Fear of Floating and the External Effects of Currency Unions

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The introduction of the Euro has considerably affected the de facto monetary policy autonomy—defined as independence from monetary policy in the key currency areas—in countries outside the European Currency Union (ECU). 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 for countries that dominantly trade with the Dollar zone. The predictions of our model find support in the data. We estimate the influence of the Bundesbank's/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 the 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.

There can be no doubt that the introduction of the Euro exerted a strong influence on monetary and fiscal policies in the Eurozone countries. Less well known is if and how the introduction of the Euro has affected the decisions of monetary authorities in countries outside the European Monetary Union (EMU). This article shows exactly this. Countries which dominantly import from EMU countries now tend to more closely align their monetary policy with the European Central Bank's (ECB) monetary policy. Countries that dominantly import goods and services from the United States on the contrary experienced a very moderate increase in de facto monetary policy autonomy (defined 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 the monetary authority can use monetary policy to offset the consumption and employment effects of an unexpected economic shock (see Franzese 2002 for an overview of this literature). In the second step we "open" the economy and allow exchange-rate fluctuations affecting the domestic inflation rate. Monetary policy can moderate exchange-rate fluctuations, but with one policy instrument for two economic goals—stabilization of employment versus stabilization of the exchange rate—the monetary authorities face a dilemma.

This second 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 countries which have pegged their exchange rate to a key currency or a currency basket but also floating countries lack monetary autonomy if monetary policy is used to stabilize the exchange rate to a key currency (Calvo and Reinhart 2002; Frankel, Schmukler, and Serven 2004; Shambaugh 2004). In our model the incentive to use soft pegs—that is, to de facto stabilize an officially floating currency—results from the inflationary effects of exchange-rate depreciations (see also Bayoumi and Eichengreen 1998). A reduction of the real

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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. Since an increase in inflation lowers government support, monetary authorities, especially in small, open economies, are motivated to stabilize the exchange rate (Calvo and Reinhart 2002, 391). Accordingly, many countries which are formally floating "are de facto 'importing' the monetary policy of the major-currency countries" (Frankel, Schmukler, and Serven 2004, 703).

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 Eurozone and Dollar zone. Countries that predominantly import goods and services from the Eurozone 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. The introduction of the Euro provides the natural test case for our theory.[1] We examine 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 ECB'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 U.S. 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 impact on the monetary policy of EFTA countries (Norway and Switzerland).[2] 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 Eurozone (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 United States than with the Eurozone (Australia and New Zealand) have gradually gained in monetary policy autonomy. And fifth, we show that Canada—a country that until 2001[3] has used the exchange rate with the Dollar as main information for determining the interest rate—does not experience significant changes in monetary policy autonomy.

These three tests are in line with the predictions 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. The fifth test case we analyze, Canada, provides a comparison to a country for which our model makes only weak predictions. In the 1990s Canada used monetary policy to stabilize the exchange rate of the Canadian Dollar to the US Dollar (Zettelmeyer 2004, 18). Canada relaxed the de facto exchange-rate fix with the US Dollar in November 2000. These policy changes coincide with the introduction of the Euro, though it is difficult to argue that the apparent changes in Canada's monetary policy around the beginning of the new century solely result from the introduction of the Euro. Nevertheless, the Canadian case does not contradict the implications of our model.

[1]In principle, our theory may be extended to make predictions on changes in 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 to 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.

[2]The inclusion of Iceland (which we left out because the country seems to be too small to cause exchange-rate effects on global capital markets) does not change our results substantively.

[3]For an analysis of the politics of the Bank of Canada's monetary policy in the 1990s, see Zettelmeyer (2004, 18), who argues that since automatic foreign exchange intervention was ineffective, monetary policy adjustments were important to stabilize the exchange rate to the US Dollar.

Monetary Policy Autonomy in Open Economies

Fixed exchange rates have crucial advantages. By reducing exchange-rate uncertainty, they lower transaction costs to international trade and thus foster economic growth (Rose 2000).[4] In addition, since the removal of exchange-rate pegs is economically and politically costly, the pegging country may borrow monetary policy credibility from the key currency's monetary authority (Keefer and Stasavage 2002; Lohmann 1992). The flip side of pegged exchange rates is that monetary policy autonomy declines. 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, domestic interest rates cannot be set independently but rather must track closely those prevailing in the country to which the domestic currency is pegged" (Frankel, Schmukler, and Serven 2004, 702). This logic was first established by Robert Mundell and Marcus Fleming in the early 1960s (Fleming 1962; Mundell 1961, 1962). The trade-off Mundell and Fleming have constituted still fuels political economic explanations of monetary, financial, and exchange-rate policies (see inter alia, Bernhard, Broz, and Clark 2002; Broz and Frieden 2001; Giavazzi and Pagano 1988; Rogoff 1985).

The Mundell-Fleming model is often interpreted dichotomously. Countries either peg their 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.[5] The dichotomous view, however, is more a useful simplification than an entirely appropriate description of exchange-rate regimes. Since pegs may come with fairly generous bandwidths, monetary authorities maintain some, albeit limited, autonomy over monetary policy. Bernhard, Broz, and Clark therefore correctly point out that the monetary authority of the pegging country "is, *to a large extent* [emphasis added], delegating monetary policy to a foreign central bank" (2002, 695).

