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The exchange rate insulation puzzle

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Abstract

We confront the notion that flexible rates insulate a country from external disturbances with new evidence on spillovers from euro-area shocks to neighboring countries. We find that in response to euro-area shocks, spillovers are not smaller, and currency movements not significantly larger, in countries that float their currency, relative to those that peg to the euro—the insulation puzzle. Unconditionally, however, currency volatility is significantly higher for floaters. A state-of-the-art open-economy model can fit our conditional evidence on lack of insulation, provided monetary policy targets headline inflation, but only at the cost of missing the unconditional evidence on currency volatility.

Keywords: Exchange-rate regime, Insulation, External shock, International spillovers,
Exchange-rate disconnect

JEL-Codes: F41, F42, E31

Non-technical summary

How much insulation can flexible exchange rates afford the open economy? The classics argue: a lot—because the exchange rate operates as an automatic shock absorber which adjusts to soften the impact of external shocks (Friedman, 1953). Moreover, flexible exchange rates give monetary policy an “extra degree of freedom” (Johnson, 1969) to pursue its internal objectives autonomously. However, skepticism about the virtue of exchange rate flexibility abounds. A large body of literature questions the functioning of the exchange rate as a shock absorber, stressing that the price of internationally traded goods and services is insensitive to currency fluctuations, that is, exchange rate pass through is low (Devereux and Engel, 2003). From a different perspective, the literature emphasizes that a US-dominated global financial cycle may constrain domestic monetary policy, even when policy is unconstrained by an exchange rate target (Rey, 2013). Finally, there is the fundamental observation that business cycles look very much alike across exchange rate regimes (Baxter and Stockman, 1989), the “exchange rate disconnect”.

In this paper we reconsider the insulation properties of flexible exchange rates on the basis of new empirical evidence and a model-based analysis of the trade-offs that govern monetary policy decisions in the open economy. Our empirical contribution consists of a study of the cross-border spillovers of identified shocks that originate in the euro area to 20 of its geopolitical neighbor countries. These countries maintain different exchange rate regimes vis-à-vis the euro. Still, comparing their dynamic response to common euro-area shocks, monetary shocks in particular, we find very little evidence for superior insulation under flexible exchange rates. Our novel evidence is puzzling not only when thinking about policy (why have a flexible exchange rate but not use it?) but also, and especially, in light of recent international macroeconomic theory. On the one hand, successful attempts at resolving the unconditional exchange-rate disconnect explain why the exchange rates of floaters are volatile with seemingly little effect on the floaters’ business cycles (Itskhoki and Mukhin, 2021). On the other hand, state-of-the-art models predict that domestic output remains fairly insulated from external disturbances, even if exports are assumed to be predominantly priced in a dominant (vehicle) currency (Gopinath et al., 2020). In a sense, our new evidence suggests precisely the opposite: conditional on a set of external shocks, we find large spillovers onto floaters’ economies and that the response of the exchange rate is quite *muted*.

A complete account for the lack of insulation under flexible exchange rates needs to confront both the *unconditional evidence* under which the exchange rate of floaters is exceedingly volatile and the *conditional evidence* under which it is not. Our model-based theoretical contribution is two-fold. First, we show that state-of-the-art international business cycle models offer a policy-based candidate explanation for our novel empirical evidence. It is centered around Johnson’s point, quoted above: flexible exchange rates merely offer an extra degree of freedom as central banks trade off conflicting stabilization objectives in the face of domestic and external shocks;

meaning they can specify a target for monetary policy. In light of the world-wide move toward inflation targeting by many countries in practice, headline inflation targeting serves as a natural reference point. We show, both by pencil and paper and by simulating a calibrated version of the model that under headline inflation targeting monetary policy tolerates very little exchange rate adjustment in the face of an external monetary shock. Hence spillovers are large and, in fact, almost as large as under a peg—in line with the conditional evidence. Second, we document an inherent tension between this model-based explanation of the conditional evidence and the unconditional evidence. Namely, once we calibrate the model to capture unconditional business cycle moments, the model can no longer account for the extent of spillovers from external shocks. Intuitively, in order to match the level of exchange rate volatility observed in the data, monetary policy would better not respond too aggressively to headline inflation, but rather stabilize output.

At a fundamental level the insulation puzzle thus persists: models that account for the unconditional business cycle evidence predict considerable insulation—at odds with the extent of spillovers that we document in the first part of the paper, and *vice versa*. Providing a unified account of the two pieces of evidence, conditional and unconditional, may require providing a rationale why floaters in response to some external shocks—even in a rich club of countries—choose to behave like peggers, while more generally they do not.

A flexible exchange rate is not of course a panacea; it simply provides an extra degree of freedom, by removing the balance-of-payments constraints on policy formation. In so doing, it does not and cannot remove the constraint on policy imposed by the limitation of total available national resources and the consequent necessity of choice among available alternatives; it simply brings this choice, rather than the external consequences of choices made, to the forefront of the policy debate.

Harry Johnson (1969)

1 Introduction

How much insulation can flexible exchange rates afford the open economy? The classics argue: a lot—because the exchange rate operates as an automatic shock absorber which adjusts to soften the impact of external shocks. And, as emphasized by Johnson in the quote above, flexible exchange rates give monetary policy an “extra degree of freedom” to pursue its internal objectives autonomously (Meade 1951; Friedman 1953; Eichengreen and Sachs 1985).¹ However, skepticism about the virtue of exchange rate flexibility abounds. A large body of literature questions the functioning of the exchange rate as a shock absorber, stressing that the price of internationally traded goods and services is insensitive to currency fluctuations, that is, exchange rate pass through is low (Devereux and Engel, 2003). From a different perspective, the literature emphasizes that a US-dominated global financial cycle may constrain domestic monetary policy, even when policy is unconstrained by an exchange rate target (Rey, 2013). Finally, there is the fundamental observation that business cycles look very much alike across exchange rate regimes (Baxter and Stockman, 1989), the “exchange rate disconnect”.

In this paper we reconsider the insulation properties of flexible exchange rates on the basis of new empirical evidence and a model-based analysis of the trade-offs that govern monetary policy decisions in the open economy. Our empirical contribution consists of a study of the cross-border spillovers of identified shocks that originate in the euro area to 20 of its geopolitical neighbor countries. These countries maintain different exchange rate regimes vis-à-vis the euro. Still, comparing their dynamic response to common euro-area shocks, monetary shocks in particular, we find very little evidence for superior insulation under flexible exchange rates. Our novel evidence is puzzling not only when thinking about policy (why have a flexible exchange rate but not use it?) but also, and especially, in light of recent international macroeconomic theory. On the one hand, successful attempts at resolving the unconditional exchange-rate disconnect explain why the exchange rates of floaters are volatile with seemingly little effect on the floaters’ business cycles (Itskhoki and Mukhin, 2021). On the other hand, state-of-the-art models predict that domestic output remains fairly insulated from external disturbances, even if exports are assumed to be predominantly priced in a dominant (vehicle) currency (Gopinath et al., 2020).²

¹Obstfeld (2020) provides an excellent assessment of Johnson’s case for flexible exchange rates.

²See their Figure 2 in which a monetary tightening abroad generates basically no output spillovers to countries

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A complete account for the lack of insulation under flexible exchange rates needs to confront both the *unconditional evidence* under which the exchange rate of floaters is exceedingly volatile and the *conditional evidence* under which it is not. Our model-based theoretical contribution is two-fold. First, we show that state-of-the-art international business cycle models offer a policy-based candidate explanation for our novel empirical evidence. It is centered around Johnson's point, quoted above: flexible exchange rates merely offer an extra degree of freedom as central banks trade off conflicting stabilization objectives in the face of domestic and external shocks; meaning they can specify a target for monetary policy. In light of the world-wide move toward inflation targeting by many countries in practice, headline inflation targeting serves as a natural reference point. We show, both by pencil and paper and by simulating a calibrated version of the model that under headline inflation targeting monetary policy tolerates very little exchange rate adjustment in the face of an external monetary shock. Hence spillovers are large and, in fact, almost as large as under a peg—in line with the conditional evidence. Second, we document an inherent tension between this model-based explanation of the conditional evidence and the unconditional evidence. Namely, once we calibrate the model to capture unconditional business cycle moments, the model can no longer account for the extent of spillovers from external shocks. Intuitively, in order to match the level of exchange rate volatility observed in the data, monetary policy would better not respond too aggressively to headline inflation, but rather stabilize output.

At a fundamental level the insulation puzzle thus persists: models that account for the unconditional business cycle evidence predict considerable insulation—at odds with the extent of spillovers that we document in the first part of the paper, and *vice versa*. Providing a unified account of the two pieces of evidence, conditional and unconditional, may require providing a rationale why floaters in response to some external shocks—even in a rich club of countries—choose to behave like peggers, while more generally they do not.

Our empirical analysis is based on a sample of European countries. This has several desirable features to study the insulation properties of flexible exchange rates. First, focusing on the euro area as a source of shocks external to other economies allows us to steer clear of a global (US-dominated) financial cycle possibly induced by US monetary policy. Second, there is significant variation in the exchange rate regime that the neighbor countries maintain vis-à-vis the euro, both across time and countries. We exploit this variation as we condition spillovers on the currency regime in each neighbor country at different points in time. The sample includes 20 countries neighboring the euro area and covers the 20-year period since the inception of the euro in 1999—providing us with a total of 4,800 monthly observations for a number of key macro indicators. Over this period, the whole region experiences a strong process of trade and economic integration, led by the institutional development of the European Union and several

that have a flexible exchange rate regime.

trade agreements with border countries outside the EU. As a result, these countries trade a lot with the euro area. What is more, and that is the third desirable feature of our data, countries' exports to/imports from the euro area are predominantly priced in euros, thus providing a prime example of the type of dominant currency setting emphasized by Gopinath (2015).

In order to classify the time-month observations in our sample as pegs and floats we build on Ilzetki et al. (2019). In our baseline about one third of the observations qualify as floats and two thirds as pegs. To assess how different economies respond to euro-area shocks and, in particular, if and how the response depends on the exchange rate regime, we pool the data for the neighboring countries, allowing for country fixed effects. We then estimate impulse responses to external shocks which we interact with a (possibly time varying) exchange rate regime dummy. We focus much of our analysis on monetary policy shocks as identified by Jarociński and Karadi (2020), but we also consider their central bank information shocks and a series of spread shocks following earlier work by Gilchrist and Mojon (2018). Our econometric specification does not rule out that an external shock causes a change of the exchange rate regime because we condition impulse responses on the exchange rate regime in the month prior to the shock. In other words, we allow the exchange rate regime to be endogenous in the face of external shocks. The main result of our empirical analysis is the exchange rate insulation puzzle: the responses of industrial production, the unemployment rate, inflation, trade flows, the short-term interest rate and, most strikingly, the exchange rate are very similar, whether a country pursues a currency peg to the euro or not.³

To explore the extent to which lack of insulation may arise from a policy choice, we rely on a New Keynesian two-country model akin to Gopinath et al. (2020). The model has standard features: there is a large country, representing the euro area to which we refer as “Foreign”, and a small country, representing a generic neighbor country; goods markets are not fully integrated because of home bias; firms may employ imported inputs in production; exports are priced in Foreign currency, that is, we assume Dominant Currency Pricing (DCP), reflecting the role of the euro in intra-European trade.⁴ Monetary policy under floating exchange rates is modelled as a targeting rule in the output gap and inflation. We show, both analytically and in a calibrated version of the model, that the predictions of the model align surprisingly well with the conditional evidence—there is lack of insulation—if floaters engage in consumer price (CPI) inflation targeting. This result provides a new angle on the notion of “fear of floating”, originally put

³Our evidence is consistent with the results of recent studies that focus on US monetary policy shocks, but the economics differ. Notably, Miranda-Agrippino and Rey (2020) show that contractionary US monetary policy shocks induce sizable spillovers to other countries, including in Europe. These authors emphasize that a monetary contraction in the US tightens global financial conditions, so that international lending falls even though policy rates abroad decline. We present evidence that suggests that our euro-area shocks do not load on US monetary shocks. And we find little evidence that a financial transmission channel is key for euro-area spillovers. This does not contradict that the *US driven* global financial cycle is an important driver of international business cycles.

⁴In our DCP environment, border import prices in the (small) domestic economy are sticky in the currency of the foreign producers (euros), as is the case in the more conventional producer currency-pricing framework in Galí and Monacelli (2005). Local currency pricing instead applies to exporters in the small country. They price exports in euros, the export market's currency.

forward by Calvo and Reinhart (2002) in the context of monetary policies pursued by emerging economies.

In the model, incomplete exchange rate pass-through under dominant currency pricing means that monetary policy cannot simultaneously stabilize inflation and the output gap in the face of external shocks. Put differently, “divine coincidence” fails in the presence of DCP. Even if currency movements do not contribute to stabilizing the economy, however, flexible exchange rates still put monetary policy in the position to stimulate domestic demand when foreign demand falters. But preserving a high level of economic activity in the face of (inefficient) foreign shocks comes at the cost of tolerating heightened volatility in exchange rates and inflation. Insulation, then, is not an inherent *automatic* feature of flexible exchange rates; rather, it is a policy choice.

While our theoretical analysis is positive rather than normative, we can compare the monetary rules that we employ to current work on optimal monetary policy under DCP (Corsetti et al., 2020; Egorov and Mukhin, 2020; Gopinath and Itskhoki, 2021). A robust result emerging from these contributions is that monetary authorities in a small open economy should target domestic marginal costs or equivalently producer price inflation—a target that does not necessarily coincide with the goal of stabilizing the output gap, nor with the goal of stabilizing consumer price inflation. As we show using a calibrated version of our model, if central banks followed rules that approximate the optimal targeting rule characterized in these contributions, insulation would not be perfect, but would be much larger than what we find in our data.

As a comparative exercise, we show that our theoretical result of (near) equivalence of currency pegs and floats under CPI inflation targeting continues to hold in our model when we set the exchange rate pass through (ERPT) equal to 100%, the case of Producer Currency Pricing (PCP). Also when we assume that ERPT is symmetrically incomplete—the case of Local Currency Pricing (LCP)—the distance between a peg and inflation targeting shrinks when the central bank targets consumer prices.⁵ There is more insulation, however, than our empirical evidence shows. Assuming LCP, a depreciation of the currency hardly affects prices. Then, even a monetary policy that targets consumer prices can lean against a recessionary external shock.

In addition to the studies mentioned above, our work is related to studies that have looked into the extent of monetary policy independence, and thus the ability of monetary authorities to stabilize the domestic economy, in the context of the Mundellian trilemma (Edwards, 2015; Goldberg, 2013; Klein and Shambaugh, 2015; Obstfeld et al., 2005; Shambaugh, 2004). Levy-Yeyati and Sturzenegger (2003) analyze empirically how the output performance depends on the exchange rate regime. There is also earlier work on how the exchange rate regime alters the transmission of external shocks (Bayoumi and Eichengreen, 1994; Broda, 2004; Giovanni and Shambaugh, 2008). More recently Jarociński (2020) and ter Ellen et al. (2020) investigate the spillovers from ECB monetary policy shocks to the US and to Sweden, Denmark, and Norway,

⁵The normative literature in LCP economies is epitomized by Engel (2011) and Corsetti et al. (2010); for an early New Keynesian model with limited exchange rate pass-through see also Monacelli (2005).

respectively. Consistent with our findings, the latter study finds that interest rate spillovers in Norway and Sweden are almost indistinguishable from those to Denmark, even though the Danish krona is pegged to the euro. Lastly, we note that our analysis could also be framed in the classical adjustment model featuring non-traded goods and a homogeneous traded good, recently reconsidered by Schmitt-Grohé and Uribe (2016).⁶

The rest of the paper is structured as follows. In Section 2 we introduce our empirical framework and data. Section 3 presents the empirical results regarding spillovers of euro-area shocks and discusses the results of various robustness checks. Section 4 first outlines the New Keynesian two-country model and presents the main arguments of the paper for a linearized version of that model and for a special case, but in closed form. Afterwards we show that the main results carry over to a calibrated version of the model with imported intermediate inputs. A final section concludes.

2 Empirical framework

In this section we introduce our empirical framework. We rely on this framework in order to establish new evidence on international spillovers to small open economies. In doing so, we focus on a group of countries that look—from a global perspective at least—rather homogeneous and that are, in terms of trade and institutions, firmly integrated, but differ in the exchange-rate regime that they maintain with a large trading partner. The shocks under study originate in the large trading partner’s economy. Namely, we focus on the euro area as the “source country” of shocks and its geopolitical close neighbors as the “recipient countries”.

In our estimation strategy we exploit the variation of the neighbor’s exchange rate regime vis-à-vis the euro, not only across, but also within neighbor countries over time. In this section, we describe the empirical strategy and provide details on our sample as well as the data sources. Having established this, in the next section we document our main result: that, in terms of economic activity and inflation, euro-area monetary policy shocks spill over to the neighbors, the currency of which floats, to much the same extent as to the neighbors that peg to the euro. We corroborate this result in several dimensions: the empirical specification, the measurement of the neighbors’ exchange-rate regime, and the shocks in question.

2.1 Estimation strategy

We seek to identify the effect that shocks in the large country have on its smaller neighbors, and how the neighbor’s choice of exchange rate regime shapes those effects. Toward this end, we use a panel of N neighbor countries, indexed by $n \in \{1, \dots, N\}$. And let $t = 1, \dots, T$ denote time. While for most of our results the panel is balanced, it need not be. In terms of the notation that

⁶In their model, as in ours, macroeconomic adjustment to negative external shocks can imply deeper recessions under fixed than under flexible exchange rates—full insulation does require extra stimulus of domestic demand.

follows, let variables with a subscript n indicate variables specific to each neighboring country. Let variables with a star pertain to the source country. Define a time-dependent indicator variable $\mathbb{I}_{n,t-1}$ that indicates the exchange-rate regime of neighbor n at time $t - 1$. $\mathbb{I}_{n,t-1} = 1$ when neighbor n operates a flexible exchange-rate regime vis-à-vis the large source country, and zero otherwise.

We estimate local projections à la Jordá (2005) for a pooled sample of observations for the neighbors while conditioning on the exchange-rate regime.⁷ Toward this end, let $h = 0, \dots, H$ mark the forecast horizon for the local projection. Let ϵ_t^* be a time series of identified structural shocks that originate in the source country. Let $x_{n,t+h}$ be the dependent variable of interest for neighbor n in period $t+h$. For each horizon $h = 0, 1, \dots, H$ we estimate the empirical specification

$$x_{n,t+h} = \alpha_{n,h} + \mathbf{z}'_{n,t} \boldsymbol{\beta}_h + \gamma_h^p (1 - \mathbb{I}_{n,t-1}) \epsilon_t^* + \gamma_h^f \mathbb{I}_{n,t-1} \epsilon_t^* + u_{n,t+h}, \quad n = 1, \dots, N, t = 1, \dots, T. \quad (1)$$

Here $\alpha_{n,h}$ is a neighbor-country fixed effect for horizon h . $\mathbf{z}_{n,t}$ is a vector of controls for each neighbor country. The time series of the controls are neighbor-specific, but we apply the same number and type of controls to each neighbor. Accordingly, $\boldsymbol{\beta}_h$ is a conforming vector that is identical across neighbors. Our object of interest are the neighboring countries' impulse responses to the large-country shock, ϵ_t^* , distinguishing neighbors that peg to the euro $\{\gamma_h^p\}_{h=0}^H$ and neighbors that float $\{\gamma_h^f\}_{h=0}^H$. Toward having consistent estimates of these terms, we assume that the relation captures the entire effect of the shock on the dependent variable. That is, we assume that the error term, $u_{n,t+h}$, is uncorrelated with the regressors in ϵ_t^* and $\mathbb{I}_{n,t-1} \epsilon_t^*$ at all leads and lags. At the same time, the error terms are allowed to be heteroskedastic, and correlated both in the cross section of neighbors and over time. We compute Driscoll and Kraay (1998) robust standard errors. Note that the estimated impulse responses will be economically meaningful as long as the choice of exchange-rate regime is not based on foresight about future shocks to the large source country. We wish to stress that our specification does not rule out that regimes $\mathbb{I}_{n,t-1}$ evolve over time, in response to changes in the state of the economy, and that our estimates capture the average response of floats or pegs, conditional on the pre-shock regime. Likewise, we emphasize that our shock measure ϵ_t^* is a generated regressor for which standard errors are asymptotically valid under the null hypothesis that the coefficients γ_h^p and γ_h^f are zero (Pagan 1984, Coibion and Gorodnichenko 2015).

We will compare the estimated impulse responses $\{\gamma_h^p\}_{h=0}^H$ and $\{\gamma_h^f\}_{h=0}^H$ with the impulse responses that we obtain from the corresponding local projections in the source country:

$$x_{t+h}^* = \alpha_h^* + \mathbf{z}_t^{*'} \boldsymbol{\beta}^* + \gamma_h^* \epsilon_t^* + u_{t+h}^*, \quad (2)$$

where again we assume that the errors u_{t+h}^* are uncorrelated with ϵ_t^* at all leads and lags. The error terms themselves can be heteroskedastic and serially correlated. Before proceeding, we find it important to be clear about the heterogeneity across neighbors that we allow for in

⁷For how local projections relate to more traditional VAR estimators, see Plagborg-Møller and Wolf (2021).

estimating model (1). In particular, we allow for neighbor fixed effects (the $\alpha_{n,h}$), and we allow for heterogeneity unrelated to the shock through allowing for potential serial and cross-sectional correlation as well as heteroskedasticity in the error terms. At the same time, we have to impose some homogeneity across member states so as to be able to conduct inference in a small sample. Namely, we assume homogeneity across countries in the coefficients β_h, γ_h^f , and γ_h^p . That is, shocks can affect differently neighbors that float and neighbors that peg, but all neighbors that float are affected by the shock the same way. Still, in our robustness analysis below, we consider estimates based on the mean group estimator and find that our main results remain unchanged.

2.2 Sample

In our application, we resort to a sample of European countries, plus the euro area. This setting, in our view, provides an ideal testing ground for how the exchange-rate regime impacts international spillovers. Not only does it comprise a large integrated economy, the euro area (EA), and a large number of smaller open economies. Each of the neighbors in our sample is also linked to the EA through outright membership in the European Union (EU) or by other close association with the EU. In the sample period we consider, indeed, institutional developments of the EU and a number of bilateral agreements have activated a process of increasing economic and trade integration. Because of this process, by global standards, the EA neighbors have many similarities. We make use of the fact that, in spite of the comparably strong ties with the EA and similarities, the neighbors differ in their exchange-rate regimes vis-à-vis the euro: there is both variation of the exchange rate regime across neighbor countries and over time.

2.2.1 The neighbor countries

Our sample consists of monthly data from the inception of the euro in 1999:M1 through 2018:M12. This gives us at most $T = 240$ observations for each country. Our sample consists of the 11 countries that formed the EA in 1999 (Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain) and $N = 20$ of its neighbors. The neighbors are Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Greece, Hungary, Iceland, Latvia, Lithuania, Malta, Norway, Poland, Romania, Slovakia, Slovenia, Sweden, Switzerland, and the United Kingdom. This is the set of countries that at the end of our sample period comprised the European Union (EU, which the UK left in January 2020 only), plus the three larger countries of the European Free Trade Association (EFTA), bar Liechtenstein.⁸ We collect time series on several macroeconomic and financial variables of interest. The data are seasonally adjusted and the source is Eurostat unless noted otherwise in data Appendix A.

⁸The composition of EFTA has been stable over our sample. The EU, instead, saw several waves of accession. Free access to the European single market typically predates EU membership by several years. An example of this is Croatia, which had preferential access to the single market since the year 2000, formalized with signing its Stabilization and Association Agreement with the EU in 2001 and, thus, before it applied for EU membership (2003) or joined the EU (2013). All other neighbors that joined the EU over the course of our sample already had applied for membership prior to 1999:M1.

2.2.2 Classification of exchange-rate regimes

For each of the N neighbors and each period $t = 1, \dots, T$, our methodology asks us to classify the exchange rate regime as a “peg” ($\mathbb{I}_{n,t} = 0$) or a “float” ($\mathbb{I}_{n,t} = 1$). Rather than resorting only to judgment of our own, as much as we can we rely on the careful work by Ilzetzi, Reinhart, and Rogoff (2019), to whom we refer as IRR for short. We corroborate their evidence, with our application in mind, based on a reading of central bank communication, communication by the European Commission through its bi-annual “Convergence Reports,” and the IMF’s Annual Report on Exchange Arrangements. For a large sample of countries (including all of the N neighbors analyzed here) IRR finely classify the *de-facto* exchange rate regime using categories 1 (No separate legal tender or currency union) to 15 (Dual market in which parallel market data is missing). We observe no instance of the latter category in our sample. In case of a peg, IRR also provide the reference currency. In case there is an official exchange rate arrangement, they verify if the country’s exchange rate against the reference currency actually follows the pre-announced rule. Otherwise, they classify the regime on the basis of its observed exchange rate volatility.⁹

Our theory later makes the case that a flexible exchange rate may not insulate a neighbor country against external shocks if the neighbor pursues inflation targeting. Under this theory, the reason is that the exchange rate may not show much fluctuation under inflation targeting. Since IRR’s classification scheme is based precisely on such observed fluctuations, we need to strike a compromise. We do so with the intention to err on the side of caution (rather accidentally labeling a floater as a pegger than *vice versa*). We label as floaters neighbors in IRR’s categories 9 through 14. At the one end, this includes neighbors that have broad bands or managed floats against the euro (their category 9). At the other end it includes the 3 percent of our observations (147 out of 4800) that IRR classify as “freely floating” (their category 13) and a few observations of IRR’s category 14 “freely falling,” namely for Romania in 1999/2000. This definition of floaters is narrow in the sense that it allows the neighbor countries room to use the exchange rate as a shock absorber. For example, IRR require of managed floats, arguably the most restricted category among our floaters, that the exchange rate does not fluctuate by more than two percent *per month* in 80% of months over a five-year window. Clearly, this still allows for exchange-rate movements that are larger than two percent in about two months per year, and for notable cumulative changes in the exchange rate. We verify that we observe a great deal of exchange rate flexibility for country-time observations that qualify as a float according to our criterion, see the figure in Appendix B.

Table 1 provides a compact overview how we sort countries according to their exchange rate regime in our baseline specification. Each column refers to one of the 20 neighboring countries in our sample. Each row refers to a month in which the classification for at least one country changes relative to the previous month. In the table, the darker cells indicate a float ($\mathbb{I}_{n,t} = 1$),

⁹IRR’s classification ends in 2016:M12 (except for Poland: 2016:M09). Based on the evidence that we have, we leave the exchange-rate classification for all countries unchanged for the rest of the sample.

Table 1: Exchange rate regimes 1999–2018

1999M1	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1	0	0	1	1	1
1999M2	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1	0	0	0	1	1
2000M1	0	0	0	1	0	0	0	1	0	1	0	1	1	1	1	0	0	0	1	1
2000M11	0	0	0	1	0	0	0	1	1	1	0	1	1	1	1	0	0	0	1	1
2001M1	0	0	0	1	0	0	0	1	1	1	0	0	1	1	1	0	0	0	1	1
2001M4	0	0	0	1	0	0	0	1	1	1	0	0	1	1	0	0	0	0	1	1
2001M9	0	0	0	1	0	0	0	1	1	0	0	0	1	1	0	0	0	0	1	1
2004M8	0	0	0	1	0	0	0	1	1	0	0	0	1	1	1	0	0	0	1	1
2005M1	0	0	0	1	0	0	0	1	1	1	0	0	1	1	1	0	0	0	1	1
2006M7	0	0	0	1	0	0	0	1	1	1	0	0	1	1	0	0	0	0	1	1
2008M9	0	0	0	1	0	0	0	1	1	1	0	0	1	1	0	0	0	1	1	1
2009M4	0	0	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0	1	1	1
2009M7	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	1	1	1
2011M9	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	1
2015M2	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	1	1	1
	Bulgaria	Croatia	Cyprus	Czechia	Denmark	Estonia	Greece	Hungary	Iceland	Latvia	Lithuania	Malta	Norway	Poland	Romania	Slovakia	Slovenia	Sweden	Switzerland	United Kingdom

Notes: rows report exchange rate regime in a specific month whenever there is change of the exchange rate regime in at least one country relative to previous month. Darker cells (1) indicate a floating exchange rate, while lighter cells (0) indicate a peg, including membership in the euro area; floats are categories 9 through 14 in the fine classification of Ilzetzi et al. (2019).

and the brighter cells indicate a peg ($\mathbb{I}_{n,t} = 0$), including membership in the EA. In total 1773 or 37 percent of our country-time observations qualify as float under our baseline specification.

Appendix B provides details on the classification for each of the neighboring countries. Here we focus on a few examples only, so as to highlight the nature of our exercise. We are interested in whether the exchange rate of a country is flexible vis-à-vis the euro, or not.¹⁰ Bulgaria is a clear-cut example of a peg. Throughout our sample period it operates a currency board under which its currency is pegged to the euro. The case of Malta, in turn, demonstrates how we deal with a neighbor’s transition toward euro membership. In January 2008 Malta joined the EA. We assume throughout that Malta and other late-adopters of the euro are too small relative to the EA economy as a whole to have notable weight in policy decisions or the EA macroeconomy.

¹⁰In our baseline we also assign Lithuania to the peggers even though it maintained a soft peg vis-à-vis the US dollar up to January 2002. From a theoretical point of view it is crucial that a neighbor country may not adjust its policy stance in the face of an external (that is, euro-area) shock.

Rather, we keep Malta and other late-adopters of the euro in our sample as having a hard peg with the euro.¹¹ At the end of the sample, all the late-adopters combined accounted for less than four percent of EA GDP. In robustness analysis, we exclude Greece and Cyprus from the sample because they may have had a non-negligible effect on EA policies during the sovereign debt crisis. We find, however, that results are basically unchanged relative to the baseline.

As a stepping stone to euro membership, a country has to engineer a stable exchange rate against the euro for some time. Namely, under the Maastricht treaty's convergence criteria (now codified in Article 140 (1) of the Treaty on the Functioning of the European Union), adopting the euro requires "the observance of the normal fluctuation margins provided for by the exchange-rate mechanism of the European Monetary System, for at least two years, without devaluing against the euro," where the latter is typically interpreted as a policy-induced devaluation out of intent. In theory, the exchange-rate mechanism allows for the exchange rate to fluctuate in a band of $\pm 15\%$ around an agreed exchange rate between the euro and the country's currency, and this is what Malta announced on May 2, 2005 when entering the Exchange Rate Mechanism. Yet, as Figure B.1 in the appendix shows, Malta did not nearly exhaust that band. Rather, in practice neighbors that aim at eventually adopting the euro operate much tighter bands. Indeed, the exchange rate of the Maltese lira against the euro was basically constant during Malta's membership in the ERM and with the exception of Latvia all neighbors that are members of the ERM are defined as operating a peg. Still, in a robustness exercise below, we use ERM membership as a criterion to classify a neighbor's exchange rate regime. Specifically, in this case we classify as floats all country-month observations for which a country is neither a member of the EA nor of the ERM. As a result, the group of floaters is considerably larger than in the baseline. Yet our main results are unchanged.

The clearest cases for a floating exchange-rate regime are the UK, Norway, Poland, and, for the largest part of the sample period, also Iceland. The clearest cases for a peg outside of the euro zone in addition to Bulgaria are Croatia and Denmark, both of which operated hard pegs throughout.

Finally, in view of our theoretical analysis below, it is important to stress that throughout most of the sample the neighbors that we classify as having floating exchange rates have operated an inflation targeting regime. The obvious cases are Sweden (since 1993) and the UK (since 1992). Based on the classification by Brito et al. (2018), Norway started being an inflation targeter in March 2001, Switzerland in January 2000. Czechia has been an inflation targeter since 1997, Hungary since June 2001, and Poland started that practice in September 1998. The only country in our sample that we classify as having flexible exchange rates for some time but that Brito et al. (2018) do not classify as an inflation targeter is Latvia.

¹¹After 1999:M1, the euro became legal tender in eight countries of our sample: in Greece (2001), Slovenia (2007), Cyprus (2008), Malta (2008), Slovakia (2009), Estonia (2011), Latvia (2014) and Lithuania (2015).

Table 2: Potential determinants of the exchange rate regime

	Peg	Float
Size in percent of euro area GDP	0.9	5.0
Trade openness vis-à-vis euro area	42.2	40.6
Capital account openness (Chinn-Ito index)	1.9	2.1
Terms of trade volatility	3.7	2.5

Notes: size, trade openness, and capital account openness are annual averages. For these entries, country-years are classified as float if a country floats for a least one month of the year. Trade openness is the sum of exports and imports (to/from the EA) in percent of GDP; capital account openness is measured by the Chinn-Ito index (Chinn and Ito, 2006). Terms of trade volatility is the standard deviation (in percent) over the entire sample period and we classify as floaters countries that operate a float in more than 50 percent of the sample.

