	(0.015)	(0.009)
MA 1 (ε_{t-1})	-0.019	-0.027	-0.016	-0.021	-0.007	-0.011
	(0.040)	(0.040)	(0.040)	(0.040)	(0.042)	(0.042)
Variance Equation:						
Intercept	0.0004	0.0003	0.0004	0.0003	0.0003	0.0003
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ARCH 1 (ε^2_{t-1})	0.063***	0.064***	0.062***	0.063***	0.063***	0.064***
	(0.014)	(0.015)	(0.014)	(0.015)	(0.018)	(0.020)
GARCH 1 (σ^2_{t-1})	0.935***	0.934***	0.936***	0.935***	0.935***	0.934***
	(0.012)	(0.013)	(0.012)	(0.013)	(0.016)	(0.017)
N	906	900	903	897	897	897
Wald chi^2	62.82	75.21	76.76	84.71	105.41	106.64
(Prob > chi^2)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log likelihood	-710.731	-705.386	-700.348	-696.447	-686.572	-686.414
***p<=0.01; **p<=0.05; *p<=0.1						

Table 2: continued

Dependent variable: changes of real interest rates	Model 4: EU, trade weighted (UK, DNK, SWE)	Model 5: EFTA, trade weighted (NOR, ICE, SWI)	Model 6: Non-European, trade weighted (AUS, NZ)	Model 7: CAN trade weighted
Mean Equation:				
Intercept	-0.085	-0.190**	-0.120	-0.023
	(0.066)	(0.097)	(0.291)	(0.193)
Level of Real Interest Rate	0.037***	0.045***	0.035	0.037**
	(0.012)	(0.010)	(0.037)	(0.016)
Δ Real Interest Rate Ger, 80-90	0.066	0.288***	-0.478	-0.069
	(0.114)	(0.089)	(0.385)	(0.091)
Δ Real Interest Rate Ger/Euro, 90-94	0.032	0.092	-0.261	0.130
	(0.079)	(0.058)	(0.195)	(0.203)
Δ Real Interest Rate Euro-zone, 94-99	0.244***	0.013	0.113	0.237
	(0.092)	(0.098)	(0.173)	(0.252)
Δ Real Interest Rate Euro-zone, 99-02	0.324***	0.475***	0.113***	0.007
	(0.102)	(0.163)	(0.029)	(0.056)
Δ Real Interest Rate Euro-zone, 02-05	0.601***	0.384**	0.034	0.132
	(0.101)	(0.158)	(0.056)	(0.123)
Δ Real Interest Rate USA, 80-90	-0.067	0.029	0.029	0.491***
	(0.044)	(0.036)	(0.050)	(0.056)
Δ Real Interest Rate USA, 90-94	0.137***	0.192***	0.368*	0.738***
	(0.055)	(0.043)	(0.197)	(0.185)
Δ Real Interest Rate USA, 94-99	0.066	0.092**	0.241**	0.624*
	(0.049)	(0.044)	(0.124)	(0.376)
Δ Real Interest Rate USA, 99-02	0.025	0.043*	0.069	0.718***
	(0.021)	(0.025)	(0.238)	(0.163)
Δ Real Interest Rate USA, 02-05	0.008	0.087***	0.207	0.934***
	(0.020)	(0.026)	(0.165)	(0.181)
Domestic Growth	-0.002	0.003	0.019	-0.011
	(0.008)	(0.004)	(0.024)	(0.015)
Growth Germany/Eurozone	-0.003	0.010	0.003	-0.002
	(0.006)	(0.006)	(0.008)	(0.009)
Growth USA	0.029***	0.001	-0.001	0.032
	(0.010)	(0.009)	(0.022)	(0.023)
Domestic Unemployment	-0.021**	-0.003	-0.033	-0.028
	(0.011)	(0.013)	(0.030)	(0.020)
FE	Yes	Yes	Yes	No
MA 1 (ε_{t-1})	-0.010	0.125***	0.047	-0.020
	(0.041)	(0.038)	(0.224)	(0.076)
Variance Equation:				
Intercept	0.0002	0.013***	0.983***	0.073***
	(0.0005)	(0.003)	(0.155)	(0.023)
ARCH 1 (ε^2_{t-1})	0.060***	0.245***	0.021	0.500***
	(0.017)	(0.039)	(0.020)	(0.123)
GARCH 1 (σ^2_{t-1})	0.938***	0.760***	-0.580***	0.361***
	(0.015)	(0.031)	(0.119)	(0.100)
N	897	883	592	299
Wald chi^2	102.42	109.15	43.81	208.97
(Prob > chi^2)	(0.000)	(0.000)	(0.000)	(0.000)
Log likelihood	-688.983	-863.057	-701.910	-230.303
***p<=0.01; **p<=0.05; *p<=0.1				

Table 3: Pooled GARCH First Differences Models. Dependent Variable: Change in Real Interest Rate of Non-EMU EU Countries, EFTA Countries and Non-European Countries

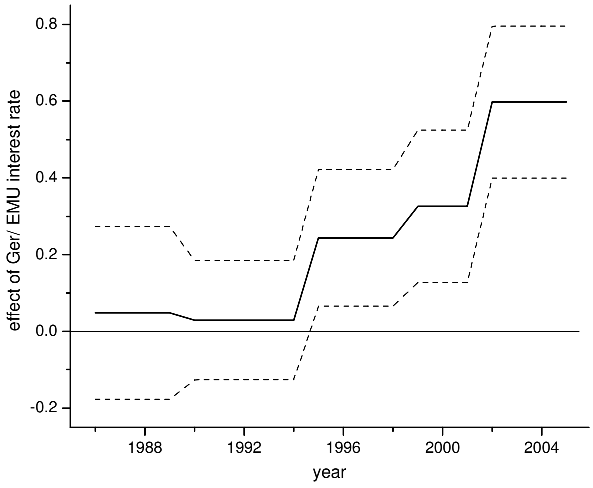

figure 1a: the impact of EMU interest rate on non-EURO EU countries' interest rate

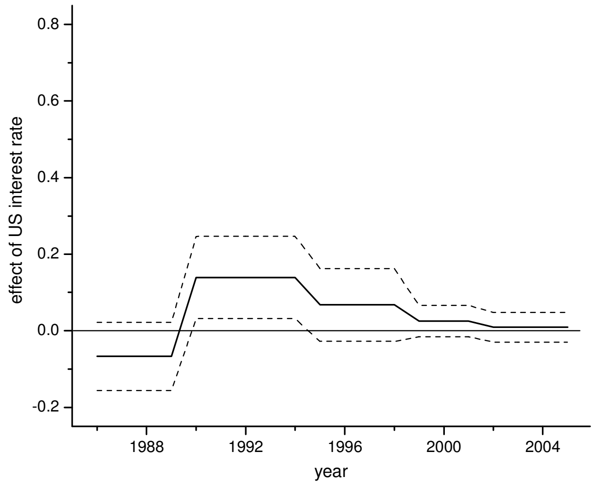

figure 1b: the impact of US interest rate on non-EURO EU countries' interest rate

Figure 1: The Impact of EMU and US Interest Rate on Non-EURO EU Countries' Interest Rate

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