Recently, the fear of floating literature has added that a floating exchange-rate system does not necessarily imply full monetary policy autonomy. Rather, monetary authorities that pretend to maintain a floating regime often de facto implement 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, identify two reasons why "countries that say they allow their exchange rate to float mostly do not" (2002, 379). Firstly, 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. And secondly, many governments stabilize their exchange rate to key currencies because of what has been dubbed "exchange-rate pass-through" (Hausmann, Panizza, and Stein 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 in 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, Bolton, and Dewatripont 2000). However, 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 seek to maintain domestic price stability.[6]

The fear of floating literature leads to a more continuous conception of the Mundell-Fleming logic. In countries with floating exchange-rate regimes, central banks face a dilemma between monetary policy autonomy and the desire to avoid import-driven inflation. The severity of this dilemma does not solely result from the chosen exchange-rate regime but also depends on the size of the country, trade openness, capital flows, 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. Thus, monetary authorities in small, open

[4]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.

[5]For example, Broz and Frieden 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" (2001, 322).

[6]Over the past few years, abundant empirical evidence has been provided in favor of the fear of floating hypothesis. See Hausmann, Panizza, and Stein (2001), Shambaugh (2008), Campa and Goldberg (2005), and Devereux, Lane, and Xu (2006) for evidence in support of the exchange-rate pass-through hypothesis.

economies are not very likely to let the exchange rate of their currency to important key currencies freely float. In other words, these countries may have limited de facto monetary policy autonomy.

The fear of floating literature provides an extension to the Mundell-Fleming model rather than a substitute. It adds important insights to the political science literature on monetary policy in open economies, which has focused on two central questions: the choice of an exchange-rate regime and exchange-rate policy (Broz and Frieden 2006). For example, Clark and Hallerberg assume that "when capital is fully mobile and exchange rates are not fixed, (. . .) monetary policy is hypereffective" (2000, 326). This assumption remains valid in the fear of floating approach. However, the fear of floating literature argues that monetary authorities will be reluctant to use monetary policies *despite* its efficacy because the use of monetary policies is often costly. The model we develop in the following section will explore this argument further. In short, we will show that de facto monetary policy autonomy of many countries is limited even if they implement a de facto floating exchange-rate regime.

At the same time, our model combines the literature on monetary policy with recent advances on policy diffusion and policy spillovers (Simmons, Dobbin, and Garrett 2006; Simmons and Elkins 2004). Assuming that countries with flexible exchange rates enjoy full monetary policy autonomy implies that monetary policies in other countries have no effect on domestic monetary policies. Our model not only argues that spatial effects of monetary policy exist; it also predicts the *determinants* and (to a certain extent) *the size* of these monetary policy spillovers.

The insight that the fear of floating literature in general and our model in particular provide on the de facto monetary policy autonomy may also enrich the important political science literature on the choice of monetary regimes (see, for example, Bernhard, Broz, and Clark 2002; Clark 2002; Hallerberg 2002). Bernhard, Broz, and Clark identify four consequences of the exchange-rate choice: First, fixing the exchange-rate "can be a substantial benefit for economies that have had difficulty controlling inflation" (2002, 707). Second, an exchange-rate fix lowers the exchange-rate risk and thus the transaction costs to international trade and investment. Third, a flexible exchange rate helps authorities to respond to an economic shock "to which monetary policy might be the appropriate response" (2002, 708). And fourth, under an exchange-rate fix a real appreciation occurs if the domestic inflation rate minus productivity growth exceeds the inflation minus the productivity growth rate in the base economy. This real appreciation harms the country's competitiveness in the long run so that flexible exchange rates, which prevent a significant real appreciation of the domestic exchange rate, are beneficial for development goals. In respect to this literature, our model not only renews the view that the choice of a fixed exchange-rate regime is most likely if the probability of asymmetric economic shocks is low and trade with the key currency area important.

As we will show in the next section, our model also highlights that the number and relative size of key currencies influence the degree to which monetary authorities in nonkey currency areas follow the monetary policy of key currencies. If countries follow the monetary policy of a key currency closely, the disadvantages of a fixed exchange-rate regime become comparably low. Yet, the model that we develop in the next section concentrates on how the establishment of a currency union influences monetary policies in countries which have not joined the union.

De Facto Monetary Policy Autonomy and Currency Unions

We develop our formal model of monetary policy in open economies with competing key currencies in three steps. In the first step, we adopt a standard textbook version of a rational expectations model of monetary policy with nonpartisan central banks. Following Giavazzi and Pagano (1988) and Persson and Tabellini (2000), we assume that monetary policy is a political instrument which can be used to offset the unfavorable impact of economic shocks on consumption or to fine-tune the economy if economic subjects do not fully anticipate the interest-rate change. 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 final, 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 central bank 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 redirected to the prime trading partner—as was the case for the European countries that remained outside the Eurozone 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). The model is based on a monetary policy authority's loss function where suboptimal consumption and inflation enter quadratically:

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

$\bar{C}$ denotes optimal consumption which by definition cannot fall below the actual level of consumption C_t. a is a constant weighting the central bank's cost of inflation relative to that of suboptimal consumption.[7] Agents rationally expect the inflation rate π^e, which is a function of the natural rate of unemployment and the expected monetary policy

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

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 convention 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 central banks 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 nonaccelerating inflationary rate of unemployment (NAIRU; Mankiw 2001). 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. Central banks may still use it to respond to unexpected economic shocks. Augmenting the central bank'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 (4) includes a term for an idiosyncratic unexpected economic shock to the domestic economy (ε_t), which provides rational 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 central banks with higher incentives to use monetary policy. But even if a is large, many central banks use monetary policy to (partly) offset economic shocks (ε_t), with a only determining the extent to which central banks do so—though whatever the central bank does, an economic shock will reduce its utility. The optimal choice of monetary policy—i.e., the first-order condition for optimal inflation—implies to set