2.2.3 Exposure to the euro area and the choice of the exchange rate regime

In theory, whether a neighbor operates a fixed exchange rate regime vis-à-vis the EA or whether it lets its exchange rate float freely depends on a number of factors, chief amongst them the exposure to the EA in terms of trade and financial flows. The choice of the exchange rate regime, in other words, is endogenous—a notion that is well understood at least since Mundell (1961) put forward criteria for an optimum currency area. At an empirical level the literature has identified a number of factors which appear to govern the choice of the exchange rate regime in the data (e.g. Levy Yeyati et al., 2010). In what follows we briefly assess whether in our sample the exchange rate regime vis-à-vis the EA varies systematically with the determinants which the earlier empirical literature has found to account for the exchange rate regime.

We show results in Table 2.¹² None of the key indicators that we consider differs strongly between pegs and floats, except for size. To some extent this simply reflects the presence of the UK in the sample, the GDP of which is equivalent to 20 percent of EA GDP on average during our sample period.¹³ We consider size alone unlikely to be the main element that rationalizes the empirical results that we will show below. The reason is simple: In terms of trade exposure to the EA, the openness of the capital account, and the volatility of trade, peggers and floaters look barely distinguishable.

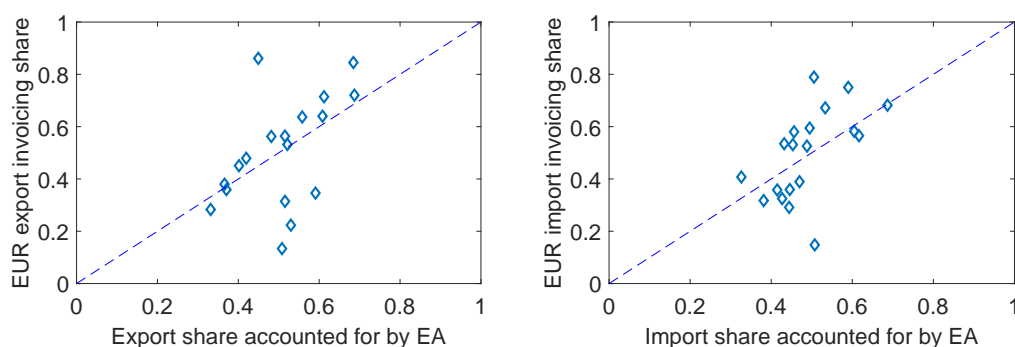
2.2.4 Dominant currency

We conclude the description of our sample with information on the invoicing regime in intra-European trade. Namely, as will become important when we rationalize the empirical results later, not only do the neighbors trade a lot with the EA, but also are their exports to/imports

¹²See the notes to the table for details on the data. Our data source is Eurostat. When we compute trade openness we lack data for Cyprus, Estonia, Greece, Latvia, Lithuania, Malta, Slovakia and Slovenia. When we compute the volatility of the terms of trade we lack data for Iceland, Norway, and Switzerland.

¹³Excluding the UK reduces the relative economic size of the average floating neighbor to 2.5 percent of EA GDP. So, floaters tend to be larger than peggers. This is consistent with earlier findings: larger countries are more likely to operate a float (Levy Yeyati et al., 2010).

Figure 1: Invoicing and trade shares in the neighbor countries



Notes: share of exports/imports accounted for by EA, and share of invoicing of exports/imports accounted for by the euro. Invoicing shares for all countries in our sample except for Croatia, and, in the case of export invoicing shares, excepting Malta, too. Sources: Gopinath (2015) and IMF Directions of Trade Statistics.

from the EA pre-dominantly priced in euros. The European setting, thus, serves as a prime example of the dominant-currency pricing regime that Gopinath (2015) stresses.

This is illustrated in the two panels of Figure 1. In each panel, the horizontal axis measures the share of, respectively, exports to the EA and imports from the EA for the countries in our sample. Against these shares, we plot the share of trade invoiced in euros along the vertical axis. The figure illustrates the degree of integration of these economies with the EA and is suggestive of a dominant role of the euro in intra-European trade, in line with the evidence put forward elsewhere (Gopinath, 2015; Amiti et al., 2018).

3 The insulation puzzle: evidence from Europe

This section provides novel evidence based on identified shocks. The results are important in their own right and—in the spirit of Galí (1999)—because they put additional restrictions on what may underpin the neighbor countries’ business cycles, and the exchange-rate disconnect, in particular.¹⁴ More in detail, we are interested in how an external shock propagates to a neighboring country, and how this propagation depends on the exchange-rate regime in place. Toward this end, we focus on shocks that originate in the EA. Throughout we compare the shocks’ effect on the neighbor countries, both pegs and floats, to what happens in the EA itself. Because the composition of the EA has changed over time and some later members of the EA are in our sample as pegs, we focus on the adjustment in the original 11 EA members (EA11) whenever appropriate.¹⁵

¹⁴As in Baxter and Stockman (1989), in our sample, too, one would be hard-pressed to tell pegs and floats apart based on basic business cycle statistics alone; except on the basis of the standard deviation of their bilateral exchange rate with the euro and the nominal interest rate; see Table 3 in Section 4.3.

¹⁵For industrial production, the unemployment rate, HICP inflation and PPI inflation we construct an aggregate time series for EA11, see Appendix A. Results for the EA19 series are very similar (and available on request). This is perhaps to be expected, given the small weight that the late adopters of the euro have in EA GDP.

For our empirical strategy we need a measure of structural EA shocks. As far as we can, we wish to rely on measures of such shocks that were identified in earlier work, outside of the scope of the current paper. For the baseline specification, we choose as counterpart for ϵ_t^* in models (1) and (2) above, the EA monetary policy shocks identified in Jarociński and Karadi (2020) and updated by Jarociński (2020). These authors combine a high-frequency approach to identification with sign restrictions. Specifically, they capture surprises in 3-months interest-rate forwards around EA monetary policy events. They further disentangle monetary policy shocks from central bank information shocks by restricting the sign of the stock market response to the surprise. Intuitively, monetary policy shocks are shocks which generate a positive response to the nominal interest rate, and a negative response of the stock market.

Since we are interested in the spillovers from EA monetary policy shocks on the EA's neighbor countries, we verify that these shocks are not systematically related to other shocks that may impact the global economy. As does Jarociński (2020), we find that there is no systematic co-movement of EA monetary policy shocks and US monetary policy shocks, as identified by Jarociński and Karadi (2020). The same holds for global risk shocks as identified by Georgiadis et al. (2021) as well as the monthly change in the VIX and the excess bond premium, both widely-used indicators of (global) financial conditions, see Figure C.1 in the appendix.

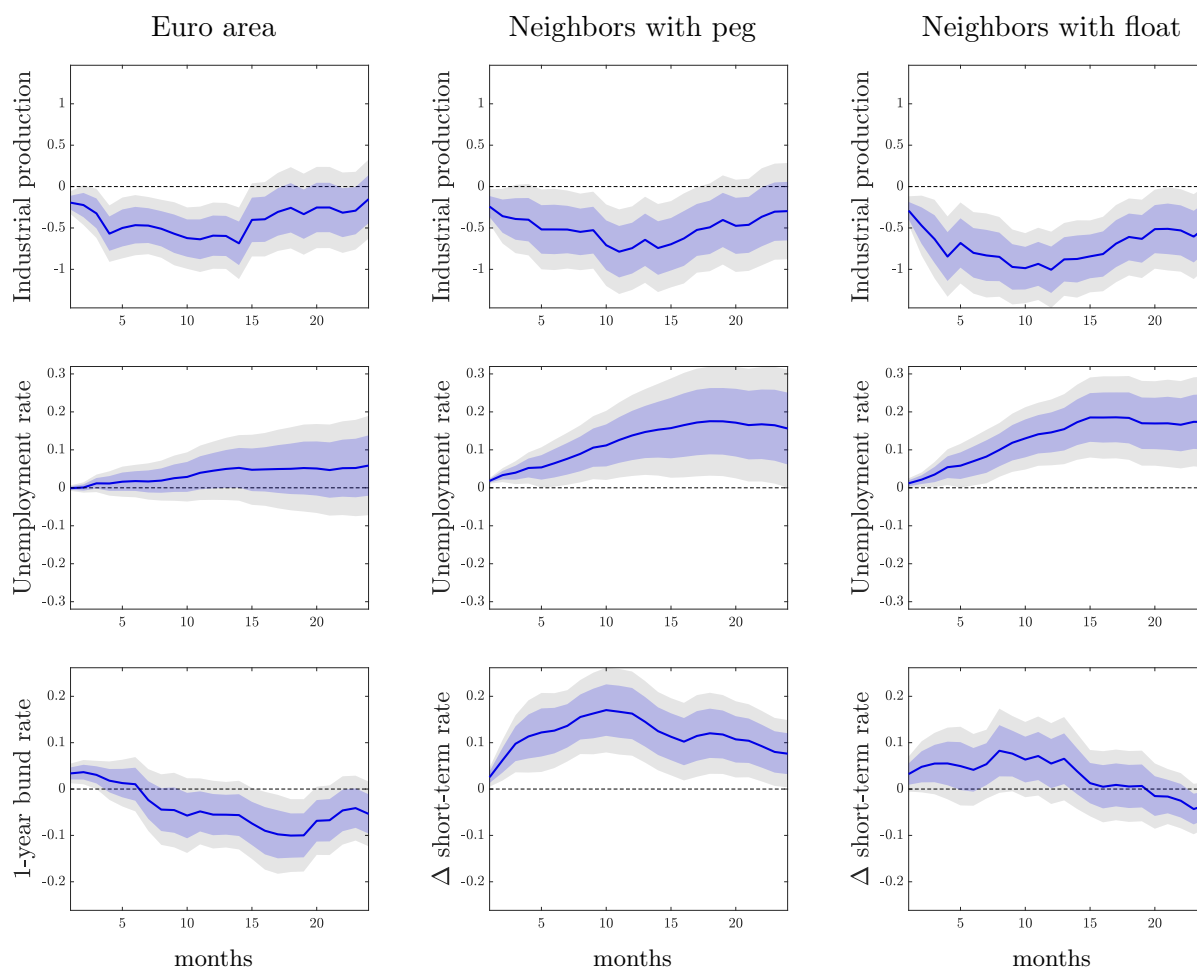
Our baseline estimates focus on the transmission of EA monetary policy shocks to the neighboring countries. In a series of robustness checks, we verify that our main results are neither specific to this measure of monetary policy shocks, nor, in fact, specific to monetary policy shocks in the first place. In our baseline, we include 12 lags of the shock and 12 lags of the dependent variable in the vector of controls. We find that our results are also robust with respect to alternative specifications along this dimension.

3.1 Euro-area monetary policy shocks and their spillovers

In what follows we present estimates for the adjustment to EA monetary policy shocks, both in the EA itself and the neighboring countries. Figures 2.A and 2.B show our main results. They compare responses of selected macroeconomic and financial variables in the EA (left columns) to the responses in the neighboring countries: in the middle columns, for countries that peg to the euro; in the right columns for countries with a floating currency.

We normalize the shock to a one-standard deviation contractionary monetary policy shock. In each panel of the figures, the horizontal axis measures time in months while the vertical axis measures the deviation of a variable from its pre-shock level in percent or in percentage points. The shaded areas represent 68 and 90 percent confidence intervals based on Driscoll and Kraay (1998) robust standard errors and the solid line corresponds to the point estimate. The first two rows of Figure 2.A show the response of two key indicators for real activity that are available at a monthly frequency: industrial production and the unemployment rate. According to the point estimates, a one-standard deviation monetary contraction in the EA reduces EA industrial production by a little over half a percent (first row, first column) and the unemployment rate

Figure 2.A: Adjustment to euro-area monetary policy shock



Notes: shock is one-standard deviation shock identified by Jarociński and Karadi (2020) using high frequency data and sign restrictions. Left column shows response of EA variables, middle column the response in neighbor countries with an exchange rate peg, right column the response in neighbor countries with a flexible exchange rate; solid line represents point estimate, shaded areas correspond to 68 and 90 percent confidence bounds based on Driscoll and Kraay (1998) robust standard errors. Horizontal axis measures time in months. Vertical axis measures deviation in percent/percentage points. From top to bottom, the panels show the percent response of industrial production and the percentage point response of the unemployment rate. The bottom panel shows the response of interest rates (annualized pp.). Left column: one-year bund rate; other columns: difference between neighbor's interest rate and euro-area interest rate.

rises by about 0.1 percentage point (second row, first column). Not surprisingly, perhaps, the shock affects neighbors that peg to the euro in much the same way as the EA itself (middle column). What is surprising, though, certainly against the received wisdom, is that there also are sizable spillovers to the neighbors that have flexible exchange rates. Indeed, there is no evidence that the flexible exchange rate insulates economic activity in the neighbor countries: the contraction for countries with a flexible exchange rate (right column) is as strong as in those

countries where the exchange rate is pegged to the euro (middle column).

The final row of Figure 2.A shows the response of interest rates. Jarociński and Karadi (2020) identify the monetary policy shock based on an event study combined with sign restrictions. It bears noting that their sample, as ours, features a decade of a varied range of unconventional monetary policies in the EA, including asset purchase programs and forward guidance, in an area where there is no common safe asset (Gertler and Karadi, 2015). Arguably for these reasons, the empirical mapping of the monetary shock to a single measure of EA interest rates is not as clear cut. In particular, the left panel reports the response of one interest rate in the EA, the one-year rate on German bunds (in annualized percentage points). This rises on impact, but the response is not persistent.¹⁶ The effect of a change in the EA’s monetary stance is however detectable through its spillovers on the interest rates of neighboring countries that peg to the euro. Indeed, interest rates there rise vis-à-vis the level of measured short term interest rates in the EA (last row, middle panel). At the short end the interest rates of pegs and floats evolve comparably (rising about 0.1 percentage point annualized above the short term rate in the EA).

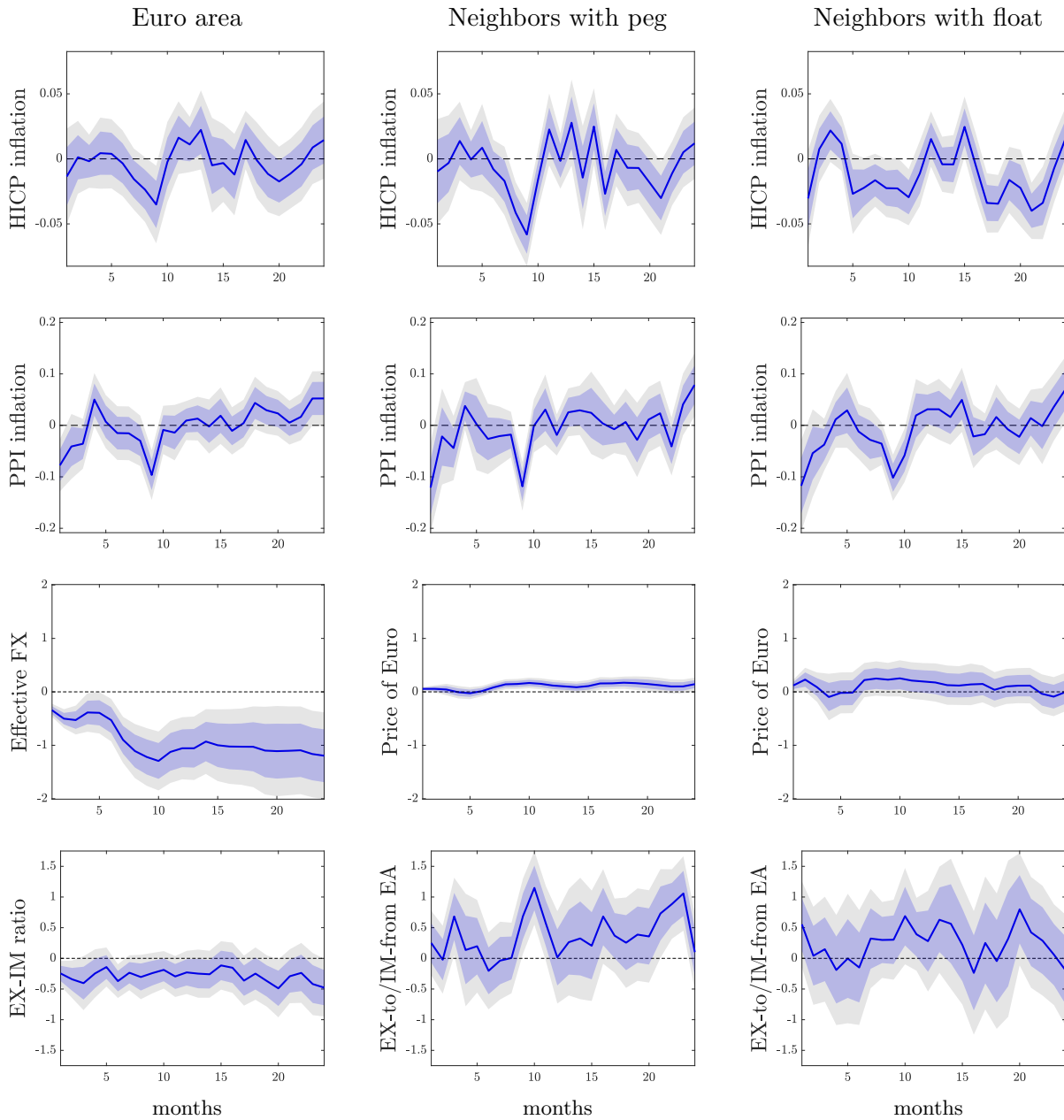
Figure 2.B shows the response of additional variables. The top row displays the adjustment of consumer price inflation, as measured by the harmonized consumer price index (HICP), expressed in percent (not annualized). In response to the shock, consumer price inflation declines somewhat in the EA. But the response is small, and largely not significant. The same pattern characterizes neighbor countries, whether they peg or float their currencies. The contractionary effect of the monetary policy shock is somewhat more visible, instead, when we consider the response of producer price inflation, as measured by the producer price index (PPI), in the second row of Figure 2.B, also measured in percent. Importantly, once more the response of producer price inflation is of comparable size in the neighbor countries, regardless of whether they peg to the euro or float.

The third row of Figure 2.B shows the response of the exchange rate, measured in percentage deviations from the pre-shock level. In the left-most column we report the effective exchange rate of the euro against the currencies of all trading partners. This is measured as the price of foreign currency expressed in terms of euro. In response to the contractionary monetary shock, it appreciates persistently (that is, it declines in the figure). In the other two columns, we report the bilateral exchange rate of the national currency of the neighbor countries with the euro. A rise corresponds to a depreciation against the euro. In line with the construction of our sample, there is virtually no response of the exchange rate among neighbors that maintain a hard or soft peg (middle column, third row): by design, neighbors in the “peg” group have limited exchange rate flexibility. What is more surprising is the response of the exchange rate of the neighbors that have a flexible exchange rate: it moves little. The depreciation against the euro does not exceed 0.2 percent (the right-most column). Hence, not only is there lack of insulation under a float, the exchange rate itself moves little in response to the EA monetary policy shock.

The traditional notion of the flexible exchange rate as a shock absorber relies on international

¹⁶Also in Jarociński and Karadi (2020) the one-year rate increases on impact only (their Figure 8.A, panel B).

Figure 2.B: Adjustment to euro-area monetary policy shock c'td



Notes: same as Figure 2.A, but showing (from top to bottom): the monthly rate of change in the consumer price index (not annualized) and the same for producer prices (not annualized); the third row shows the percent change in the effective nominal exchange rate for the EA (left panel), and the percent change of the nominal exchange rate of neighbors' currencies against the euro (other panels). A rise marks a depreciation from the perspective of the respective country. The bottom row reports the percent change in the export-import ratio. EA: all exports/imports; neighbors: only trade with EA.

expenditure switching: a depreciation of the currency leads domestic and foreign demand to

switch towards the goods and services produced domestically. So as to probe into this channel, the last row of Figure 2.B shows the adjustment of the export-to-import ratio, measured in logs relative to the no-shock level. For the EA, we report total exports over total imports. We do similarly for the neighbors, but here we focus on bilateral trade with the EA only. Expenditure switching would suggest these measures to move in the same direction as the exchange rate. Indeed, a monetary contraction cum appreciation in the EA reduces the export-to-import ratio for the EA moderately, by half a percent. Correspondingly, in the neighboring countries, exports rise relative to imports. While this pattern is consistent with expenditure switching, it is noteworthy that the responses for pegs and floats are once more quite similar. They do not point toward better insulation of the floaters.

3.2 Robustness analysis

Our main finding is that countries with flexible exchange rates do not seem to be more insulated from external shocks than countries that peg their exchange rate to the source country's currency. So far, we have established this finding empirically for a EA monetary policy shock. This section provides robustness analysis at two levels. First, we stick to analyzing the transmission of EA monetary policy shocks. We study the robustness of the results with respect to the set of controls and the classification of the groups of pegs and floats. And we look into alternative measures of EA monetary policy shocks. Second, we study the extent to which similar “non-insulation” findings emerge for the transmission of other external shocks.

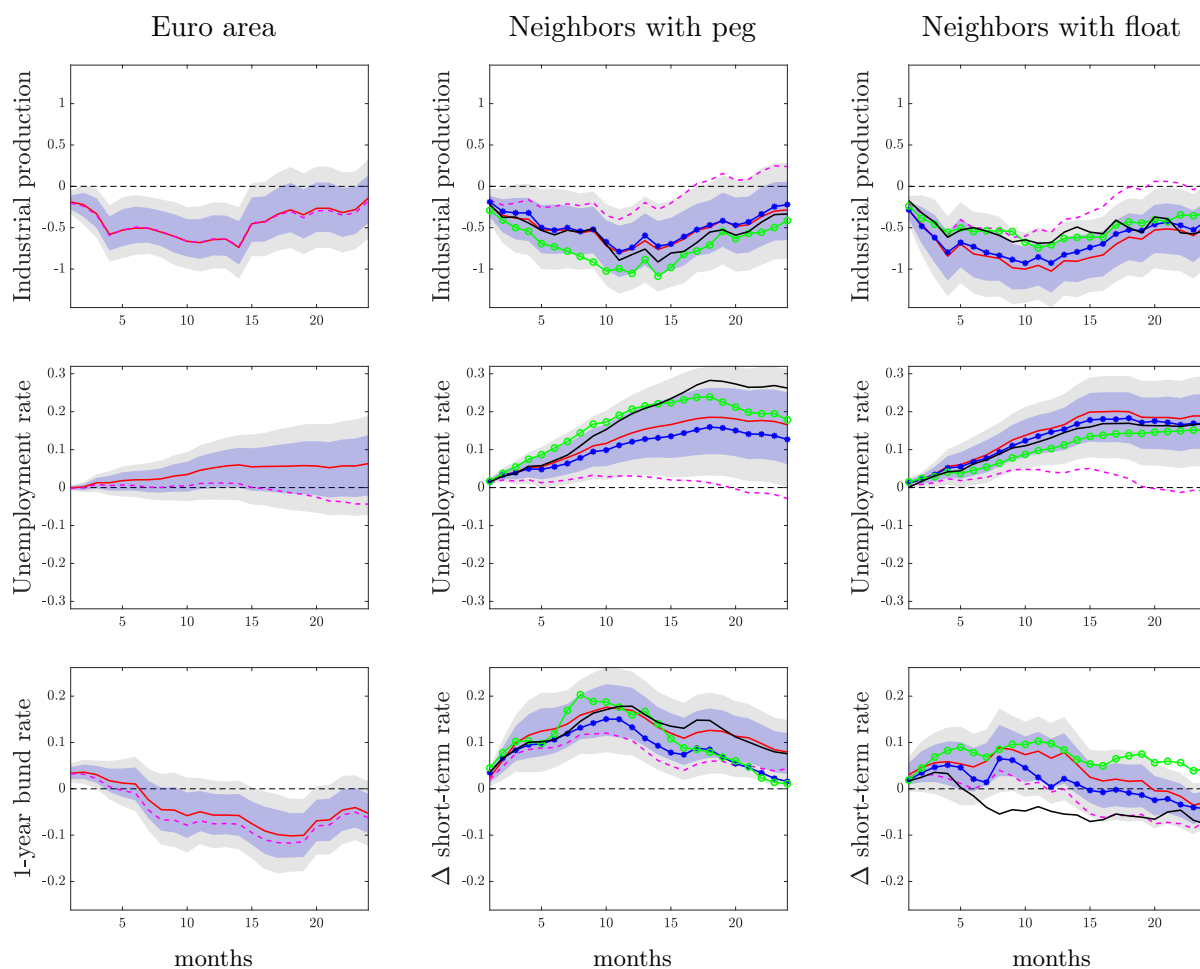
3.2.1 Robustness for euro-area monetary policy shocks

This section illustrates the robustness of our results regarding the spillovers from EA monetary policy shocks. Figures 3.A and 3.B show a selection of results; others are relegated to the appendix (Figures C.2 through D.4). In order to provide a visual benchmark against which to assess the robustness of our baseline, all the figures here plot the confidence bounds of the baseline specification against the point estimates that arise under alternative specifications.

First, we seek to make sure that the conditional comovement of the EA and its floating and pegging neighbors does not originate from a common impulse that is external to both the euro area and its neighbors. One candidate would be a US monetary policy shock that triggers a global response of economic activity. In one modification of the baseline specification, we include among the controls US monetary policy shocks as identified by Jarociński and Karadi (2020). The results are shown as red solid lines in Figures 3.A and 3.B, and are virtually unchanged relative to the baseline.¹⁷ Another candidate would be a global financial cycle that causes us

¹⁷In an additional experiment, we seek to purge the EA monetary policy shocks of any possible component caused by US monetary policy shocks before running the regressions. For this purpose we first regress EA monetary policy shocks on current US monetary policy shocks and three lags thereof. Then, we estimate our baseline model (1) on the residual obtained in the first step as the shock measure. Also in this case results are very similar to the baseline, see Figures C.2 and C.3 in the appendix.

Figure 3.A: Adjustment to euro-area monetary policy shock: alternative specifications

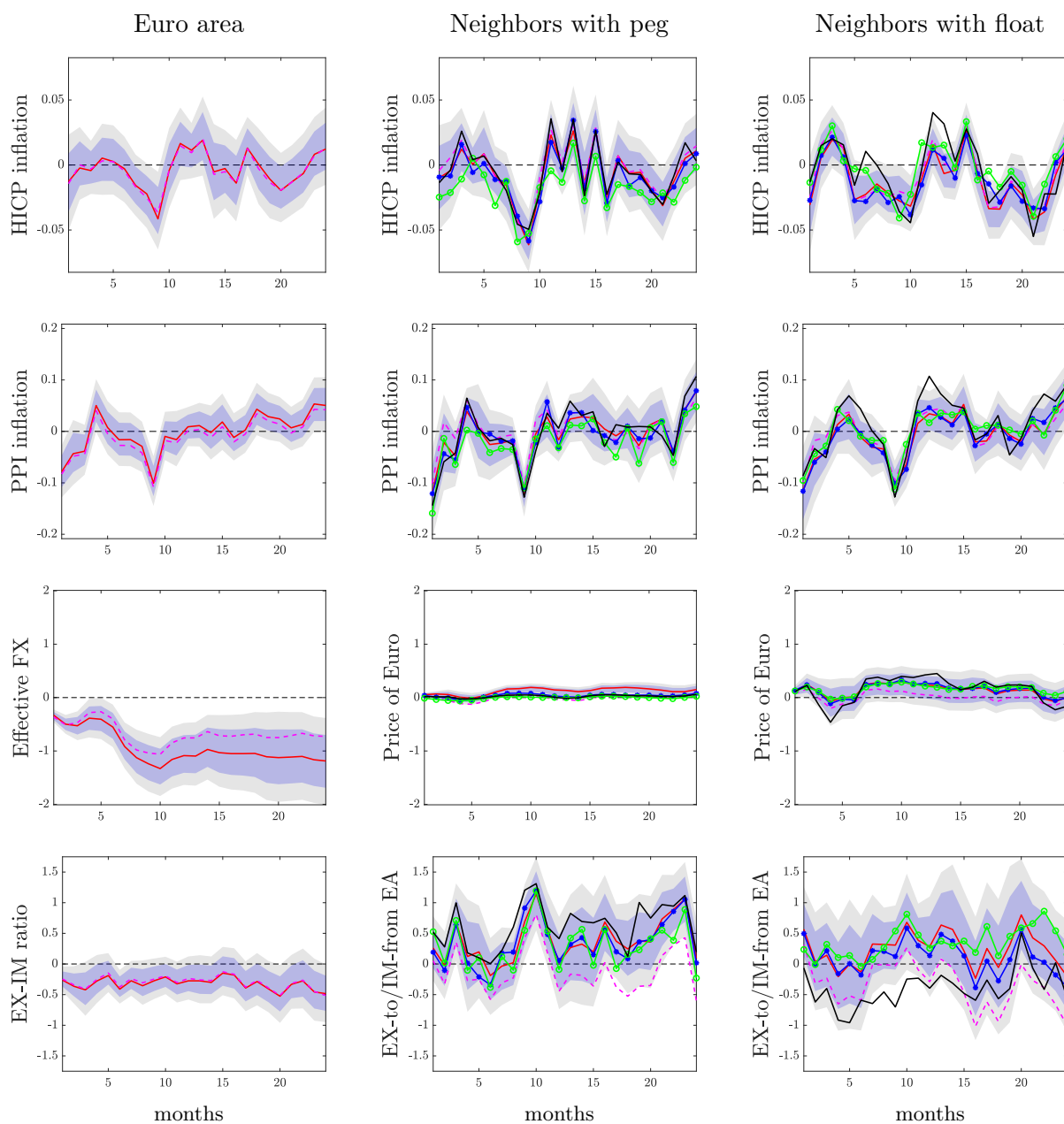


Notes: EA monetary policy shock as in Figure 2.A, but conducting robustness exercises. Shaded areas correspond to 68 and 90 percent confidence bounds of the estimate for the baseline, see Figure 2.A for details. The other lines are the point estimates for alternative specifications: US monetary policy shocks as additional control variable (red solid line), VIX & VSTOXX as additional control variables (dashed lines in magenta); no intermediate regimes, that is, we drop country-month observations with IRR classification between 5 and 9 (blue line with stars), float defined as all country-month observations where a country is neither in ERM2 nor on euro (green line with circles), mean group estimator for pure pegs and floats (black solid lines).

to confound comovement with cross-border spillovers, see Miranda-Agrippino and Rey (2020) and Rey (2013). We thus include implied stock market volatility as measured by the VIX and the VSTOXX as additional control variables.¹⁸ For some variables, notably unemployment and industrial production, the measured spillovers are somewhat weaker than in the baseline, see the dashed magenta-colored lines in the figures here. This, however, applies to pegs and floats alike. In all of the panels, the spillovers to floaters are at least as large as the spillovers to neighbors

¹⁸We also consider both indicators in isolation and find very similar results.

Figure 3.B: Adjustment to euro-area monetary policy shock: alternative specifications c'td



Notes: euro-area monetary policy shock as in Figure 2.B, but conducting robustness exercises. The robustness exercises and labels are described in Figure 3.A.

that peg.

Second, we assess the robustness of our results with regard to the classification of the exchange rate regime. Here, too, we find that differences relative to the baseline are moderate only—as one would expect when the exchange-rate regime has little bearing on the extent of spillovers. The blue solid lines with stars in Figures 3.A and 3.B show results when we omit

the 15% of country-month observations from our sample for which the classification of IRR is between 5 and 9; that is, if we omit intermediate cases.¹⁹ Next, for the green lines with circles in the figures we do not rely on IRR’s classification at all to decide who pegs and who floats. Rather, we use ERM2 membership as a criterion: we define as floats all country-month observations for which a country is neither a member of the ERM2 nor a member of the EA. This classifies 65% of observations as floaters, more than in the baseline.²⁰

Third, our baseline specification assumes a certain degree of homogeneity across countries. Namely, the slope parameters in equation (1), β_h , and γ_h^p and γ_h^f , are assumed to be the same across countries. To probe into whether this assumption matters, we conduct several exercises. In one, we select countries that consistently peg or float throughout the entire sample period and estimate a linear model for each country (rather than modelling interaction effects between the shock and the exchange rate regime). The black solid lines in the figures here show the average impulse response functions, averaging separately across countries that peg and countries that float; that is, the mean group estimator (Pesaran and Smith, 1995).²¹ Spillovers are large also then. The appendix’s Figures D.1 and D.2 report robustness checks with respect to the composition of countries in the sample. We do so to make sure that certain pertinent groups of countries do not drive or confound our findings. For one set of results, for example, we exclude all EMU accession countries (Bulgaria, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovenia, Slovakia). For another, we run the regressions on a subsample of only Central and Eastern European countries (Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia) as well as on a subsample which excludes precisely these countries. Results in all these cases are very similar to the baseline.