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

which after some simple transformation results in

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

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. Central banks can stabilize employment by responding

[7] We do not discuss partisan politics or central bank independence here (see, however, Broz 2002 and Hallerberg 2002). 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 independent central banks and perhaps also right parties have a higher α than left parties, our model can be extended. We cannot discuss possible theoretical extensions to our model because of space constraints.

to unexpected exogenous shocks of size ε. When central banks do not bring monetary policies in line with the exogenous shock, consumption decreases while inflation remains constant. Yet, this is not necessarily in the central bank's interest. Since both consumption and inflation enter the loss function quadratically, the central bank 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: under typical conditions, the best reaction is to *partly* offset the economic shock. The exact extent to which the central bank offsets exogenous shocks depends on the weight a (the lower a, the more the central bank reacts to exogenous shocks). If $a = 0$, central banks 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: $\partial \pi_t / \partial r_t < 0$. In what follows, we 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 central banks in small, open economies have lower incentives to offset the effect of exogenous shocks is well established in political economic research. If a central bank 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, in the short run 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.[8] In other words, monetary policy is less efficient the smaller and the more open the domestic economy is.

[8]It is only in the long run that a reduction of the interest rate causes a depreciation of the exchange rate, which may stimulate the economy by making domestic producers more competitive on foreign markets and foreign producers less competitive on domestic markets. In sum, a depreciation brings about a current account deterioration in the short run and an improvement in the long run—a J-curve effect. We are solely interested in short-run effects here and justify our perspective by arguing that governments use a rapid and significant exchange-rate depreciation only as "macroeconomic policy of last resort," which eases economic recovery after a fundamental crisis. See Eichengreen and Sachs (1985) on exchange-rate devaluation and economic recovery after the Great Depression and Bayoumi and Eichengreen (1994) for the influence of the exchange-rate regime on macroeconomic stabilization.

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 (Romer 1993). 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,

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

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 parentheses denotes exports of country 2 to country 1 divided by the GDP of country 1.

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

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 central bank's loss function, we get

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

Obviously the inflation rate and thus the utility of the monetary policy authority not only depend on domestic settings like optimal consumption but also on the exchange-rate effects of domestic monetary policy. 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 central bank is to use monetary policy to offset economic shocks. For these reasons, central banks 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 central bank's loss function (equation 10) with respect to exchange-rate adjustments, we observe a decline in utility (an increase in losses) if the domestic currency depreciates:

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

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 central bank cuts interest rates, capital outflows increase. As a result, the domestic currency loses value and rising prices of imported goods add to inflation[9] —a result again consistent with the empirical evidence (Shambaugh 2008).

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 static 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 country 2 is another key currency area. This setting nicely resembles a situation in which country 1 is the United Kingdom, country 2 the United States, 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. 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% of total transborder assets were held in Euro—up from a historical low of 13% in 1984 for the two dominant Eurozone 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 (BIS 2004; Galati and Tsatsaronis 2003; Plümper and Troeger 2006). 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 Eurozone. Though the BIS does not report the geographical composition of a 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%. 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 (Lane and Shambaugh 2007). Since this argument lies at the heart of our model, let us make the underlying logic clear. Suppose a world of three currencies (think of 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 "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

[9]The same holds true if central banks 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.

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 U.S. 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 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.[10] The change in country 1's monetary policy brings the system into disequilibrium. Since the central bank 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).

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

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

where $z_{1,i\neq 1}$ measures the exchange-rate effects between the currencies of country 1 and the other three 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 weight larger currencies in their portfolio more strongly. Equation (12) 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 (Kaminsky and Reinhart 1999; Radelet and Sachs 1998), lost approximately 80% 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.

We now can reconsider the part of equation (10) which sets central bank losses in relation to currency depreciation in country 1. Let

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

be the partial exchange-rate effect on utility. Hence, inserting equation (12) into (13) and simplifying the equation gives

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

Equation (14) might look inconvenient but it just describes the sum of all partial effects. With respect to the total loss in utility for the central bank in country 1, both

[10] 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.

equations provide us with unsurprising results: the 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 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 losses are higher the less equal the sizes of countries 2–4 are. In the same vein, losses are smaller, the fewer goods and services country 1 imports from the largest currency. These results of the model find support in the empirical literature. 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, Eichenbaum, and Rebelo 2002).

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

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

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:

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

We find that the interest-rate differential to country 2 becomes less important for country 1. This suggests that the influence of the U.S. 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 to 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 ($\overline{34}$) 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) the monetary policy autonomy of country 1.

Discussion and Hypotheses

In respect to the de facto monetary policy autonomy of open economies, our model makes the following 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).[11]

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:

[11] All predictions are valid only for countries without a strictly pegged exchange rate. Yet, our model can be reformulated in a way that allows us to make predictions on 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.

H1: The creation of a monetary union influences monetary policy autonomy of nonmembers (see equation 11).

Furthermore, the establishment of a union's currency influences monetary policy autonomy of nonmembers 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.

H2: 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 equations 15–16).

The dependency of third parties' monetary policy on the monetary policy of the nonunion'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.

H3: The establishment of a union's currency reduces (increases) monetary policy autonomy of nonmembers if the nonmembers import more (less) from the union's currency area than from other key currency areas (see equations 15–16).

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, Shambaugh, and Taylor 2004, 78; see also Frankel, Schmukler, and Serven 2002; 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).

Cases included on our analyses must satisfy a list of conditions: First, they must have implemented a floating exchange-rate system.[12] Second, countries should not have experienced a period of hyperinflation between 1980 and 2005. Third, countries should have had a responsive government (democracy) throughout 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.[13] 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 United Kingdom, 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.[14] We use these countries to test Hypotheses 1 and 2 in a first set of tests. The second group consists of EFTA countries. Norway and Switzerland (and Iceland) import less than the EU countries from the Eurozone, but imports from Eurozone countries still exceed imports for the United States.[15] The third group includes New Zealand and Australia. These two countries have relatively low trade openness and import more goods from the United States than from the Eurozone.[16] We therefore do not expect that the central banks of New Zealand and Australia start to follow the monetary policy

[12]Our model predicts that countries with a fixed peg to the US Dollar become less likely to maintain the exchange-rate peg after the introduction of the European currency union, but this article exclusively deals with the impact of currency unions on the monetary policy of countries outside the union.

[13]The decade of deflation in Japan made the country's monetary policy largely immune against imported inflation for much of the last 15 years—we therefore do not use Japan as a test case.

[14]The three EU countries import on average over the period under observation 50% of all imports from the Eurozone and only 8% from the United States.

[15]The three EFTA countries import about 40% from the EMU and about 8% from the United States. We ran the models including and excluding Iceland with no significant changes of the estimated effects. Due to space constraints we only present the model without Iceland. Findings including Iceland can be obtained from the authors upon request.

[16]Australia and New Zealand import on average 20% from the United States and 13% from the EMU.

of the ECB. However, our model predicts a moderate increase in monetary policy autonomy, i.e., a lesser alignment of the interest rate of these two countries to the Fed's prime rate. Thus, New Zealand and Australia allow a direct test of Hypothesis 3.

All aforementioned countries either allow their currencies to float or have implemented a de facto peg with very broad bandwidths. The last country in our sample is somewhat different. Until November 2000, Canada had de facto pegged its Dollar to the US Dollar and according to Reinhart and Rogoff (2004) kept the exchange rate within very narrow bandwidths of +/−2%. Since then, the Bank of Canada uses a forecasting model to set its prime interest rate. For the first 20 years of our sample, the Canadian monetary authorities used their monetary policy to stabilize the US Dollar exchange rate.[17] Still, our model predicts a small decline in the alignment of the Bank of Canada's prime interest rate to the Fed's discount rate. As with Australia and New Zealand, we do not expect an observable increase in the effect of the ECB's interest rate on the Canadian interest rate.

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, the EMU, and the United States, 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 observe parameter heterogeneity between the two subsets of countries. 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. Appendix A displays the summary statistics of the nominal central bank interest rates for the countries in our sample. We use the real interest rate in the regression analysis, because central banks calculate the real interest-rate difference to other currencies when setting their interest rate and because they can immediately adjust to changes in the real interest-rate difference or to any exogenous shock.

Our theory predicts a larger impact of the monetary policy set in the EMU the more important the Euro as an international safe haven currency becomes. This implies that the impact of the Eurozone 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 U.S. interest rate) and period dummies. Since the Euro was phased in, our specification distinguishes five time periods. On July 1, 1990, the EMU countries fully liberalized capital accounts vis-à-vis each other and enforced 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 rates and introduced the Euro. Finally, in January 2002 the Euro became the only means of payment in all EMU countries. We expect to find a first increase in influence of the EMU's interest rate on monetary policy in other countries in 1994 with the beginning of interest-rate harmonization and a second increase in 1999 with the introduction of the Euro. We nevertheless estimate separate slopes for the less significant periods to provide additional information and an additional test of our model.

Our econometrical setup follows the well-known Chow test (Chow 1960). Accordingly, we allow for different slopes at different stages of the Euro introduction and use simple Chi^2 tests to test whether the impact of the Eurozone 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 United States. 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 remain robust if we suppress these weights. 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 U.S. 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 were provided by Global Financial Data, Inc. The inclusion of additional variables aims at controlling business-cycle influences 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

[17] Canada traditionally imports most of its goods and services from the United States (more than 65% on average) with only a negligible small share imported from the Eurozone (about 6%).

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 control variables.

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. It is therefore recommended to either cointegrate the time series or to take the first differences. While Wu and Zang (1997) show that levels of interest rates are typically trended and at least close to nonstationarity,[18] our cointegration tests indicate that the dependent and independent interest-rate series are not cointegrated and do not fluctuate around a long-term equilibrium. Even if that were not the case, cointegration relationships are unlikely to be identical across the countries in our sample. This finding prevents cointegration 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, Shambaugh, and Taylor 2005; Shambaugh 2004), since we are interested in short-term adjustments rather than in long-term effects, but differencing also nicely reflects our theory. We look at immediate reactions of monetary authorities in the outsider countries to monetary policy changes of the European Central Bank.[19]

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 (see Plümper and Troeger 2007). For this reason, we run Panel-GARCH models, which 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 U.S. 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 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 unbiased and efficient estimation results.