Fourth, we consider alternative measures of the driving force itself, that is, of euro-area monetary policy shocks, see Figures D.3 and D.4 in the appendix. One such alternative follows what Jarociński and Karadi (2020) label the “poor man’s sign restriction.” Rather than restricting the impulse responses of an estimated VAR model as when they construct the baseline shock series, under the poor man’s approach the authors classify all those monetary surprises as monetary policy shocks for which the interest-rate forward and the stock-market move in opposite directions. As another alternative, we have used a different measure of monetary policy shocks compiled by Altavilla et al. (2019). This measure is also based on high-frequency monetary surprises but does not restrict the sign of the stock market response at all. For both of the alternative measures, results hardly change.²²

¹⁹We consider as pegs, then, regimes that operate a de facto peg or more rigid; as floats we consider exchange rate regimes that operate on a de facto crawling band narrower than or equal to +/-5%, or are more flexible still.

²⁰Our sample has 707 observations with ERM2 membership, and 948 observations with EA membership.

²¹Neighbors that peg throughout are Bulgaria, Croatia, Cyprus, Denmark, Estonia, Greece, Lithuania, Slovenia and Slovakia. Neighbors that float are Iceland, Norway, Poland, and the United Kingdom. As Figure B.1 in the appendix shows, these countries operated a floating exchange rate almost always during our sample period; Iceland early on has a few episodes marked 8 by IRR but afterwards consistently is marked 9 or above.

²²The same set of figures also shows that our choice of lag length is inconsequential. It considers an alternative

Fifth, we analyze if particular events in the sample drive our finding of a lack of insulation. This does not seem to be the case. In one specification, we drop Cyprus and Greece from the sample. The rationale is that one may be concerned that during the sovereign debt crisis these countries themselves may have been an important factor in EA monetary policy, which would violate the exogeneity assumption for the identified EA monetary policy shocks. In another specification, we drop observations for the years 2008–09, that is, for the period which is arguably dominated by the global financial crisis (GFC). The results are reported in Figures D.1 and D.2 in the appendix. The exclusion of Greece and Cyprus is inconsequential. When we drop the GFC period, the response of peggers and floaters continues to track the EA’s response, but the response is generally smaller. While this does not challenge our finding of absence of insulation, it suggests that EA monetary policy shocks during the GFC may have had a larger-than-usual impact on both the EA and the neighbor countries.

In sum, we find that our main result is robust across a wide range of alternative specifications: spillovers from EA monetary policy shocks on its neighbor countries are no smaller for countries with flexible exchange rates than for countries which peg their currencies to the euro.

3.2.2 Insulation against other euro-area shocks

So far, we have focused on spillovers from EA monetary policy shocks. The appendix probes into whether we find that the exchange-rate regime appears to have comparably limited effects on the spillovers from other shocks that originate in the EA. For this purpose we once more rely on estimating equations (1) and (2), but we consider two alternative shocks to represent ϵ_t^* .

First, we estimate the effect that a central bank information shock in the EA has on its neighbors. The shock is as identified by Jarociński and Karadi (2020) and Jarociński (2020). Intuitively, the shock accounts for a positive co-movement of interest-rate forwards and the stock market around monetary events. Results for this are shown in Figure D.5 in the appendix and discussed in more detail in the surrounding text. Spillovers to pegs and floats alike are somewhat more limited and less significant than for the euro-area monetary policy shock itself. Still, also for the information shocks the spillovers are no different for pegs and floats, as we establish formally. Results of a Wald test are reported in Appendix E. Except for very few variables at selected horizons, we cannot reject the null that responses are the same.

Second, we consider a euro-area credit “spread shock” that we identify relying on earlier work by Gilchrist and Mojon (2018). Specially, we use their index of credit risk for banks in the euro area which, in turn, aggregates individual security level data for Germany, Italy, Spain and France. We include this time series together with observations for industrial production, HICP inflation (core), and the EONIA in a VAR model and identify the spread shock recursively. The credit shocks in the EA, thus identified, spill over to industrial production and unemployment of the neighbors, and irrespectively of the exchange rate regime; see Figure D.6 in the appendix

specification which features six rather than twelve lags of the shock and the dependent variable in the vector of controls.

and Appendix E.

4 Insights from a New Keynesian two-country model

To assess our empirical results, we resort to a stylized and tractable open economy model. The structure of the model starts from earlier work of ours, on which we draw in our exposition (Corsetti et al., 2017). Relative to this, we allow for the possibility that prices of domestic exporters are sticky in the currency of a foreign country, the “dominant currency”, and that firms employ imported inputs in production as in Gopinath et al. (2020). We first provide the layout of the model and, then, develop insights for a special case analytically. Thereafter we show that these insights equally apply quantitatively in a calibrated, somewhat more general version of the model and we make the connection with exchange-rate disconnect.

4.1 The model

There are two countries, Home and Foreign. The countries differ in size, in terms of their monetary policies, and in terms of the shocks that they are exposed to. The world economy is populated by a measure one of households. Households on the segment $[0, n)$ belong to the Home country and the ones on the segment $[n, 1]$ belong to the Foreign country. Later on, we will assume that the domestic economy is generically small ($n \rightarrow 0$). The main building blocks of the model are standard. In the following, we thus provide a compact exposition that focuses on Home. When necessary, we refer to Foreign variables by means of an asterisk.

4.1.1 Households

In each country, there is a representative household. Letting C_t denote a consumption index (defined below) and H_t labor supply, the objective of the household is to maximize expected life-time utility

$$E_t \sum_{k=0}^{\infty} (\xi_{t+k} \beta^k) \left(\ln C_{t+k} - \frac{H_{t+k}^{1+\varphi}}{1+\varphi} \right), \quad (3)$$

$\beta \in (0, 1)$ is the discount factor and ξ_t is a unit-mean shock to the time-discount factor, a “demand shock” for short. $\varphi > 0$ is the inverse of the Frisch elasticity of labor supply, and E_t is the expectations operator. The household trades a complete set of state-contingent securities with the rest of the world. Letting \mathcal{X}_{t+1} denote the payoffs in $t + 1$ of the portfolio that the household has acquired in period t , in units of domestic currency, the household’s budget constraint is given by $E_t \{ \rho_{t,t+1} \mathcal{X}_{t+1} \} - \mathcal{X}_t + P_t C_t = (W_t H_t + \Upsilon_t) - T_t$. Here $\rho_{t,t+1}$ is the nominal stochastic discount factor, W_t is the nominal wage, Υ_t are the domestic firms’ nominal profits, T_t are lump-sum taxes, and P_t is the consumption-based price index. The consumption index

C_t is defined as a Dixit-Stiglitz aggregator of Home and Foreign bundles of goods

$$C_t = \left[(1 - (1 - n)v)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + ((1 - n)v)^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}. \quad (4)$$

Here $C_{H,t}$ and $C_{F,t}$ are the Home-produced and Foreign-produced bundles consumed in Home. $\eta > 0$ is the elasticity of substitution between the two bundles and $v \in [0, 1]$ measures the home bias in consumption.²³

The bundles of Home- and Foreign-produced goods are defined as follows

$$C_{H,t} = \left[\left(\frac{1}{n} \right)^{\frac{1}{\epsilon}} \int_0^n C_{H,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}}, \quad C_{F,t} = \left[\left(\frac{1}{1-n} \right)^{\frac{1}{\epsilon}} \int_n^1 C_{F,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj \right]^{\frac{\epsilon}{\epsilon-1}}, \quad (5)$$

where $C_{H,t}(j)$ and $C_{F,t}(j)$ denote differentiated intermediate goods produced in Home and Foreign, respectively, and $\epsilon > 1$ measures the elasticity of substitution between intermediate goods produced within the same country. All the intermediate goods are traded across borders. The consumer price index in Home is given by

$$P_t = \left[(1 - (1 - n)v)P_{H,t}^{1-\eta} + ((1 - n)v)P_{F,t}^{1-\eta} \right]^{\frac{1}{1-\eta}}, \quad (6)$$

where $P_{H,t}$ is the price of the bundle of domestic goods and $P_{F,t}$ is the price of the bundle of imported goods.²⁴ In maximizing utility, the household takes prices as given. Letting $P_{H,t}(j)$ and $P_{F,t}(j)$ denote the domestic currency price of a generic domestically produced and a generic import good, respectively, the price indices for the bundle of domestically produced goods and for imported goods, respectively, are given by

$$P_{H,t} = \left[\frac{1}{n} \int_0^n P_{H,t}(j)^{1-\epsilon} dj \right]^{\frac{1}{1-\epsilon}}, \quad P_{F,t} = \left[\frac{1}{1-n} \int_n^1 P_{F,t}(j)^{1-\epsilon} dj \right]^{\frac{1}{1-\epsilon}}. \quad (7)$$

We let $P_{H,t}^*(j)$ denote the foreign-currency price that the producer in Home charges for its good in Foreign. Let $P_{H,t}^*$ be a price index defined analogously to $P_{H,t}$. Let \mathcal{E}_t be the nominal exchange rate measured as the price of foreign currency in terms of domestic currency. A rise in \mathcal{E}_t , thus, represents a nominal depreciation of Home's currency. We assume that Home's export prices are sticky in foreign currency units. The law of one price, thus, does not necessarily hold. Foreign exports, too, are sticky in Foreign's currency, making Foreign's currency "dominant"

²³This specification of home bias follows Sutherland (2005) and De Paoli (2009). With $v = 1$, there is no home bias: if the relative price of foreign and domestic goods is unity, Home's consumption basket contains a share n of Home-produced goods, and a share of $1 - n$ of imported goods. A lower value of v implies that the fraction of domestically produced goods in final goods exceeds the share of domestic production in the world economy. If $v = 0$, there is full home bias and no trade across countries. The Foreign consumption basket is defined as $C_t^* = \left[(nv)^{\frac{1}{\eta}} C_{H,t}^*{}^{\frac{\eta-1}{\eta}} + (1 - nv)^{\frac{1}{\eta}} C_{F,t}^*{}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$.

²⁴The consumer price level in Foreign is given by $P_t^* = [nvP_{H,t}^{*1-\eta} + (1 - nv)P_{F,t}^{*1-\eta}]^{\frac{1}{1-\eta}}$.

for international trade in the sense of Gopinath et al. (2020). We define M_t as the resulting law-of-one-price gap for domestic goods such that:

$$M_t P_{H,t} = \mathcal{E}_t P_{H,t}^*. \quad (8)$$

For imported goods in Home, the law of one price holds.

$$P_{F,t} = \mathcal{E}_t P_{F,t}^*. \quad (9)$$

We define the Home terms of trade, S_t , as the price of imports in Home relative to the price of exports, both measured in Foreign currency (“euros”):

$$S_t = \frac{P_{F,t}^*}{P_{H,t}^*} = \frac{\mathcal{E}_t P_{F,t}^*}{M_t P_{H,t}}. \quad (10)$$

A rise in S_t marks a depreciation of the Home terms of trade (Home goods becoming relatively cheaper).

The household’s problem defines the households’ demand function for Foreign-produced and Home-produced goods. Demand from domestic consumers for a generic intermediate good produced in Home is given by²⁵

$$C_t^D(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}} \right)^{-\epsilon} \left[\left(\frac{P_{H,t}}{P_t} \right)^{-\eta} (1 - (1-n)v) C_t \right]. \quad (12)$$

4.1.2 Firms

Intermediate goods producers sell under monopolistic competition and employ labor and intermediate inputs in production:

$$Y_t(j) = Z_t H_t(j)^{1-\alpha} X_t(j)^\alpha, \quad (13)$$

where $H_t(j)$ denotes labor services employed by firm $j \in [0, n]$ in period t . $X_t(j)$ is an aggregator of intermediate inputs employed by firm j , and Z_t is a stationary aggregate productivity shock. The intermediate inputs are produced domestically and abroad, and the intermediate input aggregator $X_t(j)$ takes the same functional form as the consumption aggregator in equation (4). Likewise, the bundle of Home (Foreign) intermediate inputs $X_{H,t}(j)$ ($X_{F,t}(j)$) takes the same functional form as the Home-produced (Foreign-produced) bundle of final goods consumed in Home $C_{H,t}$ ($C_{F,t}$).

²⁵Demand from consumers in the rest of the world is given by

$$C_t^{D*}(j) = \left(\frac{P_{H,t}^*(j)}{P_{H,t}^*} \right)^{-\epsilon} \left[\left(\frac{P_{H,t}^*}{P_t^*} \right)^{-\eta} (1-n)v C_t^* \right]. \quad (11)$$

Total domestic demand for a generic intermediate good produced in Home consists of the demand from domestic consumers and the demand from domestic producers

$$Y_t^D(j) = \left(\frac{P_{H,t}(j)}{P_{H,t}} \right)^{-\epsilon} \left[\left(\frac{P_{H,t}}{P_t} \right)^{-\eta} (1 - (1-n)v) (C_t + X_t) \right], \quad (14)$$

where we made use of the assumption that consumption bundles and intermediate-input bundles are isomorphic. Total foreign demand for a generic intermediate good produced in Home consists of the demand from foreign consumers and the demand from foreign producers

$$Y_t^{D*}(j) = \left(\frac{P_{H,t}^*(j)}{P_{H,t}^*} \right)^{-\epsilon} \left[\left(\frac{P_{H,t}^*}{P_t^*} \right)^{-\eta} (1-n)v (C_t^* + X_t^*) \right], \quad (15)$$

where X_t^* has the same functional form as C_t^* .

Each period, Home producers choose the cost-minimizing pair of labor and intermediate inputs so as to meet the demand for their intermediate goods

$$\min_{H_t(j), X_t(j)} W_t H_t(j) + P_t X_t(j) - MC_t(j) [Z_t H_t(j)^{1-\alpha} X_t(j)^\alpha - (Y_t^D(j) + Y_t^{D*}(j))],$$

where the Lagrange multiplier $MC_t(j)$ represents nominal marginal costs of firm j in period t . Using the first-order conditions to the cost minimization problem, one can show that firms' marginal costs are not firm-specific, but rather that $MC_t(j) = \left(\frac{1}{\alpha}\right)^\alpha \left(\frac{1}{1-\alpha}\right)^{1-\alpha} \frac{P_t^\alpha W_t^{1-\alpha}}{Z_t}$, for all firms j , and, therefore, $MC_t(j) = MC_t$.

Under a regime of dominant currency pricing, Home producers solve separate price-setting problems for the domestic and the foreign market. For the domestic market the problem is to

$$\begin{aligned} \max_{\{P_{H,t+k}(j)\}_{k=0}^{\infty}} \sum_{k=0}^{\infty} E_t \rho_{t,t+k} \left\{ [(1+\nu)P_{H,t+k}(j) - MC_{t+k}] Y_{t+k}^D(j) \right. \\ \left. - \frac{\omega}{2} \left[(1 - (1-n)v) \left(\frac{P_{H,t+k}(j)}{P_{H,t+k-1}(j)} - 1 \right)^2 P_{H,t+k} Y_{t+k}^D \right] \right\} \\ \text{s.t. (14).} \end{aligned}$$

The price in the foreign market is determined through

$$\begin{aligned} \max_{\{P_{H,t+k}^*(j)\}_{k=0}^{\infty}} \sum_{k=0}^{\infty} E_t \rho_{t,t+k} \left\{ [(1+\nu)\mathcal{E}_{t+k} P_{H,t+k}^*(j) - MC_{t+k}] Y_{t+k}^{D*}(j) \right. \\ \left. - \frac{\omega}{2} \left[(1-n)v \left(\frac{P_{H,t+k}(j)^*}{P_{H,t+k-1}(j)^*} - 1 \right)^2 P_{H,t+k} Y_{t+k}^{D*} \right] \right\} \\ \text{s.t. (15).} \end{aligned}$$

In both cases, $\omega > 0$ indexes the extent of price adjustment costs.

4.1.3 Monetary policy

Monetary policy is conducted by adjusting the short-term nominal interest rate: $R_t \equiv 1/E_t \rho_{t,t+1}$. The monetary regime in Home and Foreign will be defined further below on a case-by-case basis.

4.1.4 Shocks

We allow for exogenous monetary shocks, demand shocks and productivity shocks in both Home and Foreign. The law of motion of these shocks will be spelled out further below.

4.1.5 Market clearing and equilibrium

In equilibrium, domestic prices and foreign sales prices, respectively, of all firms will be identical. So that demand from domestic households is $Y_t^D = (1 - (1 - n)v) \left(\frac{P_{H,t}}{P_t}\right)^{-\eta} (C_t + X_t)$, and demand from foreign households is $Y_t^{D*} = (1 - n)v \left(\frac{P_{H,t}^*}{P_t^*}\right)^{-\eta} (C_t^* + X_t^*)$. Total demand for goods is

$$Y_t = \left[\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} (1 - (1 - n)v)(C_t + X_t) \right] \left(1 + \frac{\omega}{2} \left(\frac{P_{H,t+k}}{P_{H,t+k-1}} - 1\right)^2\right) + \left[\left(\frac{P_{H,t}^*}{P_t^*}\right)^{-\eta} (1 - n)v(C_t^* + X_t^*) \right] \left(1 + \frac{\omega}{2} \left(\frac{P_{H,t+k}^*}{P_{H,t+k-1}^*} - 1\right)^2\right). \quad (16)$$

The labor markets clear if $H_t = \left(\frac{Y_t}{Z_t X_t^{1-\alpha}}\right)^{\frac{1}{\alpha}}$. Finally, in equilibrium, household behavior and international financial market clearing give rise to the familiar international risk sharing condition.

4.1.6 Focus on the small open economy

Throughout, we will focus only on the limiting case $n \rightarrow 0$. The Foreign consumption basket will almost exclusively contain Foreign-produced goods. The consumer and producer price level in Foreign, therefore, will coincide. Effectively, the Foreign economy operates like a closed economy. From the perspective of the small open Home economy, Foreign can be an important source of shocks, though, transmitted across borders through financial markets and trade.

4.2 Transmission of foreign monetary shocks: analytical insights

The goal of the section is to discuss a possible reason for the apparent insulation equivalence across exchange rate regimes documented in Section 3. Namely, especially in a dominant-currency regime world, insulating domestic economic activity from adverse foreign shocks requires stimulating *domestic* absorption. This in turn, requires a depreciation of the exchange rate and a *temporary* rise in inflation. By its design, inflation targeting prevents this, potentially

inducing the very output spillovers that we observe empirically; spillovers that occur even though exchange rates are (notionally) flexible. In what follows, we analyze this conjecture formally.

4.2.1 An analytically tractable version of the model

To obtain sharp and clear results, we focus on a model variant without round-about-production of intermediate goods, that is, we set $\alpha = 0$, and make the following additional assumptions. First, we set the trade elasticity to unity, $\eta = 1$ and assume an infinitely elastic labor supply, $\varphi = 0$. As we show below, up to first order, these assumptions imply that the terms of trade are exogenous and constant, reducing a model with two endogenous state variables (S_{t-1} and M_{t-1}) to a tractable variant that only has one (M_{t-1}). For the ease of exposition, here we also focus on the limit $\beta \rightarrow 1$, focus on monetary shocks only, and restrict the process of shocks as specified in subsection 4.2.5 below. Throughout this section, we consider a linear approximation of the model around a deterministic and symmetric zero-inflation steady state.²⁶ As regards notation, small letters correspond to the percentage deviation of a variable from the non-stochastic steady state, and variables without a time index mark the variable's steady-state value. By way of example, $y_t^* := \log(Y_t^*) - \log(Y^*)$ represents the percentage deviation of Foreign output from its steady state.

4.2.2 Equilibrium conditions for Foreign

The equilibrium conditions for the large foreign economy follow the conventional closed-economy New Keynesian model. That is, the intertemporal IS equation in Foreign is given by

$$y_t^* = E_t y_{t+1}^* - [r_t^* - E_t \pi_{t+1}^*], \quad (17)$$

linking foreign output to the foreign real interest rate. The New Keynesian Phillips curve in Foreign is given by

$$\pi_t^* = E_t \pi_{t+1}^* + \kappa^* y_t^*, \quad (18)$$

linking Foreign inflation to economic activity. Here $\kappa^* > 0$ is the slope of the Phillips curve in Foreign (and a convolute of structural parameters of the model). Last, we need to specify Foreign monetary policy. To be concrete, we assume that foreign monetary policy follows a conventional Taylor rule:

$$r_t^* = \phi \pi_t^* + \gamma y_t^* + \varepsilon_t^*, \quad (19)$$

²⁶The market value of initial wealth in Home and Foreign, respectively, is influenced by all shocks that affect the economies, the structural features, as well as by the monetary regime(s). In a linear approximation, however, initial wealth is without material consequences for the dynamics of the model economy. Therefore, we focus on a symmetric steady state so as to keep the exposition tractable. Higher-order approximations should not abstract from the market value of initial wealth (see, for instance, Corsetti et al., 2019). Welfare or the effects of risk, for which a higher-order approximation would be required, are not in the focus of the current paper.

linking the foreign interest rate, inflation and output. Here $\phi > 1$, $\gamma \geq 0$, so foreign monetary policy obeys the Taylor principle and the equilibrium is determinate. ε_t^* is the foreign monetary policy shock, the transmission of which to the Home economy the current section studies.

4.2.3 Equilibrium conditions for Home

In the (small) Home economy, the dynamic IS-relation in Home links output with the real interest rate and the law of one-price gap according to

$$y_t = E_t y_{t+1} - (r_t - E_t(\pi_{H,t+1} + v\Delta m_{t+1})). \quad (20)$$

The Phillips curve that governs sales prices of Home goods in Home is given by

$$\pi_{H,t} = E_t \pi_{H,t+1} + \kappa [y_t + v m_t]. \quad (21)$$

Export-price inflation in Foreign currency is given by

$$\pi_{H,t}^* = E_t \pi_{H,t+1}^* + \kappa [y_t - (1 - v)m_t]. \quad (22)$$

The Home terms of trade evolve according to

$$s_t = s_{t-1} + \pi_t^* - \pi_{H,t}^*. \quad (23)$$

And the law-of-one-price gap, m_t , follows

$$m_t = m_{t-1} + e_t - e_{t-1} + \pi_{H,t}^* - \pi_{H,t}. \quad (24)$$

The international risk sharing condition combined with the demand for Home-produced goods implies

$$y_t = s_t + y_t^* + (1 - v)m_t. \quad (25)$$

Consumer-price inflation in Home is given by the average of inflation rates in the Home consumer's basket

$$\pi_t = (1 - v)\pi_{H,t} + v(\pi_t^* + \Delta e_t). \quad (26)$$

Armed with the Foreign variables, equations (20) to (26) combined with a monetary policy rule in Home (to be specified) then form a system of eight variables in eight unknowns for the Home economy.

4.2.4 The natural-rate benchmark for Home: flexible prices in Home

Before spelling out the effect of the monetary regime on the transmission of Foreign monetary shocks, it is useful to derive the natural level of output in Home, y_t^n . Suppose that prices are flexible in Home ($\kappa \rightarrow \infty$), but not necessarily in Foreign. Then the Foreign shock would not affect the level of output in Home. That is, the natural level of output is given by

$$y_t^n = 0. \quad (27)$$

With a unitary trade elasticity, Foreign and Home outputs are neither complement nor substitute. If prices were perfectly flexible in Home, output in the Home economy would be completely insulated from Foreign monetary shocks, regardless of the effects of these shocks in the Foreign economy. Furthermore, the natural-rate terms of trade are given by

$$s_t^n = -y_t^*. \quad (28)$$

Under flexible prices, the terms of trade would absorb any demand effect from Foreign output. This is true for any evolution of the foreign monetary shock. For analytical tractability, we next restrict the process that governs the monetary shock.

4.2.5 The Foreign response to its own monetary shock

For expositional ease, and without further loss, from now on we focus on the symmetric case in which prices are equally rigid in Home and in Foreign, implying $\kappa^* = \kappa$. For the remainder of this section we consider a specific shock scenario. Let the two economies be in their non-stochastic steady state prior to period $t = 0$. In period $t = 0$, there is a unitary monetary shock, that is, $\varepsilon_0^* = 1$ (a foreign monetary tightening). In the next period, the shock remains present at that level with probability μ . Else, the shock ceases, being equal to zero forever after. The same applies to each subsequent period. As is well-known, this shock induces a Markov structure for Foreign output, inflation, and the interest rate: while the shock lasts $\pi_t^* = \pi_L^*$, $y_t^* = y_L^*$, $r_t^* = r_L^*$, for fixed values π_L^*, y_L^*, r_L^* . Once the shock ends, foreign variables immediately return to their steady state of zero. Proposition 1 spells out the evolution of the foreign economy.

Proposition 1. *Consider the (large) foreign economy in Section 4.2.2 amid the shock structure sketched above. Define $\mathbf{A} := \frac{1}{(1+\gamma-\mu)(1-\mu)+\kappa(\phi-\mu)}$. While the shock lasts, output in Foreign will be*

$$y_L^* = -(1 - \mu) \cdot \mathbf{A}. \quad (29)$$

Inflation in Foreign will be

$$\pi_L^* = -\kappa \cdot \mathbf{A}. \quad (30)$$

The interest rate in Foreign will be

$$r_L^* = [(1 - \mu)^2 - \kappa\mu] \cdot \mathbf{A}. \quad (31)$$

Proof. Use equations (17) through (19) along with the Markov assumption for the monetary shock. \square

The result of the shock is a contraction in foreign economic activity and inflation, owing to the increase in the real interest rate in Foreign. Observe that the *nominal* interest rate will rise if and only if $(1 - \mu)^2 - \kappa\mu > 0$, that is if the shock itself is not overly persistent (μ not too large). All the propositions shown below are valid for any $\mu \in [0, 1)$. When verbally discussing the sign of responses (and the intuition behind those), we will focus on the case in which Foreign interest rates rise when its monetary policy tightens, the conventional response.

4.2.6 Home monetary policy regimes and the transmission of Foreign shocks

We are interested in understanding the role of the exchange rate as a shock absorber, in relation to the monetary policy regime adopted by a small open economy. Our point of departure is the observation that, with world trade priced in a dominant currency, there is no “divine coincidence.” That is, regardless of the monetary regime pursued in Home, the natural allocation in which the output gap is closed and there is zero inflation cannot be attained. In Proposition 2, we formalize this result stressing an important property of our simplified model specification.

Proposition 2. *Lack of divine coincidence.* *Consider the same assumptions as in Proposition 1, but focus on the Home economy described in Section 4.2.3. Then, regardless of the monetary regime in Home, the terms of trade do not respond to the Foreign shock*

$$s_t = 0 \text{ for all periods } t.$$

Proof. Solve for $\pi_{H,t}^*$ using (23). Use this to substitute for $\pi_{H,t}^*$ in (22). Similarly, in the same equation, substitute for y_t from (25). Using the Markov structure of the shock, this leads to a second-order difference equation in s_t , the exogenous driving term of which—while the shock lasts—is $\kappa y_L^* + \pi_L^*(1 - \mu)$ (and is zero thereafter). From (29) and (30), this sum is equal to zero. The difference equation is thus homogeneous, rendering $s_t = 0$ for all t . \square

To appreciate the meaning of this proposition, contrast its prediction with what happens under flexible prices. In the natural allocation, in response to the shock, the terms of trade would move to insulate Home economic activity from foreign monetary shocks, recall equation (28). Rigid prices in a dominant-currency pricing regime, instead, rule out this stabilizing movement. Indeed, the terms of trade do not move whatsoever. Any insulation of the Home economy, therefore, will have to come from supporting domestic absorption. Stimulating domestic absorption, however, asks for tolerance of domestic inflation. Precisely, the extent to which monetary policy authorities tolerate output spillovers from foreign monetary shocks depends on the extent to which they tolerate inflation.

We articulate this point in the three propositions to follow, characterizing the evolution of the Home economy for three alternative monetary and exchange-rate regimes, targeting, respectively, the natural output, the exchange rate and CPI inflation. We start with a regime

that perfectly targets natural output, that is, it ensures that the output gap remains closed. In terms of notation, let y_t^L mark Home output in period t if in period t the external shock still lasts; correspondingly for all other variables. Variables for Home may not stay constant during that time. We opt for a superscript L for Home variables so as to be able to keep subscript t where needed.

Proposition 3. Natural-output targeting. *Consider the same assumptions as in Proposition 2. Suppose that Home monetary policy aims to completely stabilize domestic output, or equivalently, the output gap (that is, it targets $y_t = y_t^n = 0$). Let $\mathbf{A} > 0$ be as defined in Proposition 1. Then, while the foreign monetary shock lasts, the following is true:*

1. by the policy regime, output is not affected by the shock in Foreign, $y_t^L = 0$.
2. Home producer price inflation is given by

$$\pi_{H,t}^L = \frac{v}{1-v} \kappa \cdot \mathbf{A} = -\frac{v}{1-v} \pi_L^*.$$

3. Home consumer price inflation is given by

$$\pi_0^L = \frac{v}{1-v} [1 - \mu + \kappa] \cdot \mathbf{A}, \text{ and } \pi_t^L = \frac{v}{1-v} \kappa \cdot \mathbf{A}, \quad t > 0.$$

4. The nominal exchange rate is given by

$$e_t^L = \frac{1}{1-v} [(1 - \mu) + \kappa(t + 1)] \cdot \mathbf{A}.$$

5. The interest differential to Foreign is given by

$$r_t^L - r_L^* = -\frac{1}{1-v} [(1 - \mu)^2 - \kappa\mu] \cdot \mathbf{A}. \quad (32)$$

Proof. Natural output does not move (Section 4.2.4), so output gap targeting yields (1.). Solving for m_t from (25) with $y_t = 0$ and $s_t = 0$ (Proposition 2), using Proposition 1 and the Markov structure of shocks, (21) gives (2.). (23) with $s_t = 0$ gives $\pi_{H,t}^*$. Using this with the law of motion for m_t and $\pi_{H,t}$ in (24) gives (4.). Uncovered interest parity (UIP) follows from taking the difference between (20) and (17), and using (23) and (24). UIP gives (5.). Using the aforementioned results in (26) gives (3.). \square

Proposition 3 highlights that Home monetary policy can in theory completely stabilize economic activity in the face of the foreign shock. The proposition also highlights what is required to bring this about. Namely, since with a dominant currency, there is no divine coincidence, stabilizing output comes at the expense of higher producer-price *and* consumer-price inflation. Since the terms of trade do not contribute toward expenditure switching by *Foreign* households, all stabilization of output has to come from *domestic absorption*. That is, the central bank in Home needs to induce domestic demand and engineer enough expenditure switching by *Home* households. This is achieved by a sharp monetary expansion, that translates into a strong depreciation of the exchange rate on impact. As this in turn passes through to Home-currency

consumer prices of imports, the depreciation amid rigid prices is central to expenditure switching by Home households toward Home-produced goods. Note that this switching occurs in spite of the fact that the price level of Home-produced goods expressed in Home currency also rises on impact. Corollary 1 further highlights the response of the nominal and real rate of interest in Home.

Corollary 1. *Consider the same conditions as in Proposition 3. Then the following is true:*

1. *The Home nominal rate of interest r_t^L falls if the Foreign interest rate, r_L^* , rises.*
2. *The Home real rate of interest, $r_t - E_t \pi_{t+1}$, is constant, whereas the Foreign real rate rises.*

Proof. The first item follows from (31) and (32). The second item follows from $y_t = 0$ in all periods, the Home IS equation (20), (23) (with $s_t = 0$), (24), and the definition of consumer price inflation (26). \square

In sum, insulating Home output from a fall in foreign economic activity means stimulating domestic demand and tolerating producer-price and consumer-price inflation. This marks one end of the policy spectrum in which Home monetary policy can position itself. The next proposition shows the other end: a regime of fixed exchange rates.

Proposition 4. Fixed exchange rate. *Consider the same assumptions as in Proposition 3. The one difference is that Home monetary policy targets $e_t = 0$ (operates a peg). Then, while the shock lasts the following is true:*

1. *Home output evolves according to*

$$y_t^L = -(1 - \mu) \cdot \mathbf{A} = y_L^*.$$

2. *Home producer price inflation is given by*

$$\pi_{H,t}^L = -\kappa \cdot \mathbf{A} = \pi_L^*.$$

3. *Home consumer price inflation is given by*

$$\pi_t^L = -\kappa \cdot \mathbf{A} = \pi_L^*.$$

4. *By design, the nominal exchange rate is constant $e_t^L = 0$.*

5. *The Home interest rate is given by $r_t^L - r_L^* = 0$.*

Proof. Uncovered interest parity and fixed exchange rates give (5.). For the remainder, guess $y_t = y_t^*$. With this, from (25) and Proposition 2, $m_t = 0$. Using (21), the Markov structure of the shock, $y_t = y_t^*$ and Proposition 1 gives (2.). Using (26) and the law of motion for π_t^* , (3.) follows. With these results, the guess for y_t is easily verified. \square

The fixed exchange rate means that Home monetary policy gives up the ability of stabilizing its business cycle and insulating the Home economy from Foreign shocks. On the contrary, Home monetary policy follows the Foreign policy one-to-one, so as to keep the peg. Thus, Home

imports Foreign's monetary stance and with it both the foreign recession (one-to-one) and the drift in the foreign price level (one-to-one again). The home economy moves in lockstep with the Foreign economy.