Empirical Analysis

In this section, we test the three main hypotheses derived from the formal model. We perform two series of tests. In the first series, we test Hypotheses 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: the United Kingdom, Denmark, and Sweden. 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 series 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 (Switzerland and Norway) which geographically are about as close to the Eurozone as the EU members, but import slightly less from the Eurozone than the United Kingdom, Denmark, and Sweden. Because the difference is small, we expect small and perhaps insignificant differences in the monetary policy alignment of the outside countries to the Euro's interest rate. The second "control group" includes New Zealand and Australia. Both countries import slightly more goods and services from the United States than from the Eurozone. We therefore expect a very small increase in monetary policy autonomy, but significant differences in monetary policy alignment to the Euro in comparison with group 1 and 2 countries. More specifically, our theory predicts a small decline in the influence of the US Dollar's 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 a third and last control case. Since Canada maintained an exchange-rate peg with narrow bands over the period we analyze, our theory predicts no influence

[18]We were unable to detect any cointegration equations with the usual Johansen tests. We have also conducted the Augmented Dickey Fuller and the Kwiatkowski, Phillips, Schmidt, and Shin test for stationarity of the differenced time series. Both tests suggest that each of our dependent time series indeed are stationary after first differencing.

[19]As Plümper, Troeger, and Manow (2005) show, using an appropriate lag structure crucially determines the estimation results, especially in first-difference models. In our case it is theoretically reasonable and empirically plausible to expect an immediate effect of changes in the interest rate policy of the key currency area.

or an unsystematic influence of the Eurozone's monetary policy. If indeed we find no systematic effect for Canada, we can be more certain that the systematic effects we observe for the other countries were actually brought about by the introduction of the Euro (rather than by any other change in global financial markets). We report and discuss both sets of tests in turn.

Testing Hypotheses 1 and 2: The Euro and Monetary Policy in the United Kingdom, 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. Table 1 lists the regression results for the impact of the 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 trade-weighted models, but using unweighted variables does not significantly alter the results (results are available on request). Model 1 includes only the variables of our main interest, without controlling for the US Dollar's influence on the monetary policy in the United Kingdom, Denmark, and Sweden, and thus provides a test of Hypothesis 1. Model 2 adds the U.S. base interest rate and therefore tests Hypothesis 2. It can also be considered as a robustness check for Hypothesis 1. In Model 3 we include the battery of controls which we have discussed earlier.

Before turning to the discussion of the substantive empirical results, a quick note on our model specification and on the coefficient of the level of the domestic interest rate seems warranted. First, the estimation of the variance equation reveals the necessity of controlling for autoregressive conditional heteroskedasticity. 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, but the variance at time t also depends on the variance at $t - 1$. Ignoring this fact would have rendered estimates inefficient and most likely unreliable. Since the sum of the ARCH and the GARCH terms falls short of unity, our estimates conform to the stability condition for ARCH models. After having taken first differences and controlled for ARCH, the remaining residuals are white noise. And second, the contemporary level of the domestic interest rate exerts a positive albeit very small effect on the change of the interest rate. We interpret the positive sign of the level variable as indication that interest rates adjustments tend to be larger if the interest-rate level is higher. From an econometric perspective, this positive coefficient could also be interpreted as causing an explosive effect on the interest rate. Yet, for this interpretation the effect of lagged levels of the real interest rate on its changes is much too small. The lagged effect will not show up in monetary policies (monetary authorities tend to change the interest rates in steps of quarter percentages). The time series remain stationary, because the potentially explosive positive effect is much smaller than the negative intercept.

The results reported in Table 1 lend support to our theoretical model. Changes in the key currency's interest rate have the assumed significant and positive effect on the decision of the EMU outsiders to adjust their interest rates equally. This holds true for the whole period under observation. Observe, first, that the D-Mark base rate had no systematic influence on the British, Swedish, and Danish monetary policy before 1994. Since then, the influence of the Euro had been stronger than the influence of the D-Mark, while the Dollar has lost its systematic impact on the monetary policy of the three countries in our sample. Since 1999, a 1% change in the EMU interest rate was followed by at least an average increase of 0.35% points in the three EU countries that did not take part in the Monetary Union. After 2002, the association has risen above 0.60%. Thus, and most importantly, the influence of the ECB's monetary policy on the EU members which abstained from introducing the Euro increased with every single step towards the Euro. The Chi^2 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.

These results are robust to the inclusion of the U.S. monetary policy and further control variables (Models 2 and 3). To start with Model 3, the control variables explain very little of the variation in the dependent variable and do not alter our main results in any significant way. The small effect of the controls, 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, but the central banks are not very likely to respond immediately to changes in, for example, the unemployment rate. 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 U.S. growth and the negative and statistically significant effect of unemployment indicate business-cycle effects for monetary policy setting. Increasing unemployment drives central banks to cut back main interest rates to stimulate the economy and induce growth and employment.