Between the two extreme regimes above, there are many others. We turn to a monetary regime that, even if exchange rates are flexible, may not afford much insulation: The following proposition focuses on CPI inflation targeting.

Proposition 5. Targeting consumer price inflation. *Consider the same conditions as in Proposition 2. Suppose that Home monetary policy targets stable consumer prices ($\pi_t = 0$). Then, while the foreign monetary shock lasts, the following is true:*

1. Home output evolves according to

$$y_t^L = y_L^* + (1 - v) \frac{1 - \alpha^{t+1}}{1 - \alpha} \frac{\kappa(1 - \mu)}{v[2 - \alpha - \mu] + \kappa} \cdot \mathbf{A},$$

where $\alpha = 1 + \kappa/(2v) - \sqrt{[1 + \kappa/(2v)]^2 - 1}$, so that $\alpha \in (0, 1)$.

2. Home producer price inflation is given by

$$\pi_{H,t}^L = -v\alpha^t \frac{\kappa(1 - \mu)}{v(2 - \alpha - \mu) + \kappa} \cdot \mathbf{A}.$$

3. Home consumer price inflation, by construction is zero, $\pi_t^L = 0$.
4. The nominal exchange rate is given by

$$e_t^L = \left[(1 - v) \frac{1 - \alpha^{t+1}}{1 - \alpha} \frac{\kappa(1 - \mu)}{v[2 - \alpha - \mu] + \kappa} + (t + 1)\kappa \right] \cdot \mathbf{A}.$$

5. The Home interest rate is given

$$r_t^L - r_L^* = \left[-(1 - v)(1 - \alpha^{t+1}) \frac{\kappa(1 - \mu)}{v[2 - \alpha - \mu] + \kappa} + \mu \left(\frac{(1 - v)\kappa(1 - \mu)}{v[2 - \alpha - \mu] + \kappa} + \kappa \right) \right] \cdot \mathbf{A}.$$

Proof. See Appendix F. □

Targeting consumer price inflation insulates consumer prices from the Foreign shock, but at the expense of output in Home falling along with Foreign output. It falls the more so, the more open the economy is (the lower the home bias, that is, the closer v to unity) or the more rigid prices are. Second, in the extreme, if prices were perfectly rigid, $\kappa = 0$,²⁷ CPI inflation targeting would have *exactly* the same consequences as pegging the exchange rate. That is, under the special parameterization that we use in this subsection, an economy that operates a float but targets consumer price inflation would—in terms of its responses to a foreign monetary shock—be *indistinguishable* from an economy that pegs outright. In this sense, inflation targeting may

²⁷Recall that we assume $\kappa = \kappa^*$, so that completely rigid prices would prevent domestic and foreign producers from changing prices.

mask the potential of flexible exchange rates to insulate domestic activity from foreign shocks. Under a dominant currency regime, insulation of output requires a depreciation of the currency, which raises consumer prices, a rise that CPI targeting prevents.

Another insight emerges from Proposition 5. Namely, using the proposition's item 4. and the expressions for Foreign output and Foreign inflation from Proposition 1, the exchange rate relates to Foreign output and inflation as follows

$$e_t^L = -(1 - \nu) \frac{1 - \alpha^{t+1}}{1 - \alpha} \frac{\kappa}{\nu[2 - \alpha - \mu] + \kappa} y_L^* - (t + 1) \pi_L^*.$$

This shows that the flexible nominal exchange rate provides insulation, even under headline inflation targeting. But that this insulation is primarily nominal, namely, against the nominal foreign inflationary drift (the term π_L^*), which the exchange rate perfectly absorbs. To the extent that the Foreign monetary shock moves Foreign demand as well, instead, the insulation is less perfect. The exchange rate will move the more, the more flexible the prices are (the larger κ) and the less open the economy is (the smaller ν).

The appendix provides further results that help put the findings above into context. First, we show that in a dominant currency pricing regime, inflation targeting invites output spillovers, even if the target is not consumer-price inflation. Namely, Appendix G provides the producer-price inflation-targeting counterpart to Proposition 5. It shows that also if Home monetary policy were to target producer prices (instead of consumer prices), policy would fail to insulate domestic output. Output in Home falls along with Foreign output if somewhat less so than under CPI inflation targeting. Second, we assess how important the dominant-currency regime is for the spillovers. Toward this end, Appendix H provides the same scenarios as above, but assumes that there is producer-currency pricing (PCP) instead of DCP. As is well-known, under PCP there is divine coincidence: targeting producer prices induces the flexible-price allocation in Home (Galí and Monacelli, 2005). This insulation is *automatically* provided by the flexible exchange rate, in the following sense: that the nominal interest rate in Home does not need to move *at all* to bring about the insulation. Still, the appendix shows, that if the central bank were to target consumer price inflation instead of producer price inflation, it would invite some output spillovers.

Throughout this section, we have focused on the transmission of a Foreign *monetary policy* shock, and we have restricted ourselves to the case of perfectly elastic labor supply. Appendix I presents analytical solutions relaxing both assumptions. Namely, the appendix presents derivations for any $\varphi \geq 0$ and for all the possible foreign shocks that we spelled out in the model section, Section 4.1, assuming that they all follow a first-order Markov structure. The main insight survives: also for other shocks, targeting inflation in a dominant-currency regime may mask the ability of flexible exchange rates to insulate against external shocks.

4.3 The insulation puzzle: a quantitative model assessment

This section conducts a quantitative assessment in a more general version of the model economy, explicitly calibrating the model to the EA and its neighboring economies. The main result is that our evidence presents an inherent conundrum for the theory we present. Namely, if the central bank applies the same monetary strategy in the face of all shocks, it seems that either the current vintage of theory is able to account for our novel conditional evidence, or the theory can account for the sizable unconditional volatility of the exchange rate and the unconditional exchange-rate disconnect (Baxter and Stockman, 1989; Itskhoki and Mukhin, 2021), but not for both at the same time. Put differently, looking through the lens of the model one wonders why quite generally central banks seem willing to allow exchange rates to float, but might be less inclined to do so *conditional* on certain external shocks.

4.3.1 Extensions for a quantitative assessment

For the quantitative assessment, we slightly modify the model environment relative to what we had spelled out in Section 4. We provide a bird’s-eye view of the modifications next. Appendix J provides a detailed and more formal description. First, for comparison with the literature Foreign monetary policy is governed by a Taylor-type feedback rule, as applied in Gopinath et al. (2020), for example; namely,

$$r_t^* = \rho_{r^*} r_{t-1}^* + (1 - \rho_{r^*}) (\alpha_{\pi^*} \pi_t^* + \alpha_{y^*} y_t^*) + \varepsilon_t^*, \quad (33)$$

where ε_t^* is the Foreign monetary policy shock, which in the following is assumed to be white noise, $\rho_{r^*} \in [0, 1)$, $\alpha_{\pi^*} \geq 1$ and $\alpha_{y^*} \geq 0$. Second, we move to incomplete markets. The reason is as follows. Baxter and Stockman (1989) document empirically that the main outline of business cycles of countries that peg or float typically looks comparable, other than that the nominal exchange rate is volatile for floaters; an observation that—as we show below—also arises in our sample of countries. Itskhoki and Mukhin (2021) show that relative portfolio demand shocks together with home bias in the product market can help account for these facts; see also earlier work by Devereux and Engel (2002) and Kollmann (2005). Moving to incomplete markets allows us to introduce frictions to international arbitrage, and to introduce such autocorrelated shocks to relative international portfolio demand.²⁸ Third, next to the Foreign monetary shock and the shock to the international substitutability of bonds, there are serially correlated time-preference and productivity shocks in both Home and Foreign. As in Backus et al. (1992), Heathcote and Perri (2002), and Itskhoki and Mukhin (2021), we allow for direct spillovers of Foreign productivity to Home’s productivity. We do this with a view toward better accounting for the comovement of business cycles in Home and Foreign.

²⁸Moving to incomplete markets is virtually without consequence for the international transmission of monetary shocks, however. That is, for the conditional correlations.

4.3.2 Calibration to the euro area and its neighbors

One period in the model is a quarter, allowing direct comparison of unconditional moments against national accounts data. We calibrate the Foreign economy to the EA and the Home economy to a prototypical neighbor in our sample. Here we discuss only the calibration of those parameters that require emphasis, or may be non-standard. Appendix K provides a more detailed overview and summary tables for all the parameters.

Our discussion of Proposition 5 emphasized the role of openness and price rigidities for the insulation properties of flexible exchange rates. Gopinath et al. (2020) show that imported input use is important to match the empirical evidence on exchange rate pass-through into import and export prices. We set the share of intermediate inputs in production to $\alpha = 2/3$, following their work. We set $v = 0.1$ so as to match the average import and export shares of the neighboring countries vis-à-vis the EA (30 percent of GDP). And we set the price adjustment costs to $\omega = 400$, implying that the Phillips curve is reasonably flat.²⁹ As to elasticities, we set $\varphi = 0.5$, implying a Frisch elasticity of labor supply of 2, as is customary in the business-cycle literature. Following Gopinath et al. (2020), we set the elasticity of external demand (the trade elasticity) to $\eta = 2$. The Foreign monetary policy rule is parameterized in line with the estimates outlined in Adolfson et al. (2007). We set $\rho_{r^*} = 0.85$, $\alpha_{\pi^*} = 1.25$, and $\alpha_{y^*} = 0.025$. For the baseline calibration, we assume that if Home floats, monetary policy follows exactly the same Taylor rule as Foreign, responding to Home variables of course.³⁰ An important part of the exercise is that we will, later, assess the sensitivity of the results with respect to the domestic monetary policy regime. If Home pegs, instead, it follows a credible, hard peg vis-à-vis Foreign.

As to the shocks in Foreign and Home, respectively, there are monetary policy shocks, productivity shocks, and demand preference shocks. Home and Foreign monetary policy shocks each have a standard deviation of 25bps annualized, which is customary. For Foreign the autocorrelation of the productivity shock follows the EA estimates of Adolfson et al. (2007) (their Table 2). The standard deviation is scaled such that fluctuations in productivity account for 50 percent of the fluctuations in Foreign output. The demand preference shock has the same autocorrelation and is scaled such that output in Foreign has the same standard deviation as in the EA data. For Home's productivity, we assume that 90% of the Foreign productivity shock directly is reflected in Home productivity. This is somewhat larger than assumed in the literature, but seems reasonable in light of the close integration of production networks between the EA and its neighbors (ECB Working Group on Global Value Chains, 2019). Next, Home's idiosyncratic component of productivity has the same serial correlation as the Foreign component. Both the productivity shock and the demand preference shock in Home are three times as volatile as in Foreign, in line with the larger volatility of the small open economies. Last, we

²⁹Our calibration of the adjustment cost parameter matches the slope of the euro-area Phillips curve in Alvarez et al. (2006). The slope is tantamount to firms reoptimizing their prices, on average, once every 6.5 quarters in a setup with staggered price setting à la Calvo and no further real rigidities.

³⁰The inflation rate in the Home monetary policy rule is CPI inflation.

calibrate the shock to international portfolio demand as being short-lived, having a half-life of one quarter only. We choose the standard deviation of the innovation of the shock such that, under the float and assuming monetary policy follows the Taylor rule, the model replicates the volatility of the nominal exchange rate that we observe in the data. Policy apart, the parameterization is identical for pegs and floats. The one exception is that we assume that pegs are credible and that—therefore—deviations from UIP due to shocks to the international portfolio demand of bonds are smaller, consistent with the theoretical framework in Itskhoki and Mukhin (2021). Under the peg the standard deviation of the shocks to relative portfolio demand is only five percent the size as under the float. We choose five percent such that the interest rate under the peg has a variability commensurate with the data.

4.3.3 Exchange-rate disconnect in the data and theory

The parsimonious structure of the model notwithstanding, the calibrated model matches the unconditional euro-area business-cycle moments well (standard deviations, comovement with GDP and serial correlation); see Appendix K.2. What shall concern us here, however, are the business cycle moments for the neighboring countries. These are reported in Table 3. Panel A

Table 3: Business cycle moments for the neighbors—data and calibrated model

x_i	data					calibrated model				
	σ_{x_i}	ρ_{x_i,gdp_i}	$\rho_{x_i,x_i(-1)}$	$\rho_{x_i,x_{EA}}$	$\rho_{x_i,gdp_{EA}}$	σ_{x_i}	ρ_{x_i,gdp_i}	$\rho_{x_i,x_i(-1)}$	$\rho_{x_i,x_{EA}}$	$\rho_{x_i,gdp_{EA}}$
A. Float										
Δe_t	3.65	0.12	0.17	–	0.03	3.65	0.17	-0.21	–	-0.01
gdp_t	3.36	1.00	0.76	0.68	0.68	3.14	1.00	0.78	0.42	0.42
r_t	2.90	0.42	0.88	0.51	0.23	2.34	0.41	0.97	0.21	-0.02
π_t	0.93	0.29	0.51	0.32	0.19	0.58	0.58	0.47	0.19	-0.02
<hr style="border-top: 1px dashed black;"/>										
B. Peg										
Δe_t	1.17	0.05	0.04	–	0.01	0.00	0.00	0.00	–	0.00
gdp_t	4.07	1.00	0.85	0.66	0.66	3.71	1.00	0.84	0.31	0.31
r_t	1.53	0.22	0.90	0.24	0.07	1.28	0.05	0.93	0.93	0.21
π_t	0.60	0.20	0.37	0.49	0.31	0.37	0.69	0.86	0.52	0.13

Notes: left columns are the data, right columns the corresponding moments in the model; the data counterparts apply a quadratic trend. Top: moments for floats. Bottom: moments for pegs. Δe_t is the quarter-on-quarter percent change of the nominal exchange rate, gdp_t is the log of gross domestic product, r_t the nominal interest rate (annualized), and π_t quarter-on-quarter consumer-price inflation (annualized). For each block, the table shows the standard deviation of the variable, the correlation with a country's GDP, the first-order autocorrelation, the contemporaneous correlation with the same variable at the euro-area level, and the contemporaneous correlation of the variable with euro-area GDP. For the model results for floats reported here, floats follow the same Taylor rule as does Foreign.

of the table shows the business-cycle moments for neighbors that have floating exchange rates. The left block are the moments in the data, the right block the corresponding moments in the calibrated model. The simple calibration of a bare-bones international business-cycle model captures the main dimensions of the data remarkably well: strong volatility of nominal exchange rates for floats (as targeted in the calibration), but little correlation of exchange rates with economic activity, neither the EA’s activity nor the neighbors’ itself. Under the float the model also produces the positive comovement of both inflation and interest rates with the neighbors’ economic activity, and international business-cycle comovement.

Panel B in Table 3, in turn, presents the business-cycle moments for neighbors that peg. On the data side (left columns) business cycles look by and large comparable for pegs and floats. For pegs, output is somewhat more volatile than for floats, and inflation is somewhat less volatile. But these differences hardly point into a conclusive direction. Similarly, the model moments (right columns) look comparable for peg and float.

In sum, Table 3 suggests that not only does the evidence for our sample bear out the apparent disconnect between the choice of exchange rate regime and the overall shape of the business cycle (Baxter and Stockman, 1989; Itskhoki and Mukhin, 2021).³¹ But also is the model able to account for these facts—assuming that floats employ a conventional Taylor rule.

4.3.4 Home monetary policy and the insulation puzzle

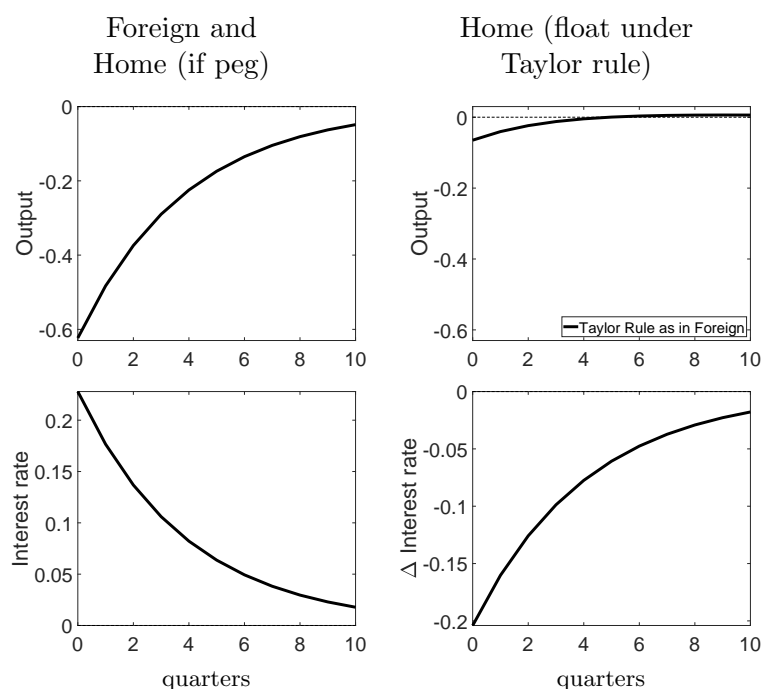
The empirical evidence that we have presented in Section 3 above goes further than this, however. Namely, the evidence is that floats and pegs empirically are also barely distinguishable when one *conditions* on a specific set of external shocks; monetary policy shocks among them. This section first shows that the baseline calibration above fails to account for the insulation puzzle. Then it shows that a policy regime in Home of headline inflation targeting, instead, can.

Figure 4 shows the responses in Foreign and Home to a Foreign monetary tightening. The left column shows the response in Foreign itself, which coincides with that in the Home economy when, under a peg, it has to align its monetary stance with the Foreign one.³² The right column shows our object of interest, the response in Home if, under a float, the central bank follows the conventional Taylor rule that underlies the baseline calibration discussed in Section 4.3.2. Because of the inflationary consequences of a Foreign tightening, the monetary authority in Home also tightens, but (under our calibration) engineers a monetary stance that remains more accommodative (bottom row, right panel). As a result, output in Home falls by only about 1/10 as much as it does under a peg (top row, right panel)—and the exchange rate depreciates by 0.3 percent (not shown in the panels). This degree of insulation, clearly, is in sharp contrast to

³¹An earlier study by Enders et al. (2013) investigates whether the introduction of the euro changed business cycles in Europe. Comparing the periods 1985–1996 and 1999–2011, they find that business cycle moments were largely unchanged for countries that have joined the euro.

³²Compare the responses to Figure 2.A. Foreign shows the conventional New Keynesian response: the interest rate rises upon a monetary tightening and output falls (left column). And, of course, if Home pegs its currency to Foreign, it has to import its monetary stance, leading to a complete spillover of the Foreign-induced recession.

Figure 4: Adjustment to Foreign monetary policy shock—baseline



Note: response to a Foreign monetary policy shock. Left: in Foreign, and in Home if Home pegs to Foreign; right: in Home if Home monetary policy follows the Taylor rule. From top to bottom: response of output (y_t^* or y_t , in percent); the interest rate in Foreign (r_t^*) or the difference between the response of the Home and Foreign interest rate ($r_t - r_t^*$), respectively. Interest rates and their differences are expressed in annualized percentage deviations from steady state.

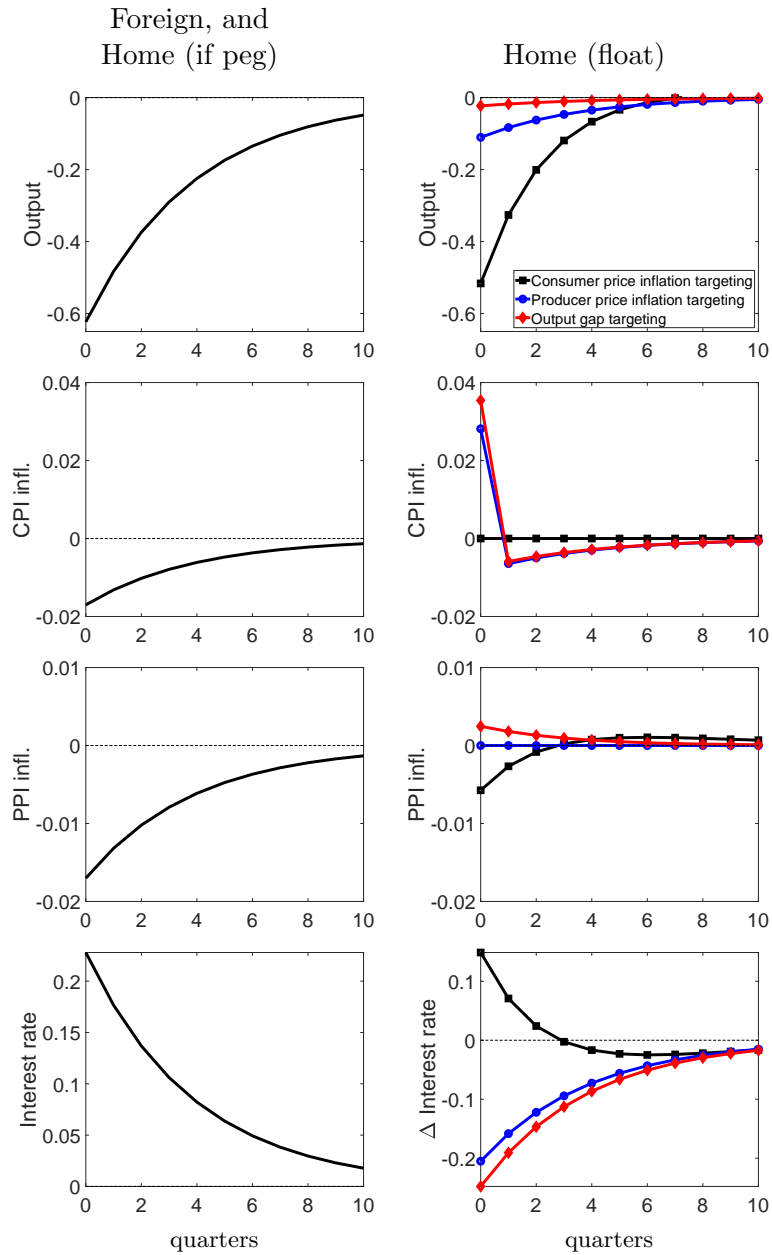
the lack of insulation for floats that we document empirically.

Figure 5 looks in more detail at the role that the choice of policy in a floating regime plays for the extent of insulation that we can observe. In its right column the figure revisits the response of the Home economy under the different targeting rules considered in Section 4.2.

The first observation is that the theory used here *can* replicate the empirical lack of insulation. Namely, as suggested by Proposition 5 under consumer price inflation targeting (black line with squares), the response of Home output is very similar to the one under the peg (first row), and roughly comparable to the response in the data. Consumer-price inflation targeting requires the Home monetary authority to tighten its monetary stance in line with (indeed, even somewhat more so than in) Foreign (bottom row). The increase in the Home real interest rate required to stabilize CPI inflation, induces large adverse output spillovers.

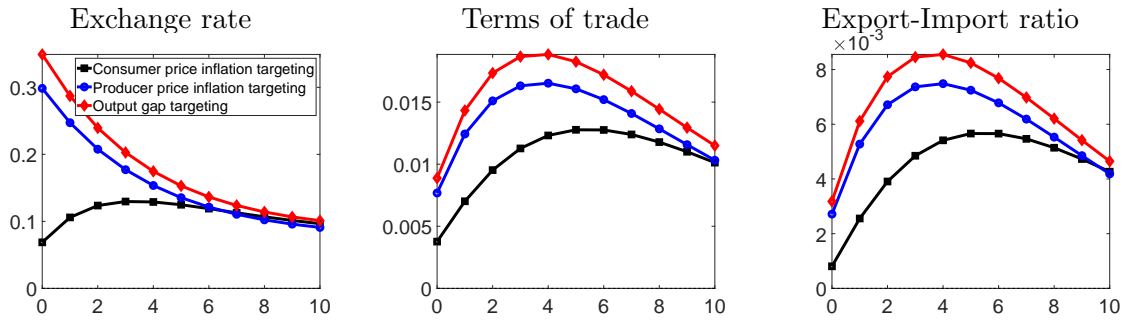
The second observation is that the lack of insulation—viewed through the lens of the model—owes to a particular *policy choice*. Even under DCP, flexible exchange rates render it possible for domestic policy to shield the level of Home economic activity from the external shock, though at the cost of heightened variability of inflation. This is exemplified by the output gap

Figure 5: Adjustment to Foreign monetary policy shock—the role of policy



Note: response to a Foreign monetary policy shock. Left: in Foreign, and in Home if Home pegs to Foreign; right: in Home if Home floats. For the latter, the panels show the case when Home operates a policy of output-gap targeting (red line with diamonds), producer-price inflation targeting (blue line with circles), or consumer-price inflation targeting (black line with squares). From top to bottom: responses of output (y_t^* or y_t , in percent), consumer-price inflation (π_t^* or π_t , quarter-on-quarter, not annualized), producer-price inflation (π_t^* or $\pi_{H,t}$, quarter-on-quarter, not annualized), the interest rate in Foreign (r_t^*) and the difference between the response of the Home and Foreign interest rate ($r_t - r_t^*$, annualized percentage points).

Figure 6: Home float: Adjustment of external variables to Foreign monetary policy shock



Note: same as Figure 5, but focusing only on floats (the right column of the aforementioned figure). From left to right: percent response of the nominal exchange rate (e_t , a rise means a depreciation from the perspective of Home), the Home terms of trade (s_t , a rise meaning a depreciation from the perspective of Home) and the percent change of the export-import ratio.

targeting regime, the red line with diamonds. Stabilizing Home output at its natural level—which declines slightly in response to the foreign shock due to the drop in Foreign demand for intermediate inputs—requires a cut in the Home interest rate, to stimulate aggregate demand in Home (bottom panel). This cut and the stabilization of output run counter to our evidence on the insulation puzzle, however. The trade-off is also apparent under producer price inflation targeting, an intermediate case between consumer price inflation and output gap targeting (right column, blue lines with circles).

Figure 6 shows the corresponding response of the external variables, including (in the left panel) the nominal exchange rate. Under consumer price inflation targeting (black solid line marked by squares), the exchange rate hardly moves in equilibrium. Remarkably, this response, too, is by and large consistent with the empirical evidence put forward in Section 3 for euro-area neighbor countries that pursue a floating exchange rate regime. The case of output gap targeting (red line with diamonds) once more shows the opposite end of the spectrum. Given the size of the monetary expansion in Home, relative to Foreign, the Home exchange rate depreciates substantially (see left panel of Figure 6). Under DCP, the role of the exchange rate as a shock absorber is limited. Specifically, since exports are priced in the foreign currency and those export prices are rigid, the depreciation does not induce immediate expenditure switching by Foreign households or firms toward Home-produced goods. Indeed, the terms of trade barely move on impact under either policy (center panel of Figure 6). Expenditure-switching effects of the exchange rate are only felt in Home: imported inflation reflecting the stronger exchange rate response induces a change in the composition of consumption by Home households and the composition of intermediate inputs used by Home firms (right panel) over and above the effect that accommodative policy has on intertemporal substitution.

Note that, while our analysis is purely positive, we have looked at well-founded monetary policy choices. On the one hand, because the majority of floaters in our sample assert that they

follow a regime of CPI inflation targeting. On the other hand because theory suggests that these regimes resemble good policy. In particular, Egorov and Mukhin (2020) show that, under DCP, the optimal policy of countries neighboring the dominant currency issuer stabilizes the prices of goods that are sticky in the domestic as opposed to the dominant currency.³³

4.3.5 Lack of insulation meets the exchange-rate disconnect

The conclusion from the previous section is that the choice of *how* to float may have a substantial bearing on the *observed* insulation properties of flexible exchange rates to external shocks; insulation is not automatic. Rather, the apparent lack of insulation that we observe in the data may lie to some extent with an aversion to imported inflation in the objectives of central banks in relatively open economies. This section brings back the puzzle. It shows that the aversion to inflation in the face of external shocks must not go in hand with a lack of aversion to imported inflation in other circumstances.

Table 4: Model-based moments for neighbors under float with strict CPI inflation targeting

x_i	σ_{x_i}	ρ_{x_i,gdp_i}	$\rho_{x_i,x_i(-1)}$	$\rho_{x_i,x_{EA}}$	$\rho_{x_i,gdp_{EA}}$
Δe_t	1.01	-0.66	0.60	–	-0.05
gdp_t	3.06	1.00	0.69	0.44	0.44
r_t	7.81	-0.62	0.47	0.06	0

Notes: Same as the right panel for floaters in Table 3, with the one difference that now the floater engages in strict CPI inflation targeting. Since CPI targeting is strict, we do not show moments for CPI inflation.

Namely, Table 4 shows the business cycle moments of floats when changing the policy from the baseline Taylor rule to headline inflation targeting; compare the right block of Panel A in Table 3 (we do not show inflation here, which is constant by design of the policy). A policy that always dampens consumer price inflation, always dampens exchange rate fluctuations. Under strict inflation targeting, as a result, the nominal interest rate would be too volatile relative to the data and the nominal exchange rate would show fluctuations that are an order of magnitude too small. Importantly, this discrepancy between the exchange rate volatility in our model and the data arises in spite of the fact that the model features incomplete international financial markets, imperfect pass-through, and portfolio demand shocks. The theory appears unable to account for the conditional evidence on spillovers without—at the same time—giving up on the unconditional evidence on exchange rate volatility.

³³Our conclusion of, at least, sizable spillovers under inflation targeting is not predicated on the lack of divine coincidence in the first place. Appendix L shows that even in economies where pass through is symmetrically *high* (complete) in all countries—the case of Producer Currency Pricing—it will still be true that the distance between a peg and inflation targeting shrinks when the central bank targets consumer prices (arguably suboptimally so). Conversely, the same applies to economies where pass-through is symmetrically *low*—the case of Local Currency Pricing (LCP). In this case, currency movements are larger even under inflation targeting, but they do not trigger expenditure switching effects, either at Home or abroad.

5 Conclusions

In this paper we challenge the traditional notion that a flexible exchange rate provides open economies with insulation from the adverse effects of external shocks based on new evidence from Europe. We show, in particular, that spillovers from euro-area shocks to neighbors that float are large and of the same size as for neighbors that peg; and exchange rates move little. We resort to the latest vintage of international macro theory that underpins the recent “flexibility pessimism” to shed light on this phenomenon. Namely, we study cross-border spillovers in a New Keynesian two-country model, where shocks originate in a large country that issues the currency that is dominant in cross-border trade. For the neighbor, dominant currency pricing results in a trade-off between stabilizing output and inflation. And, faced with this trade-off, central banks may *choose* not to insulate domestic output from external shocks in order to keep inflation in check.

At a deeper level, the exchange rate insulation puzzle persists, however. A salient feature of international business cycles is the exchange-rate disconnect that also holds in our sample: unconditionally nominal exchange rates are volatile under floating exchange rates, but otherwise business cycles of pegs and floats look alike. Since our policy-focused explanation dampens the exchange rate volatility both conditionally and unconditionally, it fails to explain the unconditional pattern. The real puzzle—in the context of existing international macro theory—then is why central banks quite generally seem willing to allow exchange rates to float, but would be unwilling to float *conditional* on certain external shocks.

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A Time-series data

Unless noted otherwise our data source is Eurostat and the sample runs from 1999:M01–2018:M12. In what follows we list details and exceptions.

Industrial production: manufacturing (series: sts_inpr_m), Index (2015=100), seasonally adjusted. First observation: 2000:M01, except for euro area, Croatia, Lithuania, Slovenia, United Kingdom, and Norway (all 1999:M01), Switzerland (2010:M10). For Iceland no data from Eurostat, use OECD (series: PRMNT001) instead (only available up to 2018:M02). To construct an aggregate series for EA11 we use the 2015 weights reported by Eurostat for the construction of the EA19 series and reweigh series accordingly. In some instances we use OECD data for 1999 as Eurostat data not available for that year, as well as for Ireland after 2010.

Unemployment rate: harmonized unemployment rate according to ILO definition (series: ei_lmhr_m), seasonally adjusted. First observation: 1999:M01, except for Bulgaria (2000:M01), Estonia (2000:M02), Croatia (2000:M01), Cyprus (2000:M01), Malta (2000:M01), Iceland (2003:M01), Switzerland (2010:M01). To construct an aggregate times series for EA11 we compute time series for labor force using Eurostat data for the number of unemployed as well as the unemployment rate. We sum the over all EA11 countries to compute the total number of unemployed and divide by the total labor force.