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

Dependent Variable: Change in Real Interest Rates of Non-EMU EU Countries (Denmark, Sweden, UK)	Model 1 Trade Weighted	Model 2 Trade Weighted	Model 3 Trade Weighted
Mean Equation:			
Intercept	−0.040*	−0.039*	−0.426**
	(0.022)	(0.022)	(0.177)
Level of Real Interest Rate (DNK, SWE, UK)	0.019**	0.018**	0.042***
	(0.008)	(0.008)	(0.012)
ΔReal Interest Rate Germany, 80–90	0.053	0.087	0.048
	(0.109)	(0.113)	(0.115)
ΔReal Interest Rate Germany/Eurozone, 90–94	0.081	0.038	0.029
	(0.077)	(0.079)	(0.079)
ΔReal Interest Rate Eurozone, 94–99	0.269***	0.247***	0.244***
	(0.091)	(0.092)	(0.091)
ΔReal Interest Rate Eurozone, 99–02	0.358***	0.355***	0.326***
	(0.103)	(0.103)	(0.101)
ΔReal Interest Rate Eurozone, 02–05	0.636***	0.615***	0.597***
	(0.098)	(0.103)	(0.101)
ΔReal Interest Rate USA, 80–90		−0.049	−0.067
		(0.044)	(0.046)
ΔReal Interest Rate USA, 90–94		0.125**	0.139**
		(0.057)	(0.055)
ΔReal Interest Rate USA, 94–99		0.066	0.068
		(0.048)	(0.049)
ΔReal Interest Rate USA, 99–02		0.018	0.025
		(0.021)	(0.021)
ΔReal Interest Rate USA, 02–05		0.013	0.009
		(0.020)	(0.020)
Exchange rate towards DM/EURO			0.032
			(0.020)
Exchange rate towards US$			0.014
			(0.019)
Growth (Denmark, Sweden, UK)			0.0001
			(0.009)
Growth Germany/Eurozone			−0.001
			(0.006)
Growth USA			0.037***
			(0.011)
Unemployment (Denmark, Sweden, UK)			−0.032**
			(0.013)

continued

More importantly, both Models 2 and 3 lend some support to Hypothesis 2, but the results are rather mixed and depend on whether we compare the post-1994 influence of the Dollar to the influence the Dollar had in the 1980s or to its influence in the early 1990s. Comparing the 1994–99, the 1999–2002, and the 2002–2005 coefficients to the 1990–94 coefficient indeed backs Hypothesis 2. However, if we compare the influence the Dollar

TABLE 1 (part 2) **Continued**

Dependent Variable: Change in Real Interest Rates of Non-EMU EU Countries (Denmark, Sweden, UK)	**Model 1 Trade Weighted**	**Model 2 Trade Weighted**	**Model 3 Trade Weighted**
FE Sweden			−0.010
			(0.045)
FE UK			0.277*
			(0.146)
Chi^2-test difference of EMU-coef 80–90 = 99–02	4.12	3.09	3.33
($p>Chi^2$)	(0.043)	(0.079)	(0.068)
Chi^2-test difference of EMU-coef 90–94 = 99–02	4.57	5.88	5.30
($p>Chi^2$)	(0.033)	(0.015)	(0.021)
			(0.000)
Chi^2-test difference of EMU-coef 90–94 = 02–05	19.58	19.69	19.67
($p>Chi^2$)	(0.000)	(0.000)	(0.000)
Chi^2-test difference of EMU-coef 94–99 = 02–05	7.49	7.08	6.75
($p>Chi^2$)	(0.006)	(0.008)	(0.009)
MA 1 (ε_{t-1})	−0.025	−0.021	−0.011
	(0.040)	(0.040)	(0.042)
Variance Equation:			
Intercept	0.0003	0.0003	0.0003
	(0.001)	(0.001)	(0.001)
ARCH 1 (ε^2_{t-1})	0.062***	0.063***	0.064***
	(0.015)	(0.015)	(0.020)
GARCH 1 (σ^2_{t-1})	0.936***	0.935***	0.934***
	(0.013)	(0.013)	(0.017)
N	897	897	897
Wald chi^2	74.50	84.68	106.62
(Prob > chi^2)	(0.000)	(0.000)	(0.000)
Log likelihood	−701.030	−696.517	−686.488

***p <= 0.01; **p <= 0.05; *p <= 0.1.

had on the three countries in our sample to its influence during the 1980s we find no systematic difference. We do not want to save Hypothesis 2 here, but the lack of clear decline in the influence of the U.S. 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-1994 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 see later that the effect of the Dollar was apparently more pronounced in other countries.

Moreover, by adding the U.S. 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 the interest rate in non-Euro countries could have been caused by the worldwide reduction in barriers to capital flows and the subsequent increase in global financial integration. However, only our model and no competing theory that we are aware of predicts a declining role of the Dollar as the key currency. The financial market integration explanation would generally predict an increase in the correlation between monetary policies of open countries. That we find no increase and possibly even a decline in the influence of the U.S. 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 1 The Impact of EMU and U.S. Interest Rate on Non-EURO EU Countries' Interest Rate

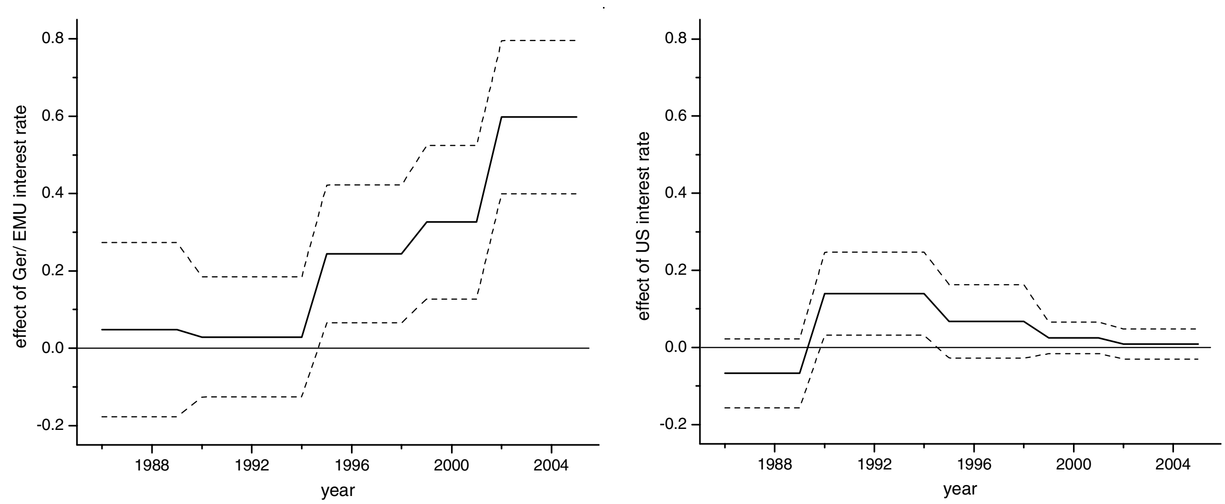

Figure 1a: The impact of EMU interest rate on non-EURO EU countries' interest rate

Figure 1b: The impact of U.S. interest rate on non-EURO EU countries' interest rate

Figures 1a and 1b visualize the relative strengths of both the D-Mark/Euro's and the Dollar's influence on monetary policy in the three non-EMU EU countries. We display coefficients (straight lines) and confidence intervals (dotted lines) from Model 3 in Table 1.

Figure 1a highlights the increasing effect of the interest rate set in the Eurozone after 1994 and also reveals that the confidence intervals become much narrower after 1990 and that the effect turns significant from 1994 onwards—the confidence bands do not include the zero line anymore. The effect of the U.S. 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 partially lost its anchor function due to the unification turbulences in German monetary policy.

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 check. Second, we now analyze countries that trade more with the United States and less with the Eurozone. Therefore, we should be able to find a stronger effect of the Euro introduction on the correlation between the US Dollar's 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, Australia, and perhaps even Canada provides a test of Hypothesis 3.

Table 2 reports four identical models for the four country groups included in our analysis.

Results of Model 4 are almost identical to Model 3. The sole difference is that Model 4 does not estimate a slope coefficient for the theoretically unimportant and insignificant exchange rates towards the Euro and the US Dollar. The results are robust to this moderate change. Model 5 estimates an identical model for the sample of the two 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 declined 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 impact 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

TABLE 2 Pooled GARCH First Differences Models. Dependent Variable: Change in Real Interest Rate of Non-EMU EU Countries, EFTA Countries, and Non-European Countries

Dependent Variable: Change in Real Interest Rates	Model 4: EU, Trade Weighted (UK, DNK, SWE)	Model 5: EFTA, Trade Weighted (NOR, SWI)	Model 6: Non-European, Trade Weighted (AUS, NZ)	Model 7: CAN Trade Weighted
Mean Equation:				
Intercept	−0.085	−0.296**	−0.120	−0.023
	(0.066)	(0.123)	(0.291)	(0.193)
Level of Real Interest Rate	0.037***	0.087***	0.035	0.037**
	(0.012)	(0.020)	(0.037)	(0.016)
ΔReal Interest Rate Ger, 80–90	0.066	0.278***	−0.477	−0.069
	(0.114)	(0.085)	(0.385)	(0.091)
ΔReal Interest Rate Ger/Euro, 90–94	0.032	0.044	−0.260	0.130
	(0.079)	(0.058)	(0.195)	(0.203)
ΔReal Interest Rate Eurozone, 94–99	0.244***	0.026	0.113	0.237
	(0.092)	(0.108)	(0.173)	(0.252)
ΔReal Interest Rate Eurozone, 99–02	0.324***	0.390**	0.113***	0.007
	(0.102)	(0.200)	(0.029)	(0.056)
ΔReal Interest Rate Eurozone, 02–05	0.601***	0.361**	0.033	0.132
	(0.101)	(0.185)	(0.056)	(0.123)
ΔReal Interest Rate USA, 80–90	−0.067	0.033	0.029	0.491***
	(0.044)	(0.032)	(0.050)	(0.056)
ΔReal Interest Rate USA, 90–94	0.137***	0.201***	0.367*	0.738***
	(0.055)	(0.039)	(0.197)	(0.185)
ΔReal Interest Rate USA, 94–99	0.066	0.174***	0.241**	0.624*
	(0.049)	(0.061)	(0.124)	(0.376)
ΔReal Interest Rate USA, 99–02	0.025	0.043*	0.069	0.718***
	(0.021)	(0.027)	(0.237)	(0.163)
ΔReal Interest Rate USA, 02–05	0.008	0.112***	0.207	0.934***
	(0.020)	(0.031)	(0.165)	(0.181)
Domestic Growth	−0.002	0.010	0.019	−0.011
	(0.008)	(0.007)	(0.024)	(0.015)
Growth Germany/Eurozone	−0.003	0.009	0.003	−0.002
	(0.006)	(0.006)	(0.008)	(0.009)
Growth USA	0.029***	−0.003	−0.001	0.032
	(0.010)	(0.009)	(0.022)	(0.023)
Domestic Unemployment	−0.021**	−0.012	−0.033	−0.028
	(0.011)	(0.015)	(0.030)	(0.020)
FE	Yes	Yes	Yes	No
MA 1 (ε_{t-1})	−0.010	0.153***	0.047	−0.020
	(0.041)	(0.050)	(0.224)	(0.076)
Variance Equation:				
Intercept	0.0002	0.028***	0.983***	0.073***
	(0.0005)	(0.009)	(0.155)	(0.023)
ARCH 1 (ε^2_{t-1})	0.060***	0.269***	0.021	0.500***
	(0.017)	(0.058)	(0.020)	(0.123)
GARCH 1 (σ^2_{t-1})	0.938***	0.630***	−0.580***	0.361***
	(0.015)	(0.067)	(0.119)	(0.100)
N	897	595	592	299
Wald chi^2	102.42	108.63	43.80	149.91
(Prob > chi^2)	(0.000)	(0.000)	(0.000)	(0.000)
Log likelihood	−688.983	−337.538	−701.910	−230.303