Interest rates: short-term interest rates for the euro area, for Croatia (since 2002:, with some observations missing afterwards), Romania (since 1999:M01), Bulgaria (since 1999:M09) from Eurostat (series: irt_st_m). For other countries we use OECD data (series: STINT), available since 1999:M01, except for Malta and Cyprus where we use long-term interest rates (source: ECB) to proxy for short-term rates. In our analysis we also use the interest rate on German government bonds with one year maturity from the Bundesbank (Term structure of interest rates on listed Federal securities (method by Svensson) / residual maturity of 1.0 year / monthly data. We remove a linear trend from the series prior to the estimation.

Harmonized index of consumer prices (HICP): All-items HICP, (series: prc_hicp_midx), 2015=100. First observation: 1999:M01, except for Switzerland (2004:M12). We construct the series for EA11 using the annual HCIP country weights reported by Eurostat for the computation of the EA19 series.

Producer price index (PPI): Domestic output price index - industry (series: sts_inppd_m). First observation: 2000:M01, except for euro area, Denmark, Lithuania, Sweden, United Kingdom (1999:M01), Estonia (2002:M01), Latvia (2001:M01), and Switzerland (2003:M05). For Iceland no data from Eurostat, use FRED Economic data instead (series: ISLPPDMMINMEI,

available since 2006:M06). To construct a series for EA11 we use the country weights for industrial production reported by Eurostat. In case Eurostat does not provide data for individual EA11 countries we use OECD data (except for Austria for which no data available for 1999).

Euro-exchange rates: for neighbor countries national currency per euro (monthly average). For countries that adopt euro in sample we use historical series (`ert_h_eur_m`) available up to 2015:M12, afterwards euro exchange rate is irrevocably fixed. For other countries we use the series `ert_bil_eur_m`. For the euro area we use the effective exchange rate of the euro from FRED Economic Data (series: NBXMBIS).

Export-Import ratio of neighbor countries with euro area: trade statistics of Eurostat are available at: <https://ec.europa.eu/eurostat/web/international-trade-in-goods/data/database>. For neighbor countries, the reporting country is EA19: imports from neighbor country n are exports of neighbor country to EA, likewise exports of EA to neighbor n are neighbor's imports. First observation is generally 2002:M01. We compute the log ratio of exports-to-imports. For EA we compute total exports-to-import ratio (source: Haver).

Real gross domestic product at market prices from Eurostat. Chain-linked volumes (2010), million euro. Quarterly. Seasonally adjusted and calendar adjusted. For Iceland: only seasonally adjusted.

B Exchange rate polices in neighbor countries

Here we provide a brief overview of the exchange rate policies of the EA neighbor countries from 1999 to 2018. Figure B.1 displays for each country in our sample the time series of the fine exchange-rate regime classification of IRR, measured against the left axis (1-14, since there are no instances of 15 in our sample), and the month-on-month change of the bilateral euro exchange rate, measured against the right axis (in percent). The shaded area indicates country-month observations that qualify as a float in our baseline (IRR category 9 or higher). Table 1 in the main text summarizes this information in a compact way. In what follows we look at each country in more detail and provide details on the classification of IRR. When appropriate, we also provide information from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER), the convergence reports by the European Commission, or the websites of the central banks.

Bulgaria: Currency board in place since 1997 under which the Bulgarian Lev (BGN) is pegged to Deutsche Mark and to the Euro afterwards. IRR classification: 2 (“Pre announced peg or currency board arrangement”).

Croatia: According to the central bank the “monetary policy framework is based on maintaining the stability of the nominal exchange rate of the kuna against the euro.” IRR classification: 4 (“De facto peg”).

Cyprus: Adoption of the euro on January 1, 2008. IRR classification: 1 (“No separate legal tender or currency union”) since then. On May 2, 2005 Cyprus joined the ERM2, but the exchange rate fluctuations were much narrower than the +/- 15% margin permitted under ERM2. IRR classification from 1999-2008: 4 (“De facto peg”); see also Central Bank of Cyprus website.

Czechia: CPI-Inflation targeting since 1998. From November 2013 to April 2017, exchange rate target as an additional monetary policy instrument, to avoid koruna to strengthen below 27 CZK/EUR (see Convergence programme of the Czech Republic, April 2017). IRR classification: 4 (“De facto peg”). IRR classification throughout 1999: 8 (“De facto crawling band that is narrower than or equal to +/-2%”), since 2000:M01: 11 (“Moving band that is narrower than or equal to +/-2%”).

Denmark: Denmark is a member of the ERM2 for the whole sample priod, but it pegs the Danish krone (DKK) against the euro allowing for a fluctuation band of only +/- 2.25% (see website of the Danish central bank). IRR classification: 2 (“Pre announced peg or currency board arrangement”).

Estonia: In the early part of our sample the Eesti kroon is pegged to euro via a currency board arrangement. In 2004, Estonia joined the ERM2, in January 2011 the euro. IRR classification: 2 (“Pre announced peg or currency board arrangement”) and 1 (“No separate legal tender or currency union”), before and after, respectively.

Greece: Adoption of the euro following a currency peg on January 1, 2002. Greece was member of the ERM2 until the end of 2001. IRR classification: 4 (“De facto peg”) and 1 (“No separate legal tender or currency union”), before and after, respectively.

Hungary: Since 2001 inflation target (see website of the Hungarian central bank) and freely floating exchange rate since February 2008 (see website of the Hungarian central bank). Prior to October 2001, the currency followed a crawling peg to a currency basket of composed of the euro (70%) and the USD (30%), allowing for horizontal bands of $\pm 2.25\%$. In May 2001, the size of the bands was increased to $\pm 15\%$. Furthermore, the reference currency was changed to the euro in 2001. This regime was upheld until 2008. IRR classification: 9 (“Pre announced crawling band that is wider than or equal to $\pm 2\%$ ”) up to 2003:M04, 10 (“De facto crawling band that is narrower than or equal to $\pm 5\%$ ”) up to 2009:M03 and 8 (“De facto crawling band that is narrower than or equal to $\pm 2\%$ ”) since then.

Iceland: In 1999 and 2000 the Icelandic króna (ISK) was pegged to a basket of nine currencies (the Canadian dollar, the Danish krone, the euro, the Japanese yen, the Norwegian krone, the pound sterling, the Swedish krona, the Swiss franc, and the U.S. dollar) allowing for horizontal bands of $\pm 9\%$. IRR classification: 8 (“Pre announced crawling band that is wider than or equal to $\pm 2\%$ ”). In March 2001 this peg was dropped in favor of an inflation target. However, a subordinate goal of exchange rate stabilisation was formulated, which gives the central bank a mandate to intervene on the foreign exchange markets (see website of the central bank of Iceland). According to the AREAER, disruptions on the international financial markets from 2008 onward led the central bank to intervene on the foreign exchange markets to stabilise the currency. IRR classification 1999–2008: 8 (“De facto crawling band that is narrower than or equal to $\pm 2\%$ ”), up 2011:M09: 12 (“De facto moving band $\pm 5\%$, Managed floating), 11 (“Moving band that is narrower than or equal to $\pm 2\%$ ”) since then.

Latvia: Up to 2004:M12 peg to IMF special drawing rights. Switch from peg to euro peg on January 1, 2005 with $\pm 1\%$ bands. Joined ERM2 in May 2005 (see website of the central bank of Latvia). Since June 2009 de facto peg to euro, joined euro in January 2014. IRR classification from 1999:M01–2001:M07: 10 (“De facto crawling band that is narrower than or equal to $\pm 5\%$ ”), up to 2004:M12: 8 (“De facto crawling band that is narrower than or equal to $\pm 2\%$ ”), up to 2009:M06: 11 (“Moving band that is narrower than or equal to $\pm 2\%$ ”), up to 2013:M12: 2 (“Pre announced peg or currency board arrangement”), and 1 (“No separate legal

tender or currency union”) since then.

Lithuania: Up to 2002 the Lithuanian litas (LTL) was pegged to the US dollar by means of a currency board arrangement. On February 2, 2002 this peg was transformed into a euro-peg. In 2004 Lithuania joined the ERM2 without changing its effective exchange rate regime (AREAER). Adoption of the euro on January 1, 2015. IRR classification up to 2014:M12: 2 (“Pre announced peg or currency board arrangement”) and 1 (“No separate legal tender or currency union”) since then.

Malta: In the early part of the sample the Maltese lira was pegged to a currency basket, with weight of euro increased in August 2002. Peg to euro only started in January 2005, and adoption of the euro on January 1, 2008 (AREAER). IRR classification: 11 (“Moving band that is narrower than or equal to $\pm 2\%$ ”) up to 2000:M12, 7 (“De facto crawling peg”) up to 2007:M12; 1 (“No separate legal tender or currency union”) afterwards.

Norway: Floating exchange rate rate. Since March 2001 CPI inflation target. IRR classification: 11 (“Moving band that is narrower than or equal to $\pm 2\%$ ”).

Poland: Up to March 2001 Polish zloty (PLN) was pegged to a currency basket consisting of the euro (55%) and the US dollar (45%). The peg followed a crawling and pre-announced central exchange rate to its reference basket. On March 24, 1999 the fluctuation band of the exchange rate around this central rate was increased from +/- 12.5% to +/- 15%. Floating exchange rate since April 2000 (AREAER). IRR classification up to 1999:M03: 10 (“De facto crawling band that is narrower than or equal to $\pm 5\%$ ”) and 12 (“De facto moving band $\pm 5\%$, Managed floating”) afterwards.

Romania: Central bank maintains “managed float, in line with using inflation targets as a nominal anchor for monetary policy and allowing for a flexible policy response to unpredicted shocks likely to affect the economy” (see central bank website). With the exception of the period from 2002 to 2004, the IMF has also classified the exchange rate regime of Romania as a managed float (AREAER). In August 2005, the central bank adopted an inflation target (see central bank website). Romania has set 2024 as its target year to adopt the euro, but has not joined the ERM2 yet (see European Commission website). IRR classification up to 2001:M01: 14 (“Freely falling”), up to 2004:M07: 8 (“De facto crawling band that is narrower than or equal to $\pm 2\%$ ”), up to 2006:M06: 12 (“De facto moving band $\pm 5\%$, Managed floating”), up to 2011:M11: 7 (“De facto crawling peg”), and 4 (“De facto peg”) since then.

Slovakia: Adoption of the euro following a managed float on January 1, 2009 (AREAER). Joined ERM2 in 2005. IRR classification up to 2008:M12: 8 (“De facto crawling band that

is narrower than or equal to $\pm 2\%$ ”), and 1 afterwards (“No separate legal tender or currency union”).

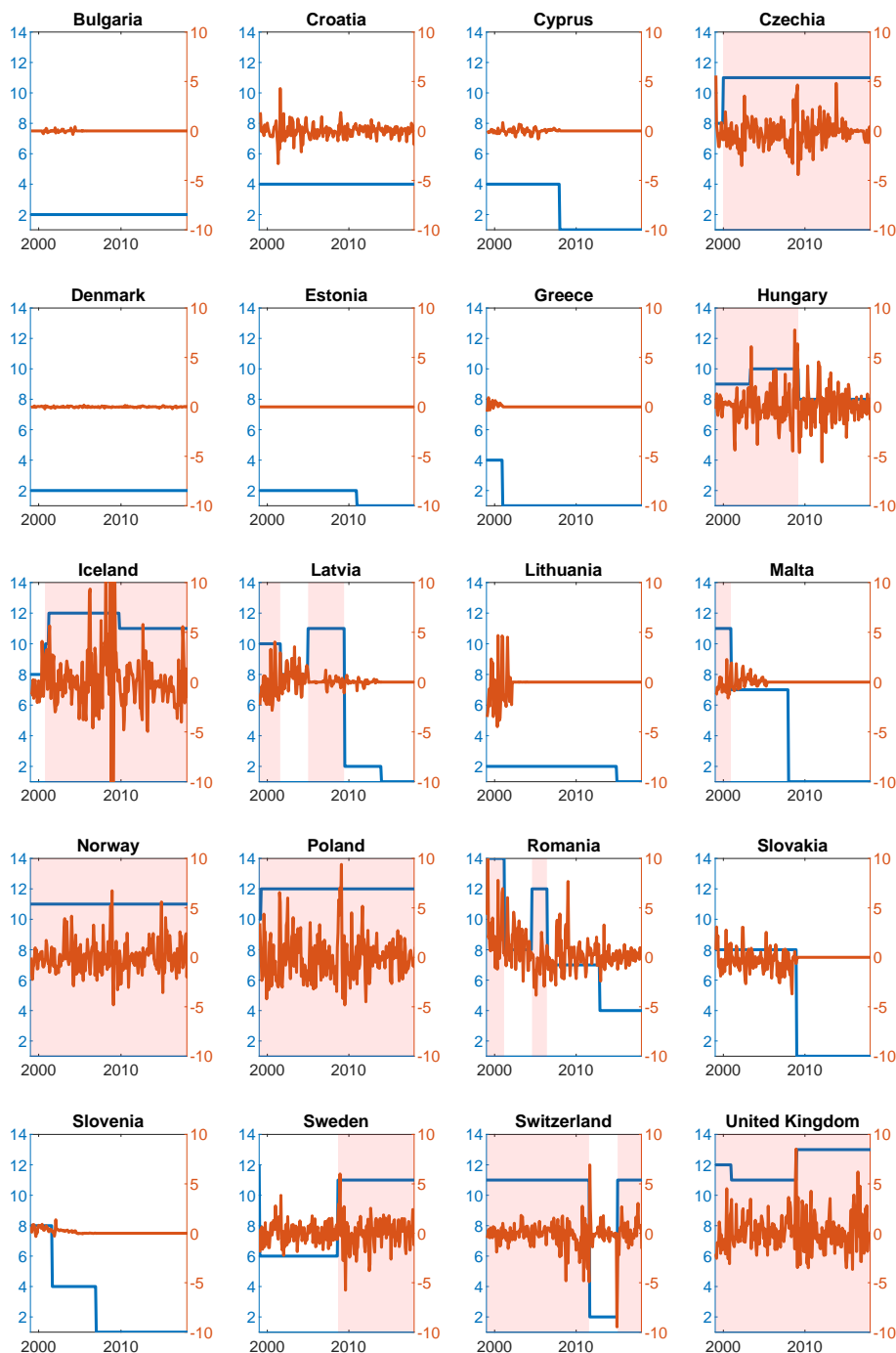
Slovenia: Adoption of the euro following a managed float on January 1, 2007. Joined ERM II in June 2004. IRR classification up to 2001:M08: 8 (“De facto crawling band that is narrower than or equal to $\pm 2\%$ ”), up to 2006:M12: 4 (“de facto peg”) and 1 afterwards (“No separate legal tender or currency union”).

Sweden: Inflation targeting since 1993; floating exchange rate. IRR classification up to 1999:M01: 12 (De facto moving band $\pm 5\%$, Managed floating), up to 2008:M08: 6 (“De facto crawling peg”) and 11 (“Moving band that is narrower than or equal to $\pm 2\%$ ”) since then.

Switzerland: Free float before September 6, 2011 and after January 15, 2015. Exchange rate floor equivalent to a de facto peg in the period in between. IRR classification up to 2011:M8: 11 (“Moving band that is narrower than or equal to $\pm 2\%$ ”), up to 2014:M12: 2 (“Pre announced peg or currency board arrangement”), and 11 since then.

United Kingdom: CPI inflation target since 1992. Flexible exchange rate. IRR: classification up to 2000:M12: 12, up to 2008:M12: 11, and 13 since then.

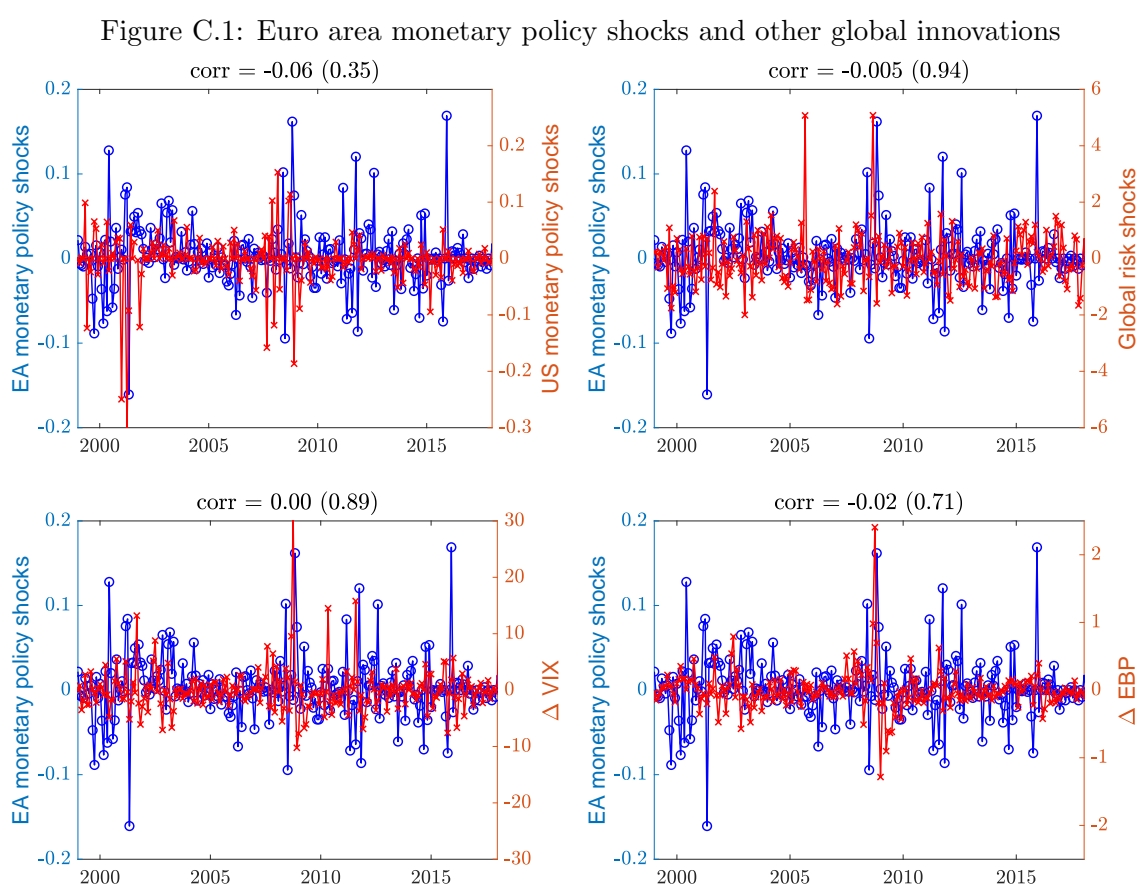
Figure B.1: Exchange rate regimes and fluctuations



Notes: each panel displays the fine exchange-rate regime classification of IRR against the left axis (1-14, since there are no instances of 15) in our sample), and the month-on-month change of the bilateral euro exchange rate against the right axis (in percent). The shaded area indicates country-month observations that qualify as a float in our baseline (IRR category 9 or higher).

C How well-identified are the euro area monetary policy shocks?

A concern that one may have is that the euro-area monetary policy shocks may not truly be euro-area shocks, but that they may reflect a common global factor. Toward this end, Figure C.1 plots the euro-area monetary policy shock series that we make use of in the baseline (left axis) against (right axis), respectively, a series of US monetary policy shocks, a series of global risk shocks, and against changes in the VIX and the excess bond premium. The title of the respective panels reports the correlation with the euro area shocks and reports the correlation (p-values in parentheses). The upshot seems to be that there is little correlation for all the series.

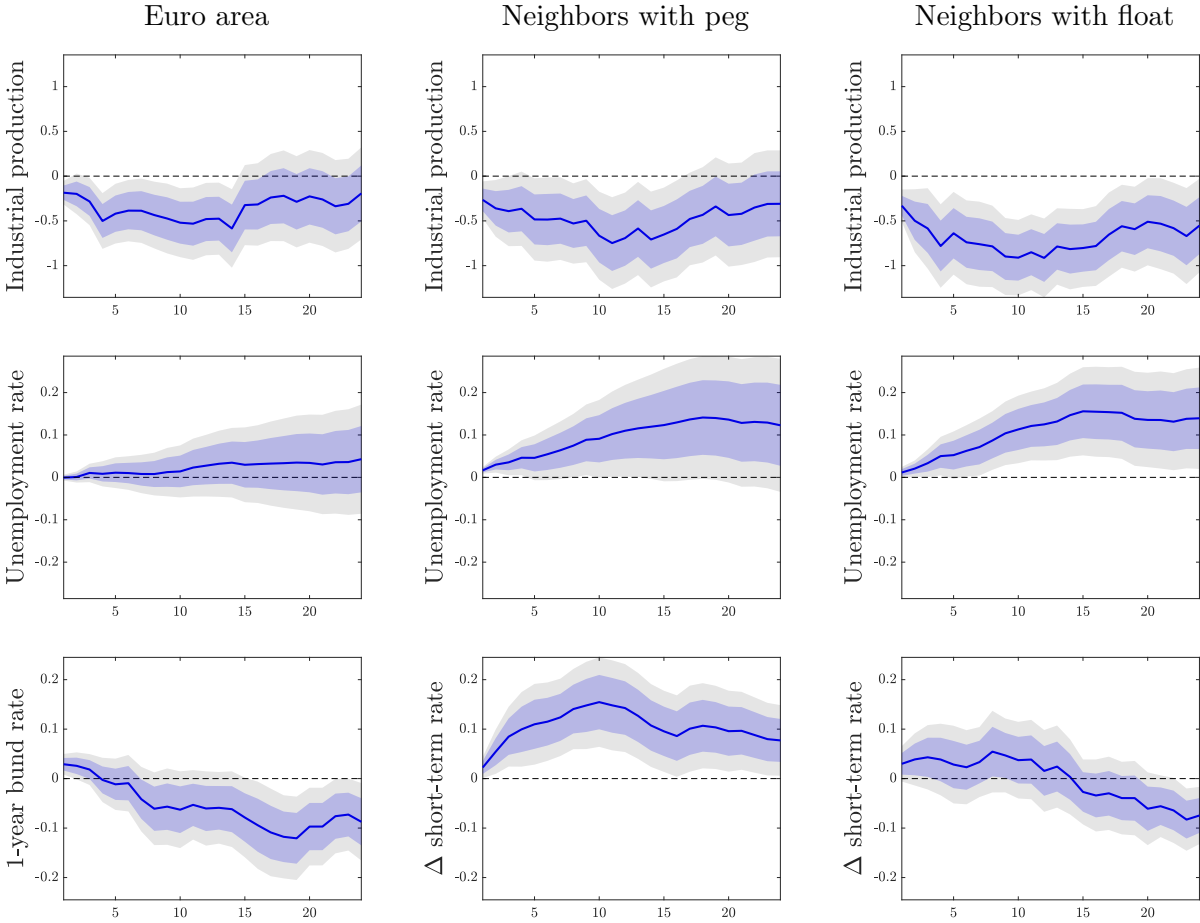


Notes: Each panel plots EA monetary policy shock (blue line) jointly with a series of US monetary policy shocks (Jarociński and Karadi, 2020), shown in the upper-left panel, jointly with a measure of global risk shocks (Georgiadis et al., 2021), shown in the upper-right panel, jointly with the monthly change in the VIX, and jointly with the monthly change in the external bond premium (Favara et al., 2016). We report the correlation of the two series on top of each panel (p-value in parenthesis).

Next, we go a step further and explicitly purge the information in US monetary policy shocks from the euro-area shocks. More in detail, we regress the euro-area monetary policy shock series from (Jarociński and Karadi, 2020) on contemporaneous (same-month) US monetary policy

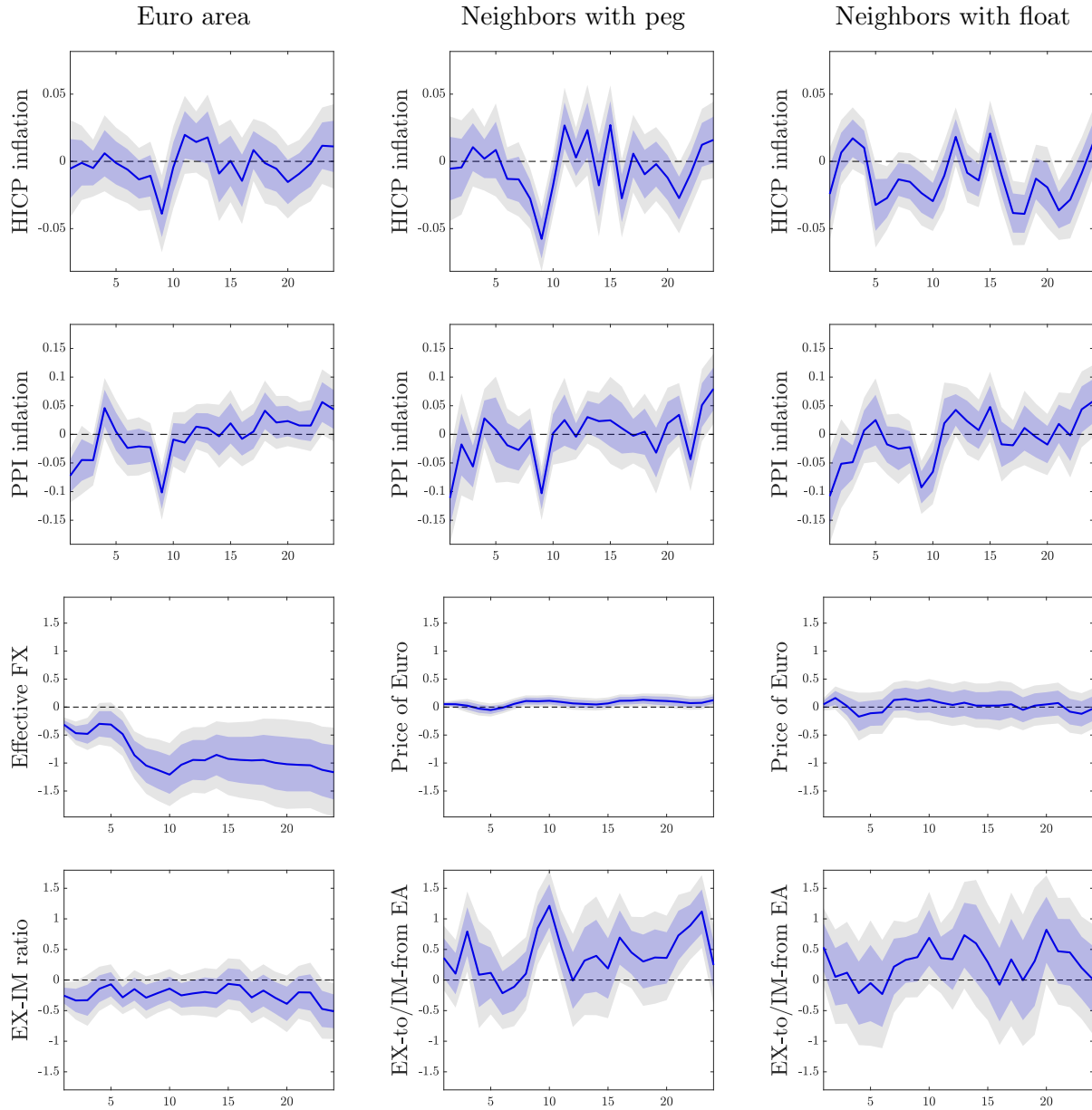
shocks and three lags of the latter. We then use as our measure of the euro-area monetary shock the residual of the above regression. This residual, by design, is orthogonal to the measure of US monetary policy shocks. Figures C.2 and C.3 show the resulting impulse responses. Perhaps not surprisingly in light of the evidence in Figure C.1, the spillovers to inflation and real activity are virtually identical to those shown in the main text (compare Figures 2.A and 2.B).

Figure C.2: Adjustment to orthogonal component of euro-area monetary policy shock



Notes: Shock is one-standard deviation shock identified by Jarociński and Karadi (2020) using high frequency data and sign restrictions, see Figure 2.A for details. The EA monetary policy shock is the residual of a regression of the Jarociński and Karadi (2020) series on the contemporaneous US monetary policy shock (and three of the latter shock’s lags).

Figure C.3: Adjustment to orthogonal component of euro-area monetary policy shock c'td



Notes: Shock is one-standard deviation shock identified by Jarociński and Karadi (2020) using high frequency data and sign restrictions, see Figure 2.B for details. The EA monetary policy shock is the residual of a regression of the Jarociński and Karadi (2020) series on the contemporaneous US monetary policy shock (and three of the latter shock's lags).

D Alternative specifications of empirical model and other shocks

Here we report robustness with respect to the sample split and with respect to the specific choice of euro-area monetary policy shock series. We also report impulse responses for euro-area shocks other than policy shocks.

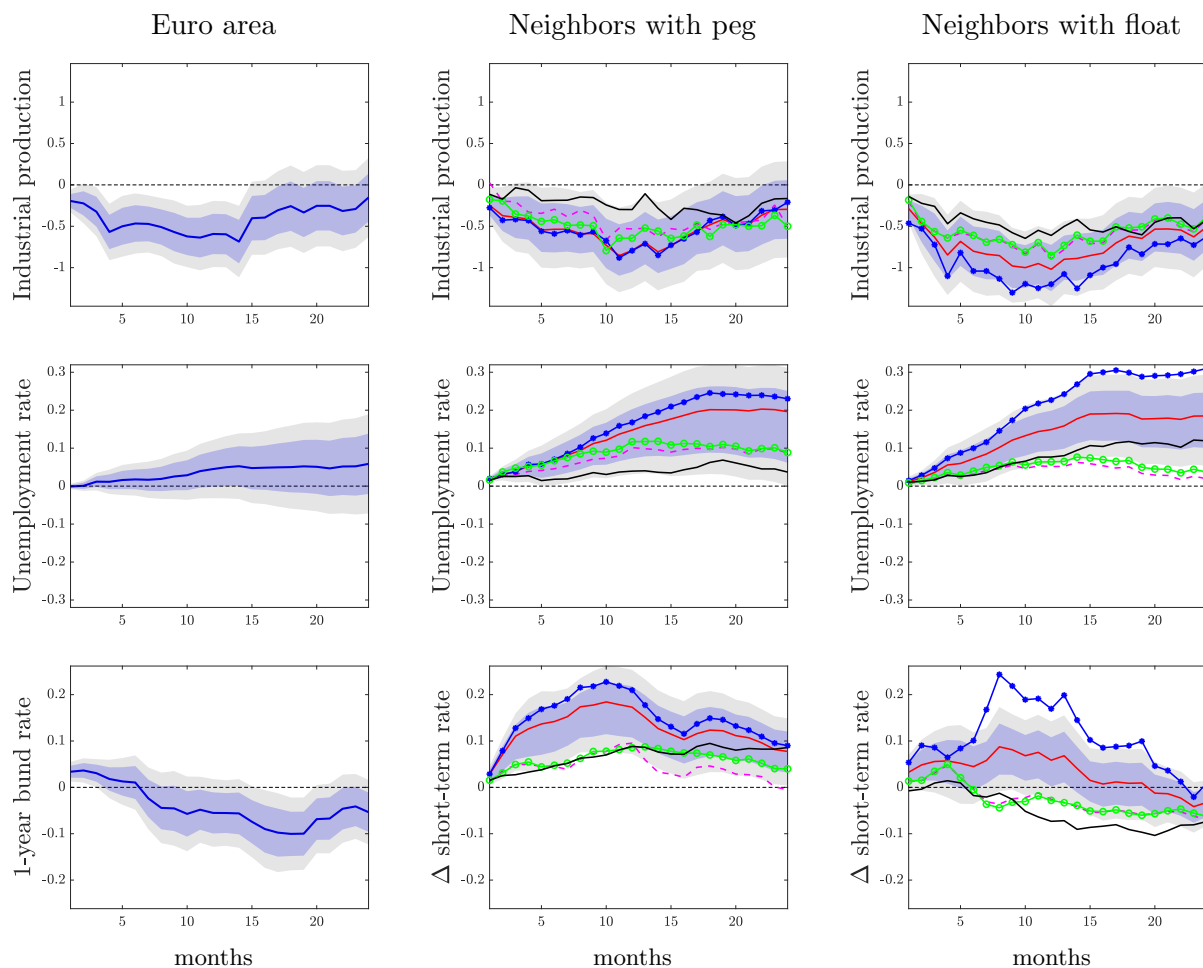
D.1 Monetary policy shocks: alternative specifications

This section documents the spillover effects for other specifications of the baseline regression.

D.1.1 Different sample split

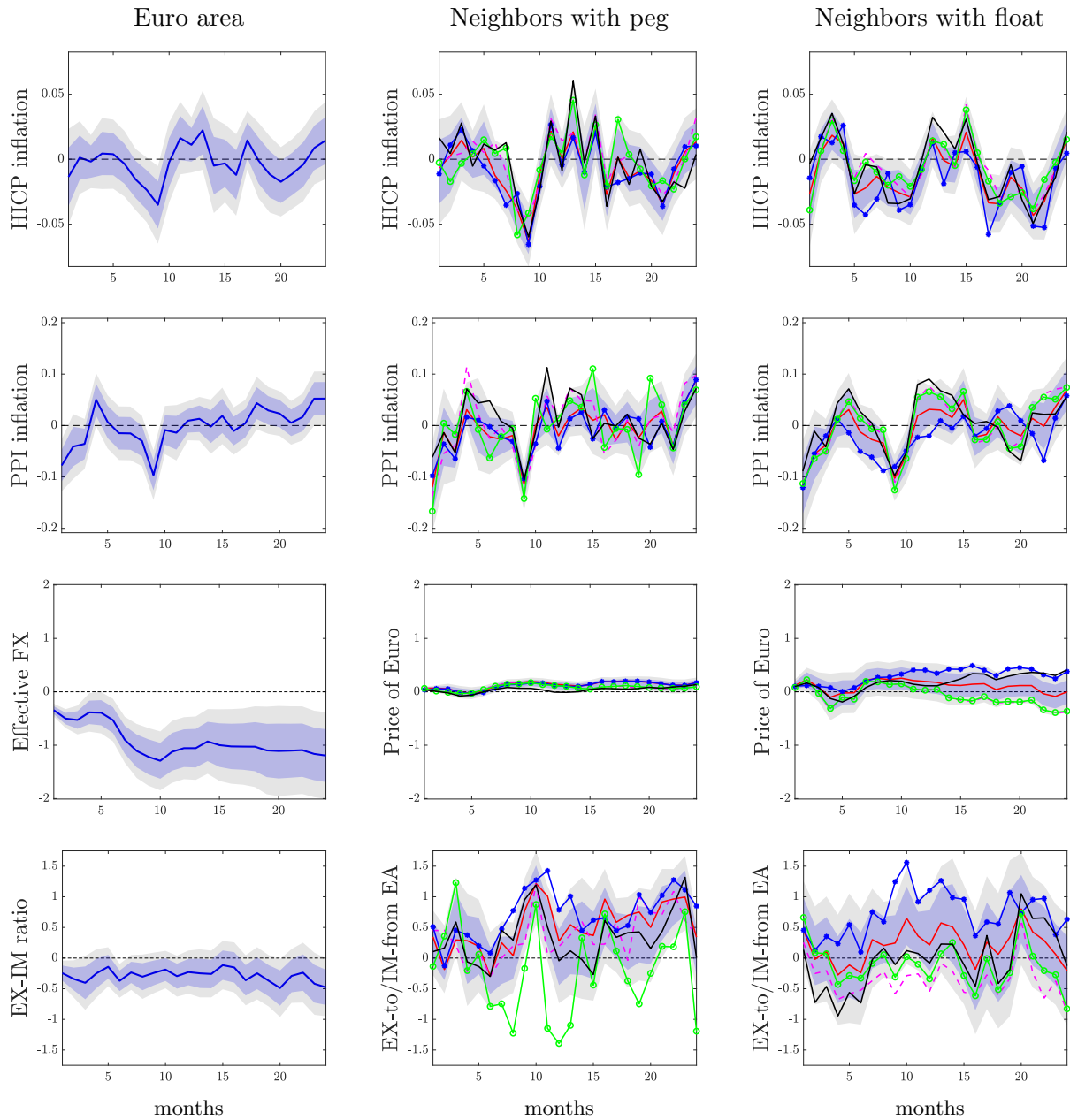
First, we do further robustness with respect to splitting the sample into pegs and floats. In the alternatives, respectively, we drop Cyprus and Greece from the sample (among the neighbors that peg, these were the countries worst-hit by the fiscal crisis), we drop EMU accession countries, and we perform sensitivity with respect to including former communist countries or not. Figures D.1 and D.2 as well as the notes to the figures provide details.

Figure D.1: Adjustment to euro-area monetary policy shock: different sample split



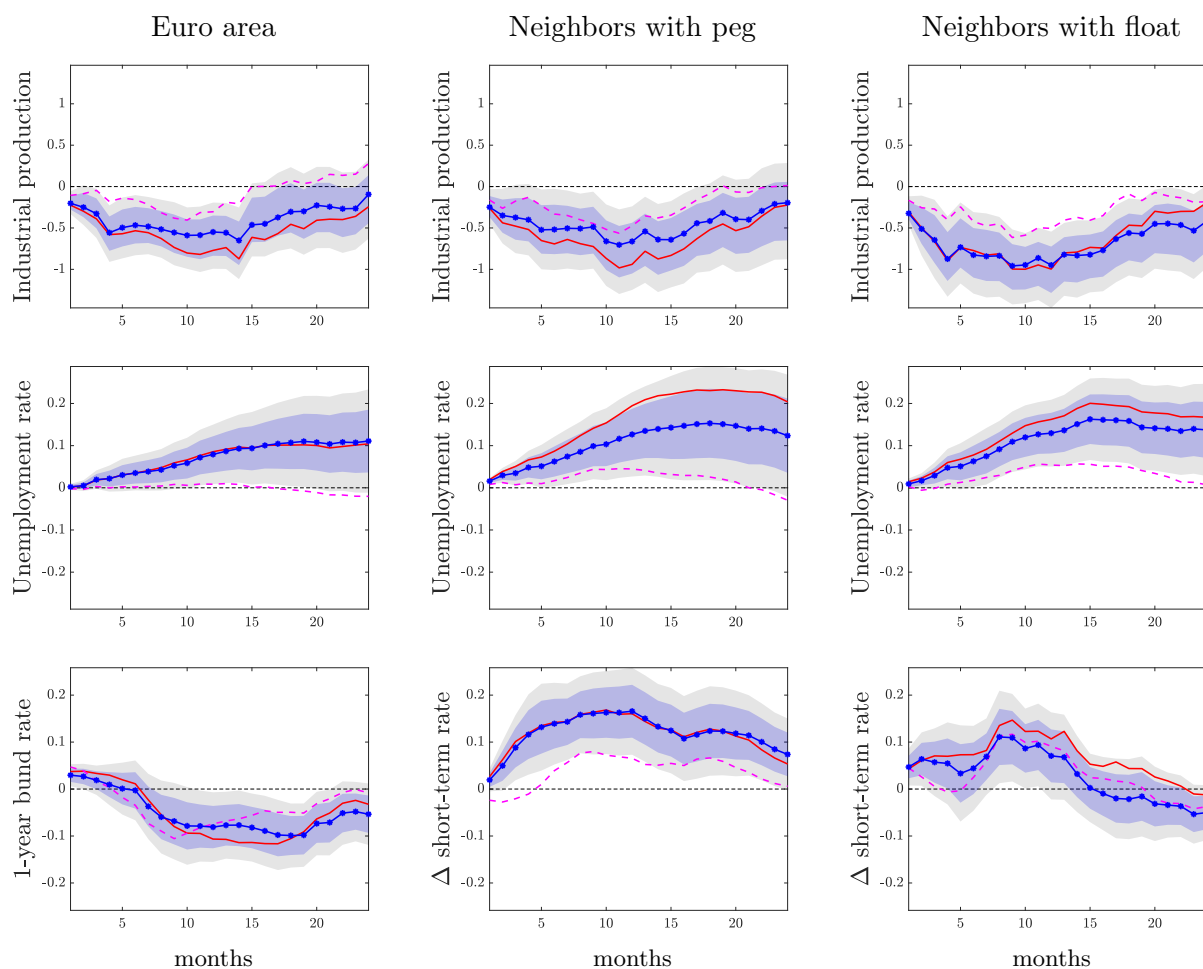
Notes: Shock is one-standard deviation shock. Left column shows responses of euro area variables, middle (right) column the response in neighbor countries with pegged (flexible) exchange rate; shaded areas correspond to 68 and 90 percent confidence bounds of estimate for baseline, see Figure 2.A in the main text for details. Point estimates for alternative specifications: No EMU accession countries in sample, that is, we drop Bulgaria, Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovenia, Slovakia (dashed line in magenta), only Eastern European countries in sample, that is, only Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia (blue line with stars), no eastern European countries in sample, that is the complement of the previous selection (green with circles), Cyprus and Greece not in sample (red solid line), drop observations for financial crisis 2008–09 (black solid line).

Figure D.2: Adjustment to euro-area monetary policy shock: different sample split c'td



Notes: same as Figure D.1, but showing additional variables. The set of variables shown here is the same as in Figure 2.B in the main text.

Figure D.3: Adjustment to euro-area monetary shock: different shock series and controls

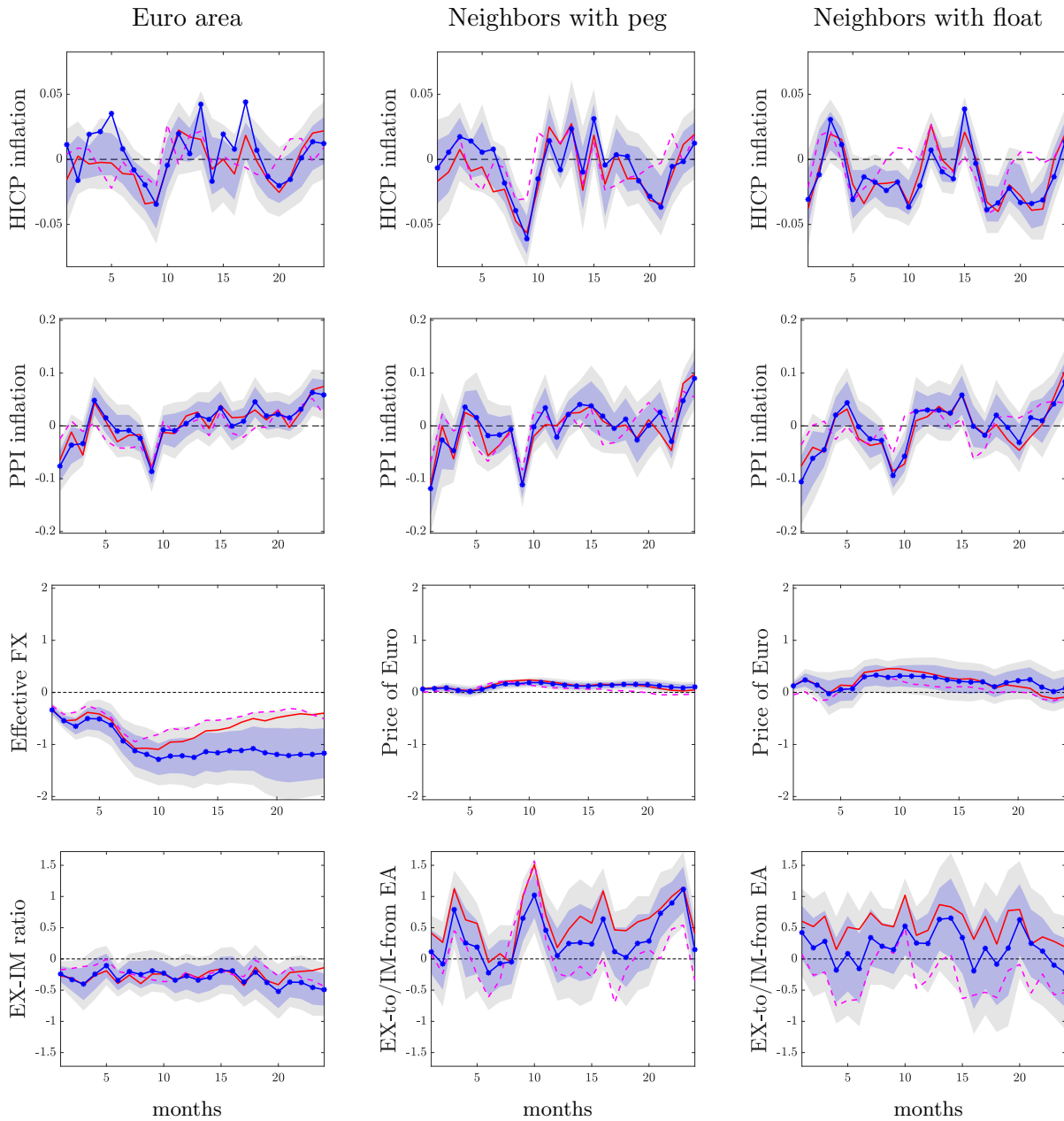


Notes: Shock is one-standard deviation shock. Left column shows responses of euro area variables, middle (right) column the response in neighbor countries with pegged (flexible) exchange rate; shaded areas correspond to 68 and 90 percent confidence bounds of estimate for baseline, see Figure 2.A in the main text for details. Point estimates for alternative specifications: monetary policy shocks identified using poorman's condition (red solid line), monetary policy shocks measured as monetary surprises in EA-MPD (dashed line in magenta), 6 (rather than 12) lags of shock and dependent variable as controls.

D.1.2 Different series for monetary shocks, and controls

This section reports on the impulse responses when using other measures of monetary policy shocks, and when changing the controls. The notes to Figures D.3 and D.4 provide the details.

Figure D.4: Adjustment to euro-area monetary shock: different shock series and controls c'td



Notes: same as Figure D.3, but showing additional variables. The set of variables shown here is the same as in Figure 2.B in the main text.

D.2 Spillovers from other shocks

So far, we have focused on euro-area monetary policy shocks. The current section probes into the spillovers from other euro-area shocks. For these as well, we find the exchange-rate regime appears to have similarly limited effects. For this purpose we once more rely on estimating models (1) and (2), but we choose shocks other than euro-area monetary policy shocks to represent $\bar{\varepsilon}_t$.

First, we estimate the effect of central bank information shocks in the euro area, as identified by Jarociński and Karadi (2020) and Jarociński (2020). Intuitively, these shocks account for a positive co-movement of interest-rate forwards and the stock market around monetary events. The idea is that a monetary surprise may provide information to market participants, to the extent that the central bank has more information about non-monetary fundamentals and is responding to these (see also Nakamura and Steinsson, 2018; Romer and Romer, 2000). The identification does not reveal the precise type of information advantage of the central bank. It seems natural to assume, however, that the euro-area monetary authorities have an information advantage, relative to the market and relative to information revealed by other central banks, primarily with respect to forces that are specific to the euro-area economy.

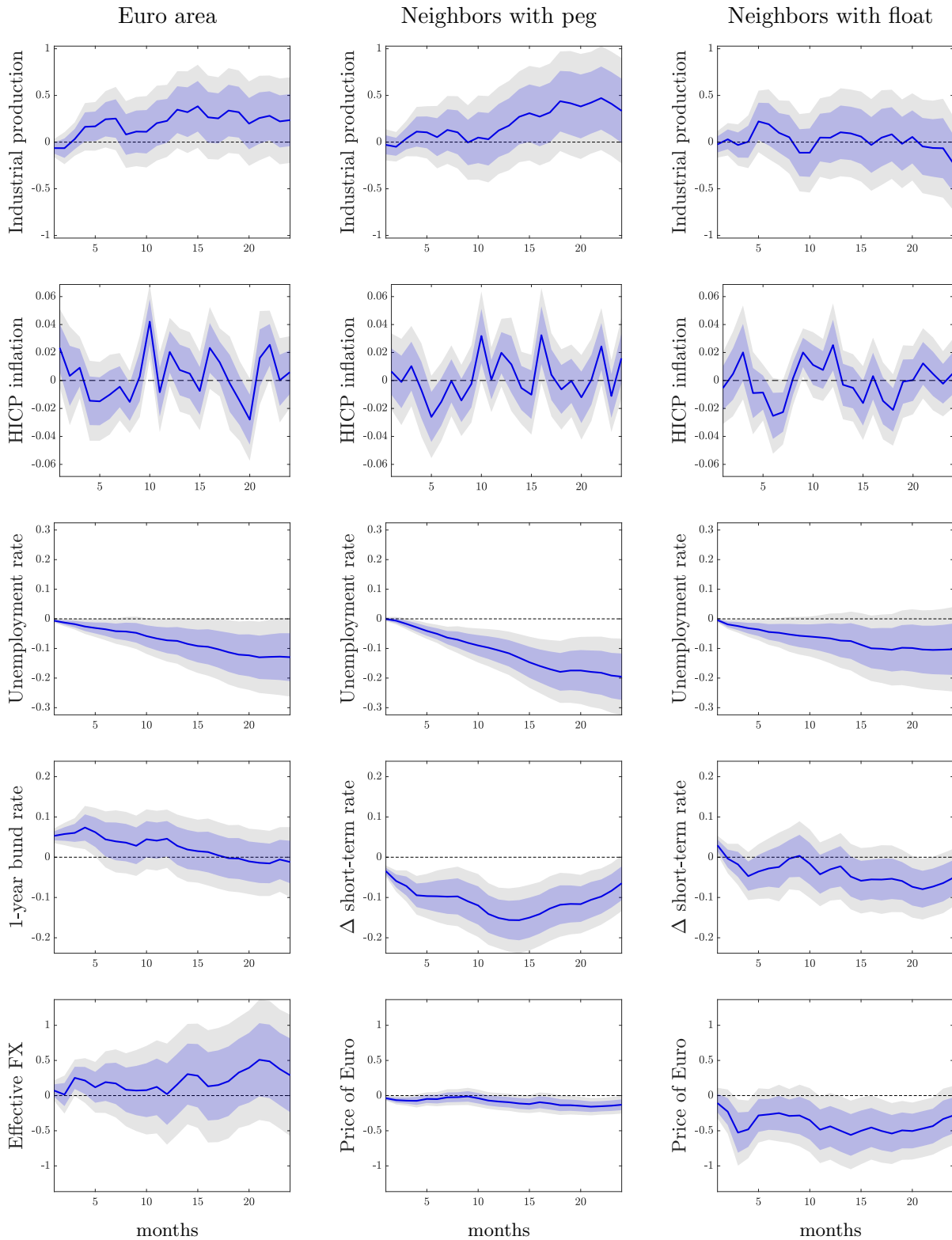
Figure D.5 shows the adjustment to euro-area central bank information shocks, both in the euro area and in the neighbor countries. It is organized in the same way as previous figures. In particular, the left column shows results for the euro area, the middle column for neighbors with a peg, the right column for neighbors with a float. In the figure, to keep the exposition compact, we focus on the response of four variables only: industrial production, unemployment, interest rates, and the exchange rate. In line with the notion that underlies a central bank information shock, we find this shock to be expansionary in the euro area. And, it is expansionary in the neighbor countries as well. Indeed, we find a very similar picture as with monetary policy shocks—except that all signs are reversed. The spillovers are positive and sizeable and they similar for floats and for pegs.

As a second alternative shock, we consider a euro-area credit “spread shock” that we identify relying on earlier work by Gilchrist and Mojon (2018). Specially, we use their index of credit risk for banks in the euro area which, in turn, aggregates individual security level data for Germany, Italy, Spain and France. We include this time series together with observations for industrial production, HICP inflation (core), and the EONIA in a VAR model and identify the spread shock recursively.³⁴

Figure D.6 shows the estimated responses to the identified euro area spread shocks. As before,

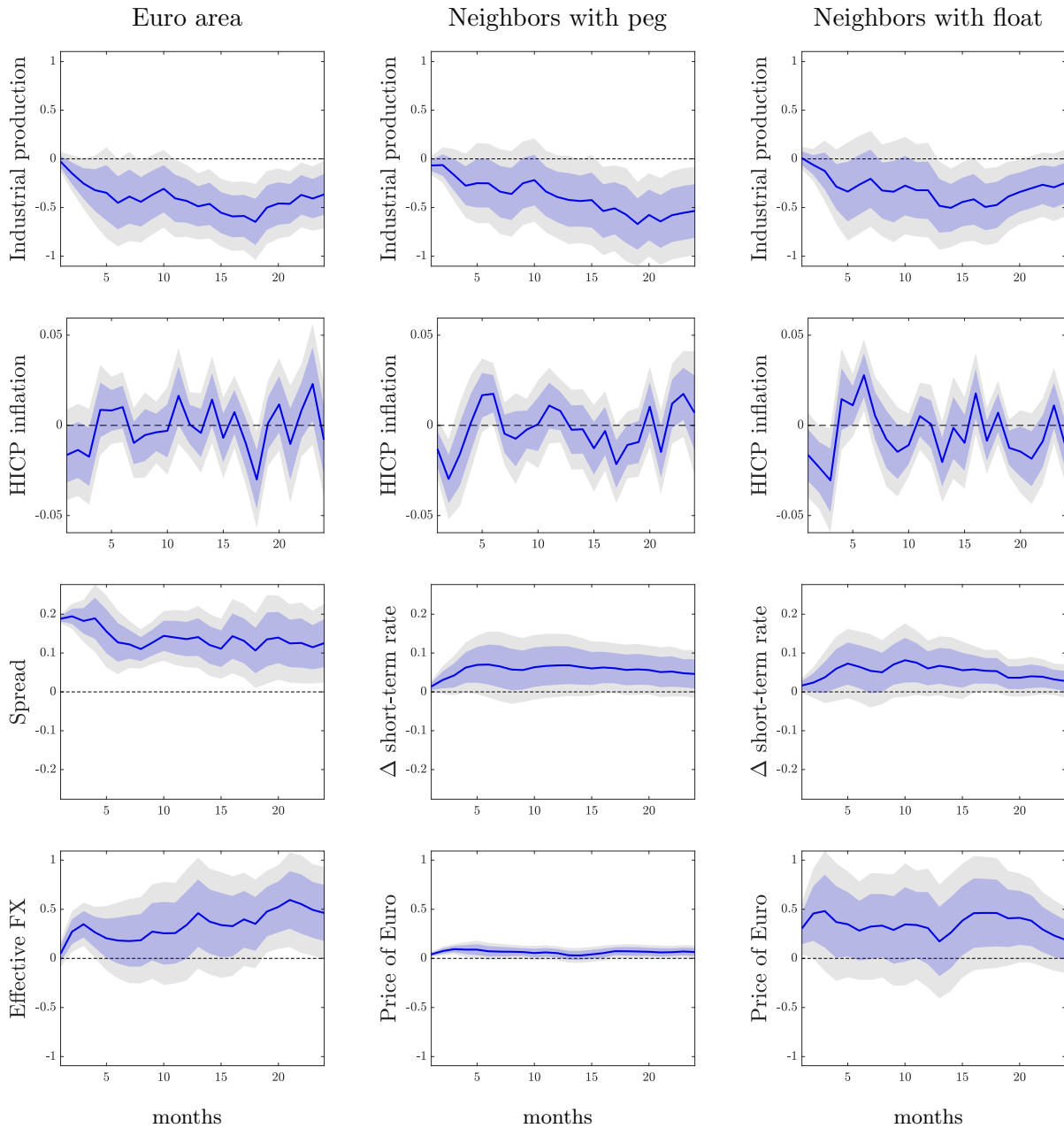
³⁴We obtain the series for the spread from the website at the Banque de France: <https://publications.banque-france.fr/en/economic-and-financial-publications-working-papers/credit-risk-euro-area>. We identify the spread shock recursively, assuming that the variables in the VAR are pre-determined relative to the credit spread. In doing so, we rely on a key result by Gilchrist and Mojon (2018). Namely, while they also consider alternative approaches, namely a FAVAR and identification by means of an external instrument, these authors emphasize that results from these alternatives are fairly similar to those obtained under a recursive VAR. We estimate the VAR on monthly time series for the period 1999M1–2018M12. Since it features 6 lags, our time series of spread shocks covers the period 1999M7–2018M12.

Figure D.5: Adjustment to euro-area central bank information shock



Notes: Central bank information shock identified by Jarociński and Karadi (2020) using high frequency data and VAR model with sign restrictions. Left column shows response of euro area variables, middle (right) column response in neighbor countries with exchange rate peg. Solid line indicates point estimate, shaded areas correspond to 68 and 90 percent confidence bounds. Horizontal axis measures time in months. Vertical axis measure deviation in percent/percentage points.

Figure D.6: Adjustment to euro-area spread shock



Notes: EA spread shock identified in recursive VAR estimated using time series of bank credit spread of Gilchrist and Mojon (2018). Left column shows response of euro area variables, middle (right) column response in neighbor countries with exchange rate peg. Solid line indicates point estimate, shaded areas correspond to 68 and 90 percent confidence bounds. Horizontal axis measures time in months. Vertical axis measure deviation in percent/percentage points.

we show the adjustment in the euro area itself in the left column. Focus first on the third row of that column. This shows that the spread shock raises the credit spread in the euro area

persistently. The euro-area spread shock induces euro-area economic activity to contract (first two rows), and the euro to depreciate in effective terms (an increase in the bottom left panel). As before, there are sizable spillovers to the neighboring countries. The response in economic activity may be somewhat more muted for floaters, but overall it hardly differs between pegs (middle panels) and floats (right panels). Just like in the case of a monetary policy shock, the contractionary effect of a spread shock spills over to industrial production and unemployment of its neighbors (first and second row). And just like for the monetary policy shock discussed above, we find a positive response of the measured interest rate differential with respect to the euro area for the neighbor countries—independently of the currency regime (third row, middle and right panels). As regards the response of the exchange rate, shown in the bottom row, we find that the currency of neighbor countries with a flexible exchange rate depreciates against the euro—an effect that we, naturally, do not observe in the neighbor countries with limited exchange rate flexibility. But even accounting for this, one may be tempted to conclude that flexible exchange rates do not seem to offer much insulation against a spread shock that originates in the euro area.

E Formal tests of lack of insulation

This section presents formal tests for the lack of insulation. In particular, Table E.1 presents the results of Walds test for the null hypothesis of “H0: the impulse response under a float is the same as the impulse response under a peg (“no insulation”),” for all impulse responses shown and for all the three shocks that we consider. Namely, we provided two-sided tests of the null $\gamma_h^p = \gamma_h^f$, separately for each horizon h . Shown are three different horizons: on impact, one year after the shock and two years after the shock.

The results support the visual impression that the main text emphasizes. With only a very few exceptions of horizon/series/shock pairs, the responses of floats and pegs do not show differences that are statistically significant, for all three shocks.

Table E.1: Difference of impulse responses (peg - float)

	Impact	After 12 months	After 24 months
EA monetary policy shock			
Industrial production	0.05 (0.54)	0.26 (0.15)	0.19 (0.46)
Unemployment rate	0.01 (0.50)	-0.01 (0.86)	-0.02 (0.81)
HICP	0.02 (0.33)	-0.01 (0.93)	0.09 (0.40)
Diff short-term rate	-0.01 (0.70)	0.11 (0.04)	0.11 (0.03)
Exchange rate (price of euro)	-0.06 (0.35)	-0.08 (0.79)	0.15 (0.59)
EX-to/IM-from EA	-0.30 (0.38)	-0.26 (0.75)	0.29 (0.62)
PPI	-0.01 (0.79)	-0.01 (0.97)	-0.03 (0.86)
EA central bank info shock			
Industrial production	-0.01 (0.95)	0.08 (0.68)	0.56 (0.03)
Unemployment rate	0.00 (0.57)	-0.04 (0.39)	-0.09 (0.19)
HICP	0.00 (0.92)	-0.04 (0.54)	0.01 (0.90)
Diff short-term rate	-0.06 (0.00)	-0.12 (0.01)	-0.01 (0.79)
Exchange rate (price of euro)	0.07 (0.54)	0.35 (0.22)	0.15 (0.57)
EX-to/IM-from EA	0.47 (0.22)	0.63 (0.39)	0.11 (0.88)
PPI	-0.03 (0.27)	-0.06 (0.67)	0.09 (0.65)
EA spread shock			
Industrial production	-0.08 (0.27)	-0.07 (0.64)	-0.29 (0.20)
Unemployment rate	0.01 (0.28)	0.05 (0.29)	0.13 (0.05)
HICP	0.01 (0.73)	0.02 (0.69)	0.06 (0.53)
Diff short-term rate	0.00 (0.79)	0.01 (0.81)	0.02 (0.66)
Exchange rate (price of euro)	-0.26 (0.04)	-0.25 (0.42)	-0.12 (0.56)
EX-to/IM-from EA	0.26 (0.42)	-0.32 (0.45)	-0.16 (0.72)
PPI	0.02 (0.55)	0.12 (0.30)	0.22 (0.07)

Notes: difference between impulse of response for pegs and floats on impact, 12 months after impact, and 24 months after impact; in parenthesis: p-values for $H_0 : \text{peg} = \text{float}$.

F Proof of Proposition 5 (CPI inflation targeting with DCP)

This section derives the formulae in Proposition 5 of the main text. The proposition shows the evolution of the economy in the regime with dominant currency pricing under strict consumer-price inflation targeting.

Proof of Proposition 5: From Proposition 2, we know that $s_t = 0$, so that by (23), $\pi_{H,t}^* = \pi_t^*$. (24) then implies

$$m_t = m_{t-1} + \pi_t^* + \Delta e_t - \pi_{H,t} \quad (34)$$

By assumption, there is strict consumer-price inflation targeting, $\bar{\pi}_t = 0$, which by the definition of consumer price inflation, (26), means $\pi_t = (1 - v)\pi_{H,t} + v(\pi_t^* + \Delta e_t) = 0$. Solving this for $\pi_t^* + \Delta e_t$, and substituting in (34) gives

$$m_t = m_{t-1} - \frac{1}{v}\pi_{H,t}, \quad (35)$$

or $\pi_{H,t} = -v\Delta m_t$. In turn, substituting this into Phillips curve (21) gives

$$-v\Delta m_t = -vE_t \{\Delta m_{t+1}\} + \kappa [y_t + vm_t].$$

Using risk sharing condition (25) to substitute for y_t (with $s_t = 0$ again) gives

$$-v(m_t - m_{t-1}) = -vE_t \{m_{t+1} - m_t\} + \kappa [y_t^* + m_t]. \quad (36)$$

We solve (36) using the method of undetermined coefficients. We do so first for the case that shocks have already ceased in period t , then for the case that the shocks still prevail in period t .

Suppose that the shocks have already ceased in period t . Guess that for any such period t , $m_t = \alpha \cdot m_{t-1}$, with $|\alpha| < 1$. Using this guess in (36), with $y_t^* = 0$ (since shocks have already ceased by assumption), and solving for the stable root gives $\alpha = 1 + \frac{\kappa}{2v} - \sqrt{[1 + \kappa/(2v)]^2 - 1}$. Next, suppose that the shocks still prevail in period t . Guess that while shocks last, $m_t^L = \alpha \cdot m_{t-1}^L + \vartheta$.

Then

$$\begin{aligned} E_t \{m_{t+1} - m_t\} &= \mu(m_{t+1}^L - m_t^L) + (1 - \mu)(\alpha m_t^L - m_t^L) \\ &= \mu[(\alpha - 1)m_t^L + \vartheta] + (1 - \mu)(\alpha - 1)m_t^L \\ &= (\alpha - 1)m_t^L + \mu\vartheta, \end{aligned}$$

where μ is the probability that the shock continues to last next period.

Using this in (36) along with the solution for y_t^* gives, after matching coefficients,

$$\vartheta = \frac{\kappa(1 - \mu)}{v(2 - \alpha - \mu) + \kappa} \mathbf{A}.$$

Using $m_t^L = \alpha \cdot m_{t-1}^L + \vartheta$, one, then, arrives at

$$m_t^L = \frac{1 - \alpha^{t+1}}{1 - \alpha} \frac{\kappa(1 - \mu)}{v(2 - \alpha - \mu) + \kappa} \mathbf{A}. \quad (37)$$

Use this in (35) to solve for the formula for $\pi_{H,t}^L$ that is given in item (2.) of the proposition. For the evolution of output in item (1.) of the proposition set $s_t = 0$ in risk sharing condition (25), use the law of motion for foreign output from Proposition 1, and use (37).

So as to obtain item (4.) of the proposition, observe that consumer price inflation targeting ($\pi_t = 0$, as in item (3.)) implies, using the definition in (26), that

$$\Delta e_t = -\frac{1 - v}{v} \pi_{H,t} - \pi_t^*, \quad (38)$$

so that while the shocks persist (using the law of motion $\pi_{H,t}^L$)

$$\Delta e_t^L = (1 - v)\alpha^t \frac{\kappa(1 - \mu)}{v(2 - \alpha - \mu) + \kappa} \mathbf{A} - \pi_L^*. \quad (39)$$

Substituting for π_L^* from Proposition 1, one obtains the law of motion for e_t^L in item (4.) of the proposition.