***p <= 0.01; **p <= 0.05; *p <= 0.1.

on monetary policy in Australia and New Zealand. As theoretically predicted, the influence of the Euro increased less than we observed for the 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 us 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—delayed adjustments, for example, enter our estimation as noise. If we interpret the results cautiously in light of Hypothesis 3, then we find some moderate support. The influence of the Dollar on monetary policy weakened with the introduction of the Euro. The Euro, however, does not exceed an equally strong impact 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 make relatively weak predictions for Canada. Thus, we do not expect much of an influence of the Euro's monetary policy and a very strong effect of the US Dollar over all periods. Still, the results reported in Model 7 are basically in line with our weak 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.

Overall Discussion

The tests of Hypotheses 1 to 3 and the comparison across the four country groups are by and large in line with our theory. Our model thus makes important 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, and we find support for Hypotheses 1 and 2 if we look at the EU countries and the EFTA countries and for Hypothesis 3 if we consider 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 United States 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 U.S. interest rate still exerts a dominant influence on 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 remain therefore small.

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. Denmark, for example, removed restrictions on foreign exchange accounts on October 1, 1988, Sweden on July 1, and Norway followed on December 8, 1989 (Miniane 2004, Table 7). Until these restrictions were fully removed, the countries defended 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. And second, during the 1980s all monetary policy authorities 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 United States' 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 de facto 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 Eurozone like the three EU members (Denmark, Sweden, and the United Kingdom) 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 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 a strong contender.

Conclusion

The ability of 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, central banks increasingly seek to reach two goals with one instrument: monetary policy shall ensure stable employment *and* stable exchange rates. We find that stabilizing the exchange rate becomes relatively more important for a country the larger its imports from key currency areas. Perhaps more crucially, our model predicts that the independence of monetary policies from the monetary policy in key currency areas declines for countries that dominantly trade with the Eurozone and slightly increases for countries that dominantly trade with the Dollar zone.

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 Eurozone on monetary policy in the United Kingdom, Sweden, Denmark, Norway, Switzerland, and Iceland is at least twice as strong as it was before the introduction of the Euro, while the influence of the U.S. 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 U.S. monetary policy on the six countries under observation declined while the influence of the Eurozone grew.

Our findings not only provide valuable insights for scholarly work dealing with monetary policy. Specifically, our model also allows researchers to model the choice of monetary policies in open economies, and it offers a microfoundation for monetary policy spillovers from key currencies to smaller currencies.

In addition, our model also speaks to the extensive political science 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 on the other hand (see inter alia Bernhard, Broz, and Clark 2002; Clark 2002; Hallerberg 2002), 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. Our findings thus suggest that the policy choice of governments which face a trade-off between monetary policy autonomy and exchange-rate stability also depends on the global monetary system: the greater the dominance of one or a small number of key currencies and the larger the correlation between monetary relations and trade relation in a dyad of countries, the more likely does the country with the smaller currency fix its exchange rate with the dominant key currency. Thus, our findings call for future research on the dyadic structure of monetary policy regime choices. Countries do not simply fix their exchange rate—countries fix their exchange rate with key currencies or a basket of key currencies.

The introduction of the Euro also increasingly challenges the leading role of the US Dollar as anchor currency. The change to a more flexible approach to monetary policy in Canada might have been a mere coincidence with the introduction of the Euro—it still is basically in line with our theoretical model, which predicts a small increase in de facto monetary policy autonomy for Canada.

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 its own currency. Across Europe, we observe a growing discussion on the delayed introduction of the Euro. From our perspective, this results from an increasing awareness of policymakers that the costs of joining the union—the decline in monetary policy autonomy—are smaller than they had previously expected. If additional countries and especially the United Kingdom 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 will decline.

Appendix

TABLE A1 Summary Statistics of Central Bank Interest Rates

	Mean	Maximum	Minimum	Std. Dev.	Obs.	Period
Discount Rates						
GER	4.44	8.75	2.00	1.88	302	1980:1–2005:2
USA	5.89	14.00	0.75	3.00	302	1980:1–2005:2
DNK	6.33	13.00	2.00	2.89	302	1980:1–2005:2
SWE	6.47	12.00	1.00	3.51	302	1980:1–2005:2
ICE	14.87	40.00	4.10	9.73	302	1980:1–2005:2
Lending Rates						
GER	7.38	11.91	3.00	1.92	302	1980:1–2005:2
USA	9.06	21.50	4.00	3.49	302	1980:1–2005:2
UK	8.70	17.00	3.50	3.64	302	1980:1–2005:2
NOR	9.85	15.50	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	20.50	7.70	3.56	302	1980:1–2005:2
CAN	9.18	22.75	3.75	4.01	302	1980:1–2005:2
NZL	12.24	20.50	6.50	4.13	302	1980:1–2005:2

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