So as to derive the interest-rate spread, item (5.) of the proposition, we use the uncovered interest parity (UIP). UIP itself follows from taking the difference between the IS equations in Home and Foreign, (20) and (17), and using (23) and (24) to simplify. UIP is given by

$$r_t - r_t^* = E_t\{\Delta e_{t+1}\}. \quad (40)$$

Use this to derive the formula for the interest spread. Suppose that shocks are still active in period t . Then using the Markov structure, and equations (35), (38), and (39),

$$\begin{aligned} E_t\{\Delta e_{t+1}\} &= -(1 - \mu)(1 - \alpha)(1 - v)m_t^L \\ &\quad + \mu(1 - v)\alpha^{t+1} \frac{\kappa(1 - \mu)}{v(2 - \alpha - \mu) + \kappa} \mathbf{A} + \mu\kappa\mathbf{A}. \\ &= -(1 - \mu)(1 - v)(1 - \alpha^{t+1}) \frac{\kappa(1 - \mu)}{v(2 - \alpha - \mu) + \kappa} \mathbf{A} \\ &\quad + \mu(1 - v)\alpha^{t+1} \frac{\kappa(1 - \mu)}{v(2 - \alpha - \mu) + \kappa} \mathbf{A} + \mu\kappa\mathbf{A} \\ &= (1 - v)(\alpha^{t+1} - 1) \frac{\kappa(1 - \mu)}{v(2 - \alpha - \mu) + \kappa} \mathbf{A} + \mu \left[\kappa + (1 - v) \frac{\kappa(1 - \mu)}{v(2 - \alpha - \mu) + \kappa} \right] \mathbf{A}, \end{aligned}$$

whence item (5.) in the proposition follows. This completes the proof of Proposition 5. \square

G Dominant currency, stabilizing producer price inflation

Under otherwise the same assumptions as in Section 4.2.6, the current appendix derives the response of the Home economy to Foreign monetary shocks if the Home central bank targets producer-price inflation.

Proposition 6. Targeting producer price inflation. *Consider the same conditions as in Proposition 2. Let Home monetary policy target stable producer prices ($\pi_{H,t} = 0$). Then, while the foreign monetary shock lasts, the following is true:*

1. Home output evolves according to

$$y_t^L = -v(1 - \mu) \cdot \mathbf{A} = v y_L^*.$$

2. Home producer price inflation, by design, is zero $\pi_{H,t}^L = 0$.
3. Home consumer price inflation is given by

$$\pi_0^L = v(1 - \mu) \cdot \mathbf{A}, \text{ and } \pi_t^L = 0 \text{ for } t > 0.$$

4. The nominal exchange rate is given by

$$e_t^L = [1 - \mu + (t + 1)\kappa] \cdot \mathbf{A}.$$

5. The Home interest rate is given by $r_t^L = 0$, with the interest differential between Home and Foreign

$$r_t^L - r_L^* = -[(1 - \mu)^2 - \kappa\mu] \cdot \mathbf{A}, \quad (41)$$

resulting from a change in the Foreign interest rate only.

Proof. With strict producer-price inflation targeting, $\pi_{H,t} = 0$ (item (2.)) by design. Then, from Phillips curve (21), we have that $y_t + v \cdot m_t = 0$. Add $v \cdot m_t$ to each side of the risk sharing condition (25) and use $y_t + v \cdot m_t = 0$ to simplify. This gives $m_t = -y_t^* = (1 - \mu)\mathbf{A}$, where the last step uses the law of motion for Foreign output from Proposition 1. Using this, one arrives at the expression for y_t^L in item (1.) of Proposition 6. With $\pi_{H,t} = 0$ (from the policy regime) and $s_t = 0$ (from Proposition 2), the definition of the terms of trade in (23) gives $\pi_{H,t}^* = \pi_t^*$. From (24) on, then, has that $\Delta e_t = \Delta m_t - \pi_t^*$. With the expression for m_t derived earlier and the law of motion for π_t^* from Proposition 1, this gives item (4.) of the proposition. Item (3.) follows from the definition of CPI inflation, equation (26), along with the earlier results. Last, the interest differential in item (5.) follows from UIP, the derivation of which is described in the proof of Proposition 5. To see that the $r_t^L = 0$, compare (41) to the Foreign interest rate response in (31). \square

Under a dominant currency regime, targeting producer price inflation insulates producer prices but neither domestic output nor consumer price inflation. Output in Home falls along with Foreign output, and the more so, the more open the economy is (the lower home bias is, that is, the closer v to unity). The partial insulation of output that there is originates from a sharp depreciation on impact, accommodated by a more accommodative monetary policy in Home than in Foreign. Indeed, the interest rate in Home does not move at all upon the monetary

shock in Foreign; refer to equation (31) to see that the response of the interest differential in (41) is due only to the Foreign interest rate. In sum, in a dominant-currency regime, flexible exchange rates do not afford insulation of output at its natural level as long as monetary policy targets inflation, be it producer price inflation (Proposition 6 above) or consumer-price inflation (Proposition 5 in the main text).

H Producer currency pricing

For comparison, it is useful to inspect, if only briefly, producer currency pricing (PCP, henceforth). This is because PCP underpins the classic notion that flexible exchange rates provide automatic insulation. Under PCP, targeting the producer price level amounts to targeting the natural level of output. So the two regimes are equivalent, as Proposition 7 states. Under producer currency pricing, equation (22) is replaced by the law of one price:

$$\pi_{H,t}^* = \pi_{H,t} - (e_t - e_{t-1}), \quad (42)$$

rendering the law-of-one-price gap zero ($m_t = 0$ throughout).

Proposition 7. *Divine coincidence under PCP.* *Consider the economy of Section 4.2. Let pricing be given by PCP. Let the shocks be as described in Section 4.2.5. Let Home monetary policy target the natural level of output (or, equivalently, target producer-price stability $\pi_{H,t} = 0$). Then, while the foreign monetary shock lasts, the following is true.*

1. *The terms of trade and output follow their natural values, so $s_t^L = -y_t^*$ and $y_t = 0$.*
2. *Producer price inflation is zero $\pi_{H,t}^L = 0$.*
3. *Consumer price inflation is given by*

$$\pi_0^L = (1 - \mu)v \cdot \mathbf{A}, \text{ and } \pi_t^L = 0 \text{ for } t > 0.$$

4. *The nominal exchange rate is given by*

$$e_t^L = [(1 - \mu) + (t + 1)\kappa] \cdot \mathbf{A} = s_t^L - (t + 1) \cdot \pi_t^*.$$

5. *The interest rate in Home is $r_t^L = 0$, with the interest differential*

$$r_t^L - r_L^* = -[(1 - \mu)^2 - \kappa\mu] \cdot \mathbf{A},$$

resulting from a change in the Foreign interest rate only.

Proof. With strict producer-price inflation targeting, $\pi_{H,t} = 0$ by definition. Then, from Phillips curve (21) we have that $y_t + v \cdot m_t = 0$. With producer currency pricing $m_t = 0$ (easily verified using (24)), so that $y_t = 0$. From risk sharing (25), then, $s_t = -y_t^*$. Together this establishes items (1.) and (2.) of the proposition. Using the law of one price, (42), with $\pi_{H,t} = 0$, gives $\pi_{H,t}^* = -\Delta e_t$. Using this in the definition of the terms of trade, (23), yields $\Delta e_t = \Delta s_t - \pi_t^*$, which together with the law of motion for Foreign output from Proposition 1 and $s_t = -y_t^*$ yields item (4.) of the proposition. Item (3.) follows from the definition of consumer price inflation in (26) and the earlier results. Item (5.) follows from UIP, where we derived UIP itself in the proof of Proposition 5. To see that the $r_t^L = 0$, compare the interest differential in the proposition here to the Foreign interest rate response in (31). \square

Compare Proposition 7 here to the corresponding Propositions 3 and 6 for the dominant currency regime. As is well known, under PCP exchange rate adjustment lines up expenditure switching with domestic output gap stabilization. In particular, in response to the fall in Foreign

demand, when monetary policy in Home targets producer prices, output in Home is perfectly stabilized. And so is consumer price inflation in all but the initial period. Indeed, on impact, the CPI inflation in Home rises, in line with the depreciation of the nominal exchange rate. Note further that, in the special case shown here, the interest rate in Home need not move *at all*. Rather, the interest gap required for the exchange rate to depreciate reflects the response of the foreign interest rate only.

The evolution of the economy under fixed exchange rates is identical under PCP and DCP, see Proposition 8. So, with fixed exchange rates, also under PCP, the economy would evolve as in Proposition 4.

Proposition 8. Fixed exchange rate under PCP. *Consider the same assumptions as in Proposition 7, but let Home monetary policy target fixed exchange rates ($e_t = 0$). Then, the evolution of the economy under PCP is identical to the evolution under DCP described in Proposition 4. That is, under fixed exchange rates, the equilibrium of the PCP economy is the same as in the DCP economy.*

Proof. The key to seeing this is that the DCP and PCP economy have the same equilibrium, whenever $m_t = 0$ in the DCP economy (that is, if the law of one price holds under DCP). This is the case here; see the proof of Proposition 4 in the main text. \square

What remains to be discussed is consumer-price inflation targeting under PCP. Also under producer currency pricing shielding domestic activity from foreign shocks requires some initial consumer-price inflation (compare Proposition 7). It may, therefore, be useful to spell out the consequences of consumer price inflation targeting under PCP. We do so in Proposition 9.

Proposition 9. Targeting consumer price inflation under PCP. *Consider the same assumptions as in Proposition 7, but Home monetary policy target consumer price stability (target $\pi_t = 0$). Then, while the foreign monetary shock lasts, the following is true.*

1. Output follows

$$\begin{aligned} y_t^L &= \left[-(1 - \mu) + \frac{1 - \alpha^{t+1}}{1 - \alpha} \frac{\kappa(1 - \mu)}{v[2 - \alpha - \mu] + \kappa} \right] \cdot \mathbf{A} \\ &= y_L^* + \frac{1 - \alpha^{t+1}}{1 - \alpha} \frac{\kappa(1 - \mu)}{v[2 - \alpha - \mu] + \kappa} \cdot \mathbf{A}, \end{aligned}$$

where $\alpha = 1 + \kappa/(2v) - \sqrt{\kappa^2/(4v^2) + \kappa/v} \in (0, 1)$. And the terms of trade follow

$$s_t^L = \frac{1 - \alpha^{t+1}}{1 - \alpha} \frac{\kappa(1 - \mu)}{v[2 - \alpha - \mu] + \kappa} \cdot \mathbf{A}.$$

2. Producer price inflation is

$$\pi_{H,t}^L = -v\alpha^t \frac{\kappa(1 - \mu)}{v[2 - \alpha - \mu] + \kappa} \cdot \mathbf{A}.$$

3. Consumer price inflation is zero, by construction.

4. The nominal exchange rate is given by

$$e_t^L = \left[\frac{1 - \alpha^{t+1}}{1 - \alpha} \frac{(1 - v)(1 - \mu)}{v[2 - \alpha - \mu] + \kappa} + (t + 1) \right] \kappa \cdot \mathbf{A}.$$

5. The interest differential is given by

$$r_t^L - r_L^* = \frac{1}{v[2 - \mu - \alpha + \kappa]} \left(-(1 - \alpha^{t+1})(1 - \mu)(1 - v) + \mu[1 - \mu + v(1 - \alpha) + \kappa] \right) \cdot \kappa \cdot \mathbf{A}.$$

Proof. Use the law of one price, (42), to substitute for $\pi_{H,t}^*$ in (23). Then, use the definition of consumer price inflation (26) and $\pi_t = 0$ (item (3.)) to simplify. This yields $\pi_{H,t} = v(s_{t-1} - s_t)$. Substitute for $\pi_{H,t}$ in Phillips curve (21). Having substituted, too, for y_t from (25) this yields

$$v[s_{t-1} - s_t] = v[s_t - E_t s_{t+1}] + \kappa[s_t + y_t^*].$$

Solving the difference equation in s_t for the stationary solution by the method of undetermined coefficients, gives item (1.). Item (2.) follows from $\pi_{H,t} = v(s_{t-1} - s_t)$. Item (4.) follows using the above solutions and the definition of consumer price inflation, (26), with $\pi_t = 0$. Item (5.) follows from UIP, where we derived UIP itself in the proof of Proposition 5. \square

From this, CPI inflation targeting, also under PCP invites output spillovers. This is so, in particular if prices are rather rigid. Indeed, in the limit, as $\kappa \rightarrow 0$, the evolution of the economy with PCP and CPI targeting converges to that of a regime of fixed exchange rates.

I More general analytical solutions

Section 4.2 in the main text and the corresponding Appendix G and Appendix H have analyzed the transmission of one shock to the Home economy: a foreign monetary policy shock. In addition, for tractability, they had focused on the limit $\beta \rightarrow 1$ and they had restricted labor supply to be infinitely elastic, setting $\varphi = 0$. We did so for the sake of tractability.

This appendix, instead, provides more general results that relax the three assumptions. The appendix spells out the response of the Home economy to any of the foreign shocks discussed above. It allows labor supply to be inelastic. And it allows for any $\beta \in (0, 1)$. We retain the Markov structure of shocks, however, and continue to look at a linear approximation around the non-stochastic steady state.

I.1 Linearized economy

So as to make this self-contained, we spell out all model equations even if this means that we duplicate some from the main text. For the Home economy, all that matters in Foreign is the evolution of the foreign level of output, y_t^* , the foreign inflation rate, π_t^* , and the foreign interest rate, r_t^* , and the foreign demand preference shock ξ_t^* . The reason why the latter matters is international consumption-risk sharing. For any shock, instead, that does not directly shift consumption preferences, knowledge of the evolution of triple (y_t^*, π_t^*, r_t^*) suffices to derive the evolution of the Home economy. Note that the evolution in Foreign will be induced by a combination of Foreign shocks and the response of Foreign monetary policy. Once the mapping is done, however, foreign shocks other than preference shocks would not matter for Home independently of the equilibrium triple (y_t^*, π_t^*, r_t^*) . In this sense, the structure that we present here is not confined to a particular subset of shocks, but would allow for other shocks in Foreign as well. This is the reason why, further below, we report the response in Home in terms of (y_t^*, π_t^*, r_t^*) and ξ_t^* .

The international risk sharing condition combined with the demand for Home-produced goods

$$y_t = s_t + y_t^* - (1 - v)\xi_t^* + (1 - v)m_t. \quad (43)$$

In equilibrium, Home output relates positively to the terms of trade, Foreign output, and the demand shock in relative terms. The Home New Keynesian Phillips curve links Home producer-price inflation to expected inflation and marginal costs:

$$\pi_{H,t} = \beta E_t \pi_{H,t+1} + \kappa [(1 + \varphi) y_t + v m_t - v \xi_t^*]. \quad (44)$$

Home marginal costs depend on the Home wage. The wage rises with demand for the domestic good. Hence it is increasing in output. In addition, the wage will depend on preference shocks affecting the relative desire of Home and Foreign households to consume in the current

period. Export-price inflation differs across pricing scenarios. Under DCP we have

$$\pi_{H,t}^* = \beta E_t \pi_{H,t+1}^* + \kappa [(1 + \varphi) y_t - (1 - v) m_t - v \xi_t^*]. \quad (45)$$

Alternatively, under PCP we have from the law of one price for exports: $\pi_{H,t}^* = \pi_{H,t} - \Delta e_t$. From (10), linearizing the Home terms of trade we have:

$$s_t = s_{t-1} + \pi_t^* - \pi_{H,t}^*. \quad (46)$$

Where π marks the inflation rate of the respective price indexes. The law-of-one-price gap, m_t takes the following form

$$m_t = m_{t-1} + e_t - e_{t-1} + \pi_{H,t}^* - \pi_{H,t}. \quad (47)$$

As in the main text, consumer-price inflation in Home is given by the average of inflation rates in the Home consumer's basket

$$\pi_t = (1 - v) \pi_{H,t} + v(\pi_t^* + \Delta e_t). \quad (48)$$

The dynamic IS-relation in Home is derived by combining the first-order condition for consumption and saving of Home households with the Home goods-market clearing condition, the risk-sharing condition and the definition of the Home consumer-price index:

$$y_t = E_t y_{t+1} - (r_t - E_t(\pi_{H,t+1} + v \Delta m_{t+1}) + v E_t \Delta \xi_{t+1}^*). \quad (49)$$

y_t , is Home output, r_t the nominal interest rate in Home. Last, we would need to specify Home monetary policy. We will do so below, in a way that binds r_t , e_t , or $\pi_{H,t}$. Combined with a monetary policy rule and armed with the Foreign variables, the monetary policy rule and equations (43) to (49) then form a system of eight variables in eight unknowns all of which are linked to the evolution of the domestic economy.

The equations for the large foreign economy follow the conventional closed-economy New Keynesian model. That is, the intertemporal IS equation in Foreign is given by

$$y_t^* = E_t y_{t+1}^* - (r_t^* - E_t(\pi_{t+1}^*) + E_t \Delta \xi_{t+1}^*), \quad (50)$$

and the New Keynesian Phillips curve in Foreign is given by

$$\pi_t^* = \beta E_t \pi_{t+1}^* + \kappa (1 + \varphi) [y_t^* - Z_t^*]. \quad (51)$$

A foreign interest-rate rule completes the model environment. From here, as before, one could derive the conventional UIP condition, (40).

I.2 Flex-price benchmark

The natural level of output in Home is given by

$$y_t^n = \frac{v}{1 + \varphi} \xi_t^*. \quad (52)$$

Not surprisingly, the natural level of output is not affected by the invoicing regime whatsoever. The natural terms of trade while the shocks last are given by

$$s_t^n = \frac{1 + \varphi(1 - v)}{1 + \varphi} \xi_t^* - y_t^*. \quad (53)$$

I.3 The transmission of shocks in Foreign

As in the main text, we assume that all shocks originate in Foreign, and that these shocks follow Markov processes and induce a Markov structure for foreign inflation, foreign output, the foreign interest rate. We do so for tractability. Shocks may occur (and disappear) jointly, or individually. The essence of the results below is not affected by this choice. Starting from the non-stochastic steady state, in the first period there is a shock or a combination of shocks that induces a response of foreign variables. In the next period, the shock remains present at that level with probability μ . Else, the shock ceases. That is, we shall assume that while the shock lasts $\pi_t^* = \pi_L^*$, $y_t^* = y_L^*$, $r_t^* = r_L^*$, and $\xi_t^* = \xi_L^*$, for some values π_L^* , y_L^* , r_L^* , and ξ_L^* . Once the shock ends, foreign variables immediately return to their steady state. Note that we do not need to spell out exactly how the combination of the four Foreign variables (π_L^* , y_L^* , r_L^* , and ξ_L^*) comes to pass. The following proposition summarizes one example.

Proposition 10. *Consider the large economy sketched in Appendix I.1 and the shock structure of Appendix I.3. For better readability, mark the external shocks in bold font (ϵ_t^{m*} , ξ_t^* , and \mathbf{Z}_t^*) Suppose monetary policy in Foreign perfectly stabilizes prices and output in Foreign once the shocks cease. Suppose that while the shocks last, monetary policy in Foreign follows a Taylor rule*

$$r_t^* = \phi \pi_t^* + \gamma y_t^* + \epsilon_t^{m*}, \quad (54)$$

where ϵ_t^{m*} is a monetary shock that follows said Markov structure. Suppose that parameters are such that there is determinacy. Then, while shocks last, output in Foreign will be

$$y_L^* = \frac{1}{1 - \mu + \gamma + \frac{\kappa(1+\varphi)}{1-\beta\mu}(\phi - \mu)} \left[\frac{\kappa(1+\varphi)}{1-\beta\mu}(\phi - \mu) \cdot \mathbf{Z}_L^* + (1 - \mu) \cdot \xi_L^* - \epsilon_L^{m*} \right].$$

Inflation in Foreign will be

$$\Pi_L^* = \frac{\frac{\kappa(1+\varphi)}{1-\beta\mu}}{1 - \mu + \gamma + \frac{\kappa(1+\varphi)}{1-\beta\mu}(\phi - \mu)} \left[-[(1 - \mu) + \gamma] \cdot \mathbf{Z}_L^* + (1 - \mu) \cdot \xi_L^* - \epsilon_L^{m*} \right].$$

The Foreign interest rate will be

$$\begin{aligned}
r_L^* &= -\frac{1}{1-\mu+\gamma+\frac{\kappa(1+\varphi)}{1-\beta\mu}(\phi-\mu)} \frac{\kappa(1+\varphi)}{1-\beta\mu} \left[\phi(1-\mu) + \gamma\mu \right] \cdot \mathbf{Z}_L^* \\
&+ \frac{1}{1-\mu+\gamma+\frac{\kappa(1+\varphi)}{1-\beta\mu}(\phi-\mu)} \left[\phi \frac{\kappa(1+\varphi)}{1-\beta\mu} + \gamma \right] (1-\mu) \cdot \boldsymbol{\xi}_L^* \\
&+ \frac{1}{1-\mu+\gamma+\frac{\kappa(1+\varphi)}{1-\beta\mu}(\phi-\mu)} \frac{(1-\mu)(1-\beta\mu)-\kappa(1+\varphi)\mu}{1-\beta\mu} \cdot \boldsymbol{\epsilon}_L^{m*}.
\end{aligned}$$

Proof. Straightforward algebra using (50) and (51) along with Taylor rule (54) and the Markov structure of shocks. \square

The following corollary highlights that Proposition 10 nests several special cases.

Corollary 2. *Proposition 10 nests two important scenarios as a special case.*

a) Inflation targeting in Foreign. Nested as $\phi \rightarrow \infty$ and $\gamma = 0$. Then, $y_L^* = \mathbf{Z}_L^*$, $\Pi_L^* = 0$, and

$$r_L^* = v(1-\mu) \cdot \left[\boldsymbol{\xi}_L^* - \mathbf{Z}_L^* \right]$$

b) The effective lower bound binds in Foreign. Suppose that while the shocks last, monetary policy in Foreign does not respond to shocks, but keeps $r_L^* = 0$. Nested with $\phi = \gamma = \epsilon_L^{m*} = 0$. Then,

$$\begin{aligned}
y_L^* &= \frac{1-\beta\mu}{(1-\mu)(1-\beta\mu)-\kappa(1+\varphi)\mu} \left[-\frac{\kappa(1+\varphi)\mu}{1-\beta\mu} \cdot \mathbf{Z}_L^* + (1-\mu) \cdot \boldsymbol{\xi}_L^* \right]. \\
\Pi_L^* &= \frac{\kappa(1+\varphi)}{(1-\mu)(1-\beta\mu)-\kappa(1+\varphi)\mu} \left[-(1-\mu) \cdot \mathbf{Z}_L^* + (1-\mu) \cdot \boldsymbol{\xi}_L^* \right].
\end{aligned}$$

Proof. The results follow directly from Proposition 10. \square

I.4 The response in Home under DCP

We are interested in understanding the role of the exchange rate as a shock absorber, in relation to the choice of monetary policy regime. Therefore, we solve the model under alternative monetary and exchange rate regimes for Home, focusing on three of the scenarios that we had also discussed in the main text. First, we look at a policy that stabilizes the natural rate of output. This gives one end of the spectrum in terms of insulating domestic activity. Second, we look at a policy that stabilizes domestic producer price inflation. We use this policy so as to highlight that under DCP a focus on inflation implies output spillovers. Third, we look at a policy that stabilizes the exchange rate (that is, a fixed exchange rate).³⁵ We do this for both, producer currency pricing and dominant-currency pricing. We start with dominant-currency

³⁵These are the most tractable cases algebraically. For $\varphi > 0$, depending on monetary policy in Home, the model may have two endogenous state-variables, s_{t-1} and m_{t-1} . This renders solutions in which the central bank targets consumer price inflation algebraically cumbersome. The numerical simulations in Section 4.3 look at targeting domestic consumer price inflation and producer prices.

pricing. Appendix I.5 below shows the results for PCP. Throughout, we report the response of the key variables while the shock lasts.

I.4.1 Natural-output policy under DCP, $y_t = y_t^n$

The first scenario assumes that the domestic central bank sets interest rates so as to anchor output at the natural level of output. Because of DCP, we know that there is no ‘divine coincidence.’ closing the output gap does not stabilize inflation, and exchange rate movements do not bring about efficient expenditure switching. As in the main text, in the following, we let a superscript L on a variable, e.g., s_t^L , mark the variable while the shocks last.

Proposition 11. *Consider the small Home economy discussed in Section I.1. Let pricing be given by DCP. Let the shocks be as described in Section I.3, with the first period of the shock being period 0. Let Home monetary policy target the natural level of output. Then, while the shocks last, the following is true.*

1. The terms of trade are given by

$$s_t^L = (1 + \alpha_{y^n} + \dots + \alpha_{y^n}^t) \gamma_{y^n} \left[\pi_L^* (1 - \beta\mu) - \kappa y_L^* + \kappa \frac{1 + \varphi(1 - v)}{1 + \varphi} \xi_L^* \right], \quad (55)$$

with $\alpha_{y^n} = \frac{1 + \beta + \kappa}{2\beta} - \frac{1}{2\beta} \sqrt{(1 + \beta + \kappa)^2 - 4\beta}$, and $\gamma_{y^n} = 1 / (1 + \beta + \kappa - \beta\alpha_{y^n} - \beta\mu)$. One can show that $0 < \alpha_{y^n} < 1$ and $0 < \gamma_{y^n} < \frac{1}{\kappa}$.

2. Home output is given by the natural level of output in (52).
3. Home producer price inflation is given by

$$\pi_{H,t}^L = -\frac{v}{1 - v} [\pi_L^* - \Delta s_t^L]. \quad (56)$$

4. Home consumer price inflation is given by

$$\pi_t = v(\Delta s_t + \Delta e_t). \quad (57)$$

5. The nominal exchange rate is given by

$$e_t^L = -\frac{1}{1 - v} \left(\left[y_L^* - \frac{1 + \varphi(1 - v)}{1 + \varphi} \xi_L^* \right] \right) - (t + 1) \frac{1}{1 - v} \cdot \pi_L^*. \quad (58)$$

6. The interest differential between Home and Foreign is given by

$$r_t^L - r_L^* = \frac{1}{1 - v} \left[-\mu \pi_L^* + (1 - \mu) y_L^* - (1 - \mu) \frac{1 + \varphi(1 - v)}{1 + \varphi} \xi_L^* \right]. \quad (59)$$

Proof. By the assumption on policy, $y_t = y_t^n = \frac{v}{1 + \varphi} \xi_t^*$, where the last equation follows from (52). Use this in Phillips curve (45), to get

$$\pi_{H,t}^* = \beta E_t \pi_{H,t+1}^* - \kappa(1 - v) m_t.$$

Use the risk sharing condition (43) along with the equilibrium y_t to solve for

$$(1 - v)m_t = \frac{1 + \varphi(1 - v)}{1 + \varphi} \xi_t^* - s_t - y_t^*.$$

Substitute this into the Phillips curve above. From the definition of the terms of trade (46) solve for $\pi_{H,t}^*$ and substitute this in the Phillips curve, giving

$$\pi_t^* + s_{t-1} - s_t = \beta E_t \{ \pi_{t+1}^* + s_t - s_{t+1} \} - \kappa \frac{1 + \varphi(1 - v)}{1 + \varphi} \xi_t^* + \kappa s_t + \kappa y_t^*.$$

Solving this for s_t^L using the method of undetermined coefficients and the Markov structure of the model yields the expression for s_t^L as the unique non-explosive solution (item (1.)). Next, observe from the two Phillips curves (44) and (45) and the solution for y_t that $(1 - v)\pi_{H,t} + v\pi_{H,t}^* = 0$, so that

$$\pi_{H,t} = -\frac{v}{1 - v} \pi_{H,t}^* = -\frac{v}{1 - v} [\pi_t^* - \Delta s_t],$$

that is, equation (56) follows (item (2.)). The law of motion of the nominal exchange rate (item (4.)) then follows from (47) using the intermediate solutions for m_t and $\pi_{H,t}^*$, $\pi_{H,t}$. The interest spread (item (5.)) follows from the UIP condition, which takes the familiar form (40). Item (3.) follows from the definition of consumer price inflation, (48). \square

In order to put verbal content to this, consider – for the sake of exposition – an isolated fall in foreign demand $y_L^* = -1$, with $\pi_L^* = r_L^* = \xi_L^* = 0$. This fall in foreign output does not affect the natural level of output in Home, recall equation (52). A policy that stabilizes the output gap, therefore, completely insulates output in the Home economy from the fall in foreign economic activity. Under a policy of output gap targeting, the Home terms of trade deteriorate when foreign output falls (Home-produced goods sold in Foreign become cheaper relative to Foreign-produced goods sold in Foreign), $0 < s_0^L = \kappa \gamma_{y^n} < 1$. Foreign demand being given by $v [\hat{s}_t^L + \hat{y}_L^*]$ (compare (16)), the deterioration of the terms of trade leads to expenditure switching by foreign households. This alone is not sufficient, however, to perfectly stabilize domestic output. Rather, perfect stabilization is achieved by the added effect of expenditure switching in Home. The nominal exchange rate depreciates disproportionately, see equation (58). Recalling that under DCP there is full pass-through of the exchange rate to *import* prices in Home, the depreciation is key to expenditure switching by Home households toward Home-produced goods. Note that this switching occurs in spite of the price level of Home-produced goods expressed in Home currency rising on impact, equation (56). Combining this with the pass-through in import prices from the exchange rate depreciation, consumer price inflation rises persistently, (57). Yet domestic consumption is crowded in by a persistent cut in nominal interest rates (59). In sum, insulating Home output from a fall in foreign economic activity means stimulating domestic demand and tolerating producer-price *and* consumer-price inflation.

I.4.2 Stabilizing producer price inflation under DCP, $\pi_{H,t} = 0$

We now consider a monetary policy that stabilizes producer price inflation (i.e. domestic marginal costs) in all periods $\pi_{H,t} = 0$. Again, lacking the divine coincidence property, stabilizing marginal costs does not coincide with stabilizing the output gap. If monetary policy resolves to stabilize producer prices, it positions itself in this trade-off.

Proposition 12. *Consider the same conditions as in Proposition 11, but let Home monetary policy target $\pi_{H,t} = 0$. Then, while the shocks last, the following is true.*

1. The terms of trade are given by

$$s_t^L = (1 + \alpha_{\pi_H} + \dots + \alpha_{\pi_H}^t) \gamma_{\pi_H} \left[\pi_L^* (1 - \beta\mu) - \kappa \frac{1 + \varphi}{1 + \varphi(1 - v)} y_L^* + \kappa \xi_L^* \right], \quad (60)$$

with $\alpha_{\pi_H} = \frac{1 + \beta + \kappa \frac{1 + \varphi}{1 + \varphi(1 - v)}}{2\beta} - \frac{1}{2\beta} \sqrt{\left[1 + \beta + \kappa \frac{1 + \varphi}{1 + \varphi(1 - v)} \right]^2 - 4\beta}$, and $\gamma_{\pi_H} = 1 / (1 + \beta + \kappa \frac{1 + \varphi}{1 + \varphi(1 - v)} - \beta \alpha_{\pi_H} - \beta\mu)$. One can show that $0 < \alpha_{\pi_H} < 1$ and $0 < \gamma_{\pi_H} < \frac{1}{\kappa} \frac{1 + \varphi(1 - v)}{1 + \varphi}$. Further, $\alpha_{\pi_H} < \alpha_y$.

2. Home output is given by

$$y_t^L = \frac{v}{1 + \varphi(1 - v)} (s_t^L + y_L^*). \quad (61)$$

3. By design, $\pi_{H,t}^L = 0$.

4. Home consumer price inflation is given by

$$\pi_0^L = v \left[\xi_L^* - \frac{\varphi v}{1 + \varphi(1 - v)} s_0^L - \frac{1 + \varphi}{1 + \varphi(1 - v)} y_L^* \right] \quad (62)$$

in the initial period, and by

$$\pi_t^L = -v \frac{\varphi v}{1 + \varphi(1 - v)} \alpha_{\pi_H}^t s_0^L, \text{ for } t > 1.$$

5. The nominal exchange rate is given by

$$e_t^L = - (1 + \alpha_{\pi_H} + \dots + \alpha_{\pi_H}^t) \frac{\varphi v}{1 + \varphi(1 - v)} s_0^L + \xi_L^* - \frac{1 + \varphi}{1 + \varphi(1 - v)} y_L^* - (t + 1) \pi_L^*. \quad (63)$$

6. The interest differential between Home and Foreign is given by

$$\begin{aligned} r_t^L - r_L^* &= (1 - \mu) \frac{\varphi v}{1 + \varphi(1 - v)} (1 - \alpha_{\pi_H}) s_t^L \\ &\quad - \mu \left[1 + \alpha_{\pi_H}^{t+1} \frac{\varphi v}{1 + \varphi(1 - v)} \gamma_{\pi_H} (1 - \beta\mu) \right] \pi_L^* \\ &\quad - \left[(1 - \mu) + \mu \alpha_{\pi_H}^{t+1} \frac{\varphi v}{1 + \varphi(1 - v)} \gamma_{\pi_H} \kappa \right] \xi_L^* \\ &\quad + \frac{1 + \varphi}{1 + \varphi(1 - v)} \left[(1 - \mu) + \mu \alpha_{\pi_H}^{t+1} \frac{\varphi v}{1 + \varphi(1 - v)} \gamma_{\pi_H} \kappa \right] y_L^* \end{aligned} \quad (64)$$

Proof. Item (2.), $\pi_{H,t} = 0$, follows from the assumption on policy. Use Phillips curve (44) to observe that under this policy $(1 + \varphi)y_t + v(m_t - \xi_t^*) = 0$. Using this expression in the risk sharing

condition (43) implies the expression for output in the proposition, (61). Substitute from here in Phillips curve (45) such that inflation is forced by the terms of trade and foreign variables only. Substitute for $\pi_{H,t}^*$ from (46). Solving by the method of undetermined coefficients for a bounded solution yields (65). This proves item (1.). The other terms are determined in a manner analogous to lines sketched in Proposition 11. \square

As before, for the verbal exposition we focus on a fall in foreign demand in isolation, $y_L^* = -1$. If the Home central bank targets domestic producer price inflation, the terms of trade still deteriorate (as in the previous case). But now the foreign output shock *does* spill over to Home output, see equation (61): Home output unambiguously falls. Relative to the case of natural output targeting, with PPI targeting the nominal exchange rate (63) depreciates by less, and domestic households do not switch expenditures to the same extent. Still, the consumer price level in Home rises on impact, compare equation (62).

In sum, a focus on inflation stabilization induces shocks to foreign demand to translate into a fall of domestic activity. The numerical simulations of Section 4.3 in the main text show that consumer price inflation targeting curbs the domestic demand stimulus (amid rising inflation) to a still larger extent. This brings the response of output closer still to the case of fixed exchange rates (a regime which prevents domestic demand stimulus altogether).

I.4.3 Stabilizing consumer price inflation under DCP, $\pi_t = 0$

We now consider a monetary policy that stabilizes consumer price inflation (i.e. domestic marginal costs) in all periods $\pi_t = 0$. For the special case of an infinitely elastic labor supply, $\varphi = 0$, the following proposition summarizes the response of the Home economy to the external shocks.

Proposition 13. *Consider the same conditions as in Proposition 11, but let Home monetary policy target $\pi_t = 0$ and let $\varphi = 0$. Then, while the shocks last, the following is true.*

1. *The terms of trade are given by*

$$s_t^L = (1 + \alpha_\pi + \dots + \alpha_\pi^t) \gamma_\pi \left[\pi_L^* (1 - \beta\mu) - \kappa y_L^* + \kappa \xi_L^* \right], \quad (65)$$

with $\alpha_\pi = \frac{1+\beta+\kappa}{2\beta} - \frac{1}{2\beta} \sqrt{[1 + \beta + \kappa]^2 - 4\beta}$, and $\gamma_\pi = 1/(\kappa + 1 + \beta - \beta\alpha_\pi - \beta\mu)$. One can show that $0 < \alpha_\pi < 1$ and $0 < \gamma_\pi < \frac{1}{\kappa}$.

2. *Home output is given by*

$$\begin{aligned} y_t^L = & \left[(1 - v)[1 + a_m + \dots + a_m^t] \kappa \gamma_m + v[1 + \alpha_\pi + \dots + \alpha_\pi^t] \kappa \gamma_\pi - (1 - v) \right] \cdot \xi_L^* \\ & + \left[1 - (1 - v)[1 + \alpha_m + \dots + \alpha_m^t] \kappa \gamma_m - v[1 + \alpha_\pi + \dots + \alpha_\pi^t] \kappa \gamma_\pi \right] \cdot y_L^* \\ & + (1 - \mu\beta)v[1 + \alpha_\pi + \dots + \alpha_\pi^t] \gamma_\pi \pi_L^*, \end{aligned} \quad (66)$$

with $\alpha_m = \frac{1+\beta+\kappa/v}{2\beta} - \frac{1}{2\beta}\sqrt{[1+\beta+\kappa/v]^2 - 4\beta}$ and $\gamma_m = 1/(\kappa + v[1+\beta - \beta\alpha_m - \beta\mu])$.

3. Producer price inflation is given by

$$\pi_{H,t}^L = -v\alpha_m^t \gamma_m \kappa [\xi_L^* - y_L^*]. \quad (67)$$

4. By design, Home consumer price inflation is given by $\pi_t = 0$.

5. The nominal exchange rate is given by

$$e_t^L = (1-v)(1+\alpha_m + \dots + \alpha_m^t) \gamma_m \kappa [\xi_L^* - y_L^*] - (t+1)\pi_L^*. \quad (68)$$

6. The interest differential between Home and Foreign is given by

$$\begin{aligned} r_t^L - r_L^* &= -\mu\pi_L^* \\ &+ (1-v)\gamma_m \kappa [a_m^{t+1} - (1-\mu)] \cdot [\xi_L^* - y_L^*]. \end{aligned} \quad (69)$$

Proof. For all the derivations here assume that $\varphi = 0$. To derive item (1.), use risk sharing condition (43) in the Phillips curve for exports (45). In the resulting relation, use the definition of the terms of trade (46) to substitute for $\pi_{H,t}^*$. Solving the resulting second-order difference equation for s_t (and observing the Markov structure of the shocks) give the terms of trade. Next, CPI targeting means $\pi_t = 0$, item (4.). With the definition of CPI inflation from (48), this gives $\Delta e_t = -\pi_t^* - \frac{1-v}{v}\pi_{H,t}$. Use this to substitute for Δe_t in (47). This gives $\pi_{H,t} = -v\Delta[m_t + s_t]$. Use this to substitute for $\pi_{H,t}$ in Phillips curve (44). This gives a second-order difference equation in $m_t + s_t$. Solving this equation for the stable root gives $m_t + s_t = \alpha_m[m_{t-1} + s_{t-1}] + \gamma_m \kappa [\xi_t^* - y_t^*]$. With this, solve for $\pi_{H,t}$. This gives item (3.). Item (2.) follows from using the above results along with the risk sharing condition (43). Item (5.) follows from $\Delta e_t = -\pi_t^* - \frac{1-v}{v}\pi_{H,t}$ and the solution for $\pi_{H,t}^L$ in item (3.). Last, item (6.) follows from uncovered interest parity. \square

As before, for the verbal exposition we focus on a fall in foreign demand in isolation, $y_L^* = -1$. If the Home central bank targets domestic consumer price inflation, the terms of trade still deteriorate (as in the previous case). The foreign output shock *does* spill over to Home output, see equation (66). The nominal exchange rate (63) depreciates. Producer prices fall on impact, compare equation (67).

I.4.4 Fixed exchange rates under, DCP/PCP, $e_t = 0$

We now turn to the case of a fixed exchange rate. We consider a monetary policy that stabilizes the exchange rate in all periods—the exchange-rate regime is assumed to be perfectly credible. In the model spelled out above, when the exchange rate is credibly pegged, prices and allocations are identical under DCP and PCP, the reasoning of Proposition 8 applying here, too; namely, $m_t = 0$ under DCP (see the proof to Proposition 14 below).

Proposition 14. *Consider the same conditions as in Proposition 11, but let Home monetary policy target $e_t = 0$. Then, while the shocks last, the following is true.*

1. The terms of trade are given by

$$s_t^L = (1 + \alpha_e + \dots + \alpha_e^t) \gamma_e \left(\pi_L^* (1 - \beta\mu) + \kappa [1 + \varphi(1 - v)] \xi_L^* - \kappa(1 + \varphi) y_L^* \right), \quad (70)$$

with $\alpha_e = \frac{1 + \beta + \kappa(1 + \varphi)}{2\beta} - \frac{1}{2\beta} \sqrt{[1 + \beta + \kappa(1 + \varphi)]^2 - 4\beta}$, and $\gamma_e = 1 / (1 + \beta + \kappa(1 + \varphi) - \beta\alpha_e - \beta\mu)$. One can show that $0 < \alpha_e < \alpha_{\pi_H} < 1$ and $0 < \gamma_e \kappa(1 + \varphi) < 1$.

Home output is given by

$$y_t^L = s_t^L + y_L^* - (1 - v) \xi_L^*. \quad (71)$$

2. Home producer price inflation is given by

$$\pi_{H,t}^L = \pi_L^* - \alpha_e^t \gamma_e \left(\pi_L^* (1 - \beta\mu) + \kappa [1 + \varphi(1 - v)] \xi_L^* - \kappa(1 + \varphi) y_L^* \right). \quad (72)$$

3. Home consumer price inflation is given by

$$\pi_t^L = \pi_L^* - (1 - v) \alpha_e^t s_0^L. \quad (73)$$

4. The nominal exchange rate is given by $e_t = 0$.

5. The interest differential between Home and Foreign is given by

$$r_t^L - r_L^* = 0. \quad (74)$$

The same would be true under PCP.

Proof. With fixed exchange rates item (4.) follows by assumption. Use the Phillips curves (44) and (45) to arrive at the expression

$$\pi_{H,t}^* - \pi_{H,t} = \beta E_t \{ \pi_{H,t+1}^* - \pi_{H,t+1} \} - \kappa \cdot m_t.$$

From (47), with fixed exchange rates $\pi_{H,t}^* - \pi_{H,t} = m_t - m_{t-1}$. Substituting this for the differences in the Phillips curves yields a linear homogeneous difference equation in m_t . Hence, $m_t = 0$, whence $\pi_{H,t}^* = \pi_{H,t}$. In Phillips curve (44), substitute for y_t from the risk sharing condition (43) and use $m_t = 0$. Use (46) with $\pi_{H,t} = \pi_{H,t}^*$ to substitute for $\pi_{H,t}$ in the Phillips curve. The result is a difference equation in s_t and Foreign driving terms. Solving this for s_t results in the stable solution (70). Home output, then, follows from the risk sharing condition, giving item (1.) in the proposition. Home producer price inflation then follows from (46) (with $\pi_{H,t} = \pi_{H,t}^*$), giving item (2.). Consumer price inflation follows directly from definition (48), using the aforementioned results, item (3.). The interest spread, item (5.) immediately follows from UIP. Last, observe that since $\pi_{H,t} = \pi_{H,t}^*$ and $e_t = 0$, $\pi_{H,t}^* = \pi_{H,t} - \Delta e_t$. The latter equation substitutes for Phillips curve (45) under PCP. Since this is the only difference, and both equations hold, the same derivations apply to PCP as well. \square

A fixed exchange rate means that Home monetary policy no longer can provide domestic demand stimulus through the interest rate, equation (74). Buffering a fall in foreign demand, thus, relies entirely on expenditure switching by domestic and foreign households. At the same

time, domestic expenditure switching is limited—driven by price adjustment only. Also under a peg, the terms of trade deteriorate in response to a contraction in foreign output, favoring expenditure switching by foreign households. In order to have domestic expenditure switching in Home, producer price inflation in Home has to fall. It does, but only gradually, (72). In addition, home CPI inflation falls (73). Output unambiguously falls, and more strongly so than in the previous scenarios, see equation (71). In sum, an exchange rate peg means that a Foreign fall in demand results in a fall in inflation in Home, and a fall in output in Home. That is, a fixed exchange rate neither achieves stabilization of inflation, nor of output.

I.5 The response in Home under PCP

For comparison, it is useful to inspect, if only briefly, producer currency pricing. This is because PCP underpins the classic notion that flexible exchange rates provide automatic insulation. Under PCP, targeting the producer price level amounts to targeting the natural level of output. So the two regimes are equivalent, as Proposition 15 states. We wish to emphasize that the two parameter restrictions that we keep entertaining are $\eta = 1$ (a unitary trade elasticity), and $\alpha = 0$ (no use of intermediate inputs in production). All other parameters are left unrestricted. The result, thus, is true for any of the shocks that we entertain, any labor supply elasticity, and any Foreign monetary policy.

Proposition 15. *Consider the economy of Section I.1. Let pricing be given by PCP. Let the shocks be as described in Section I.3, with the first period of the shock being period 0. Let Home monetary policy target the natural level of output (or, equivalently, target producer-price stability $\pi_{H,t} = 0$). Then, while the shocks last, the following is true.*

1. *The terms of trade are given by*

$$s_t^L = \frac{1 + \varphi(1 - v)}{1 + \varphi} \xi_L^* - y_L^*, \quad (75)$$

that is, the terms of trade are constant.

Output is given by (52).

2. *Home producer price inflation by $\pi_{H,t} = 0$.*
3. *Home consumer price inflation is given by*

$$\pi_0^L = -v y_L^* + v \frac{1 + \varphi(1 - v)}{1 + \varphi} \xi_L^*, \quad (76)$$

and

$$\pi_t^L = 0, \quad t > 0. \quad (77)$$

4. *The nominal exchange rate is given by*

$$e_t^L = \frac{1 + \varphi(1 - v)}{1 + \varphi} \xi_L^* - y_L^* - (t + 1) \cdot \pi_L^*. \quad (78)$$

5. The interest differential is given by

$$r_t^L - r_t^{*,L} = -\mu\pi_L^* + (1 - \mu) \left(y_L^* - \frac{1 + \varphi(1 - \nu)}{1 + \varphi} \xi_L^* \right). \quad (79)$$

The nominal rate in Home, in turn is given by

$$r_t^L = (1 - \mu) v \frac{\varphi}{1 + \varphi} \xi_L^*.$$

Proof. With $\pi_{H,t} = 0$, the Phillips curve (44) gives that output is equals natural output, and *vice versa*, establishing item (2.). The risk sharing condition (43) can then be used to solve for the terms of trade, (75), establishing item (1.). The evolution of the nominal exchange rate (item (4.)) follows from (46) and the law of one price (that prevails under PCP and translates to $\pi_{H,t}^* = \pi_{H,t} - \Delta e_t$). Given these results, the interest differential (item (5.)) follows from UIP. The nominal rate in Home follows by deriving and substituting r_t^* from (50) using the Markov structure. Consumer price inflation (item (3.)) follows from definition (48). \square

As is well known, under PCP exchange rate adjustment lines up expenditure switching with domestic output gap stabilization. In particular, in response to the fall in Foreign demand, when monetary policy in Home targets producer prices, output in Home is perfectly stabilized. And so is consumer price inflation in all but the initial period, see equation (77). Indeed, on impact, the consumer price inflation in Home rises, equation (76), in line with the depreciation of the nominal exchange rate, (78), which – in turn – is brought about by a cut in Home’s interest rate in response to a fall in Foreign demand. Producer currency pricing underlies much of the intuition of flexible exchange rates serving as an optimal stabilizer. Proposition 15 shows why. Namely, for all shocks other than the preference shocks (which affect natural output) full insulation of output is achieved without any change (in equilibrium) of Home’s interest rate.

J Extensions of baseline model for a numerical assessment

This appendix describes the model that we use in Section 4.3. The model is the same as laid out in Section 4.1, bar for a few extensions that we list in the following, using the linearized version of the model.

J.1 Incomplete markets

We follow Itskhoki and Mukhin (2021) in the way in which we introduce incomplete financial markets; see also earlier work by Devereux and Engel (2002) and Kollmann (2005). Foreign and Home households can hold domestic and Foreign safe nominal bonds. The international relative demand for the two regions' bonds itself is subject to shocks. Therefore, we replace the risk sharing condition, which had implied uncovered interest parity, by a modified version of UIP. Namely, in linearized terms,

$$r_t - r_t^* = E_t \{ \Delta e_{t+1} \} + \psi_t^* - \gamma b_t, \quad \gamma \geq 0.$$

Here ψ_t^* is a shock to the international substitutability of bonds issued in different currencies. b_t is the net foreign asset position of the Home economy as a share of steady state Home output. Once linearized, the net foreign asset position evolves according to

$$\beta b_t - b_{t-1} = v((\eta(2-v) - 1)s_t + \eta(1-v)m_t + (1-\alpha)(c_t^* - c_t) + \alpha(x_t^* - x_t)).$$

J.2 Monetary policy in Foreign and in Home

Foreign monetary policy is governed by a Taylor-type feedback rule

$$r_t^* = \rho_{r^*} r_{t-1}^* + (1 - \rho_{r^*}) (\alpha_{\pi^*} \pi_t^* + \alpha_{y^*} y_t^*) + \varepsilon_t^*, \quad (80)$$

where ε_t^* is the Foreign monetary policy shock.

In the baseline, Home monetary policy follows the same rule, but responding to Home variables and being subject to a Home monetary shock.

J.3 Law of motion of external shocks

There are four external shocks, a Foreign monetary shock, a shock to the international substitutability of bonds, and Foreign time-preference and productivity shocks. Let ζ_t^* mark the shocks, with $\zeta_t^* \in \{\varepsilon_t^*, \psi_t^*, Z_t^*, \xi_t^*\}$. All the external shocks, in principle, are serially correlated. In (log) deviation from steady state, they each follow

$$\zeta_t^* = \rho_{\zeta^*} \zeta_{t-1}^* + \sigma_{\zeta^*} u_{\zeta^*,t}, \quad \text{with } \rho_{\zeta^*} \in [0, 1), \sigma_{\zeta^*} > 0, \text{ and } u_{\zeta^*,t} \stackrel{\text{iid}}{\sim} N(0, 1), \quad \zeta^* \in \{\varepsilon^*, \psi^*, Z^*, \xi^*\}.$$

J.4 Law of motion of domestic shocks

The same types of shocks that affect Foreign directly also affect the Home economy. We allow for potential spillovers such that

$$\zeta_t = \zeta_t + \chi_\zeta \zeta_t^*, \text{ with all } \chi_\zeta \in [0, 1]; \zeta \in \{\varepsilon, Z, \xi\}.$$

Here ζ_t is the disturbance affecting the Home economy. This disturbance has two components: the spillover from the Foreign shock, the extent of which is measured by χ_ζ (separately for each shock), and shocks that are specific to the small open economy (and uncorrelated with Foreign shocks). The Home-specific shock component follows

$$\zeta_t = \rho_\zeta \zeta_{t-1} + \sigma_\zeta u_{\zeta,t}, \text{ with } \rho_\zeta \in [0, 1), \sigma_\zeta > 0 \text{ and } u_{\zeta,t} \stackrel{\text{iid}}{\sim} N(0, 1), \text{ where } \zeta \in \{\varepsilon, Z, \xi\}.$$

K Calibration

We calibrate the model to the euro-area economy (Foreign country) and to a prototypical neighboring small open economy (Home). Conceptually, the calibration proceeds in two steps. First, we calibrate those parameters that we need to set to assess the extent to which the model can replicate the conditional evidence on monetary transmission that we have documented empirically. Then, second, we calibrate the remaining parameters (pertaining to the other shock processes, in particular) that are required to compare the theory with the unconditional moments in the data.

K.1 Calibration part I: parameters governing monetary transmission

Table K.1 documents the first part of the baseline parameterization. We calibrate the model such that one period is a quarter, which allows us to compare the model's unconditional moments against national accounts data. Most parameters are standard. Our choice of β implies an

Table K.1: Baseline parameterization, Part I

Parameters	Description	Values
A. Preferences		
β	Discount factor	0.995
φ	Inverse of labor supply elasticity	0.5
ϵ	Elasticity of substitution between intermediate goods	10
η	Trade elasticity	2
v	1 - Home bias	0.1
B. Production and price setting		
α	Share of intermediate inputs in production	2/3
ω	Price adjustment costs	400
C. Foreign monetary policy rule		
ρ_{r^*}	Interest rate smoothing	0.85
α_{π^*}	Response to inflation	1.25
α_{y^*}	Response to output	0.025
D. Foreign shocks (monetary)		
ρ_{ε^*}	AR(1) parameter monetary policy shock	0
σ_{ε^*}	Standard deviation monetary policy shock	0.25/400
E. International financial markets		
γ	Response of spread to net foreign assets	0.001

annual real rate of interest of 2 percent. We set $\varphi = 0.5$, implying a Frisch elasticity of 2, as is customary in the business-cycle literature. We set the elasticity of substitution to $\epsilon = 10$, another customary value. Following Gopinath et al. (2020), we set the elasticity of external demand to $\eta = 2$. The share of intermediate inputs in production is set to $\alpha = 2/3$, again following

Gopinath et al. (2020). We set $v = 0.1$ so as to match the average import and export shares of the neighboring countries vis-à-vis the euro area of 30 percent. We set the price adjustment costs to $\omega = 400$, implying that the Phillips curve is reasonably flat.³⁶ The Foreign monetary policy rule is parameterized roughly in line with the estimates in Adolfson et al. (2007). We set $\rho_{r^*} = 0.85$, $\alpha_{\pi^*} = 1.25$, and $\alpha_{y^*} = 0.025$. Next, the Foreign monetary policy shock is assumed to be iid, with the innovation having a standard deviation of 25bps, annualized. Both of these choices are customary. Last, turning to international financial markets, in line with Schmitt-Grohé and Uribe (2003) and Itskhoki and Mukhin (2021), we set $\gamma = 0.001$, a small value that is sufficient to render the real value of net foreign assets stationary. Once complemented by an assumption on monetary policy in Home, the parameters in Table K.1 alone are sufficient to compare the model with the transmission of Foreign monetary shocks presented in Figures 2.A and 2.B above.

K.2 Calibration part II: external shocks

A comparison with the unconditional business cycle moments, however, requires us to calibrate also the remaining parts of the model; the shock processes in particular. This is what we do next. We start with Foreign (the euro area). The left panel of Table K.2 presents business cycle statistics for the euro area, using the same data set as in our analysis above, except that we opt for a quarterly frequency here, as is the standard in the international business-cycle literature. This allows us to directly compare model and data. Data moments are computed after applying a quadratic trend. The right panel of Table K.2 shows the corresponding moments

Table K.2: Business cycle moments for the euro area (Foreign)

x_{EA}	data			model		
	$\sigma_{x_{EA}}$	$\rho_{x_{EA},gdp_{EA}}$	$\rho_{x_{EA},x_{EA}(-1)}$	$\sigma_{x_{EA}}$	$\rho_{x_{EA},gdp_{EA}}$	$\rho_{x_{EA},x_{EA}(-1)}$
GDP	2.11	1.00	0.96	2.11	1.00	0.87
i rate	0.94	0.76	0.92	1.23	0.23	0.97
HICP infl.	0.30	0.39	0.32	0.24	0.43	0.89

Notes: Moments for the euro area in the data and the calibrated model. Left block: quarterly aggregates of monthly data for the euro area. All data are detrended using a quadratic trend. Right block: unconditional moments in the model. GDP is from the quarterly national accounts. The interest rate is quarterly average value and annualized. HICP inflation is reported as quarter-on-quarter inflation rates (not annualized). For each block, the table shows the standard deviation of the variable, the correlation with output, and the first-order autocorrelation.

in the calibrated model. In calibrating the two non-monetary shocks to Foreign, we proceed as follows. The autocorrelation of the productivity shock follows the estimates for the euro area given in Table 2 of Adolfson et al. (2007). We set the standard of the productivity shock so

³⁶Our calibration of the adjustment cost parameter matches the slope of the euro-area Phillips curve in Alvarez et al. (2006). The slope is tantamount to firms reoptimizing their prices, on average, once every 6.5 quarters in a setup with staggered price setting a la Calvo and no further real rigidities.

that half the variance of GDP is accounted for by productivity. The preference (demand) shock is as persistent as the productivity shock, roughly in line with estimates in the literature, such as in Adolfson et al. (2007) or Andrade et al. (2021). We adjust the standard deviation of the innovation to the demand shock such that economic activity of the Foreign country in the model aligns with the volatility of euro-area GDP that we measure in the data. Section F of Table K.3 summarizes these parameter choices. The parsimonious structure of the model notwithstanding, the simple calibration exercise leads to business-cycle moments that line up rather well with the data; see the right panel of Table K.2 in comparison with the same table's left panel.

K.3 Calibration part III: Home monetary policy and remaining shocks

We calibrate the remaining parameters for the Home economy as follows. We proceed for

Table K.3: Calibration c'td

Parameters	Description	Values
F. Foreign shocks c'td		
ρ_{Z^*}	AR(1) parameter productivity shock	0.935
σ_{Z^*}	Standard deviation productivity shock	0.0024
ρ_{ξ^*}	AR(1) parameter preference shock	0.935
σ_{ξ^*}	Standard deviation preference shock	0.016
G. Home shocks		
χ_Z	productivity spillover	0.9
ρ_Z	SOE-specific productivity shock, AR(1)	ρ_{Z^*}
σ_Z	Standard deviation productivity shock	$(1 - \chi_Z)3\sigma_{Z^*}$
χ_ξ	demand preference shock spillover	0
ρ_ξ	SOE-specific preference shock, AR(1)	ρ_{ξ^*}
σ_ξ	Standard deviation preference shock	$(1 - \chi_\xi)3\sigma_{\xi^*}$
χ_ε	monetary shock spillover	0
ρ_ε	AR(1) parameter monetary policy shock	ρ_{ε^*}
σ_ε	Standard deviation monetary policy shock	$(1 - \chi_\varepsilon)\sigma_{\varepsilon^*}$
H. International financial markets		
ρ_{ζ^*}	AR(1) parameter international financial shock	0.5
σ_{ζ^*}	Standard deviation international financial shock	0.016
I. Home monetary policy under Taylor rule		
ρ_r	Interest rate smoothing	ρ_{r^*}
α_π	Response to consumer price inflation	α_{π^*}
α_y	Response to output	α_{y^*}

the floaters. We assume that Home monetary policy follows the same Taylor rule as Foreign (see panel I. of Table K.3). The monetary-policy and demand-preference shocks in Home are independent from Foreign, so that $\chi_\varepsilon = \chi_\xi = 0$. For the productivity shock, instead, we do

allow for direct spillovers from Foreign to Home. As in Itskhoki and Mukhin (2021), we do so with a view toward better accounting for the comovement of business cycles. In our baseline calibration, 90 percent of the Foreign TFP shock is assumed to be reflected in Home TFP ($\chi_Z = 0.9$). This value is larger than used in Backus et al. (1992) or Heathcote and Perri (2002) but seems reasonable given the close integration of production networks between the euro area and its neighbors (ECB Working Group on Global Value Chains, 2019). The monetary policy shock has the same size in Home as in Foreign. At the same time, the idiosyncratic shocks in productivity and demand preferences are scaled to be twice as large as in Foreign; this with a view toward the larger volatility of the Home economy. The resulting parameter values are documented in panel G. of Table K.3. Finally, we assume that shocks to the international substitutability of bonds are rather short-lived, $\rho_\zeta^* = 0.5$. We choose the standard deviation of the innovation of the shock such that, under the float, the model roughly replicates the volatility of the nominal exchange rate that we observe in the data.

L Alternative pricing regimes and the insulation puzzle

Our baseline model used in the main text features DCP. For comparison, we here present simulation results for two alternative pricing regimes, producer currency pricing (PCP) and local currency pricing (LCP). Figures (L.1) and (L.2) show the responses of the Home economy to a Foreign monetary policy shock. The parameter calibration is identical to the one used in the main text. We focus on the case of a floating exchange rate, since the responses under an exchange rate peg are invariant to the pricing regime.

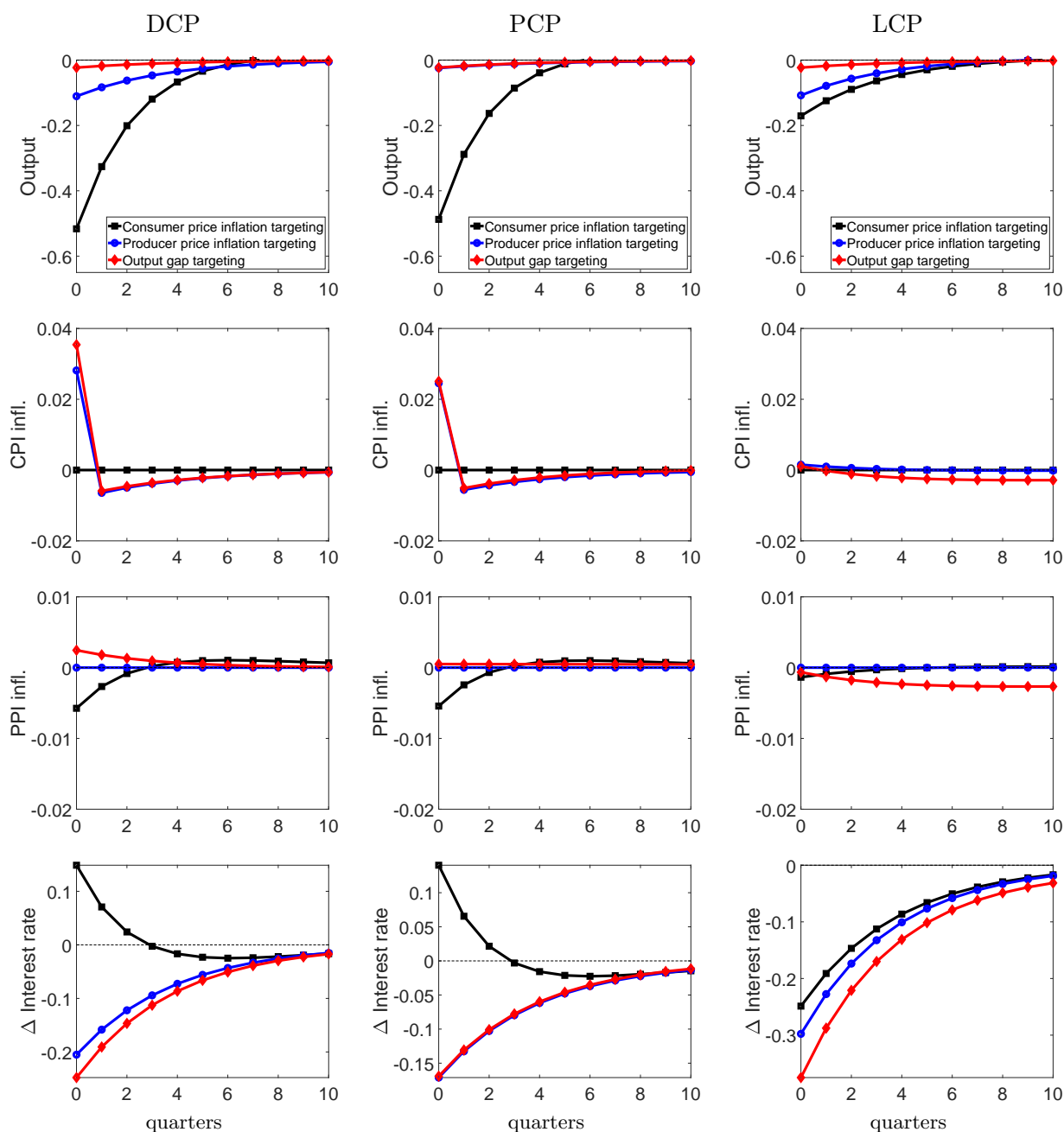
The left columns of the two figures show responses under DCP, the case discussed in the main text. The middle columns show responses under PCP. When the Home monetary authority pursues consumer price inflation targeting, the responses of Home variables are very similar to those under DCP. That is, consistent with our empirical results, the drop in output is essentially as large as under a peg. We observe more substantial differences between DCP and PCP, when the Home monetary authority targets producer price inflation. Under PCP, the so-called divine coincidence holds, meaning that stable producer prices are commensurate with a closed output gap. Consequently, the drop in output is much smaller under PCP than under DCP. Under PCP, the depreciation of the Home exchange rate deteriorates the Home terms of trade and leads to expenditure switching of both Home and Foreign households and firms towards goods produced in Home, as shown by the increase in the Home export-import ratio.

The right columns of the two figures show responses under LCP. When prices in both countries are sticky in local currency, consumer price inflation targeting is associated with a notably smaller drop in output than under DCP. That is because when Home import prices are sticky in domestic currency, the Home monetary authority lowers the interest rate more aggressively in response to the shock and allows the exchange rate to depreciate without compromising stable consumer prices. Producer price inflation targeting and output gap targeting feature output responses that are similar to those under DCP.³⁷ For other variables the differences in responses is more pronounced. For instance, the interest rate response in Home is more accommodative under LCP than under DCP, and this is reflected in a stronger depreciation of the Home exchange rate. The terms of trade, on the other hand, appreciate under LCP whereas they remain largely unaffected by the foreign shock under DCP.

All in all, our two main results from the main text are robust to assuming alternative pricing regimes. First, under a floating exchange rate, lack of output insulation is first and foremost a policy choice. That is, the Home monetary authority can, in principle, choose a monetary policy strategy that insulates Home output from the Foreign monetary policy shock. Second, when the Home monetary authority targets consumer price inflation, relative, to targeting—say—producer price inflation, it invites output spillovers. These spillovers are smaller under LCP than under DCP and PCP. In the latter two cases, when the central bank targets consumer

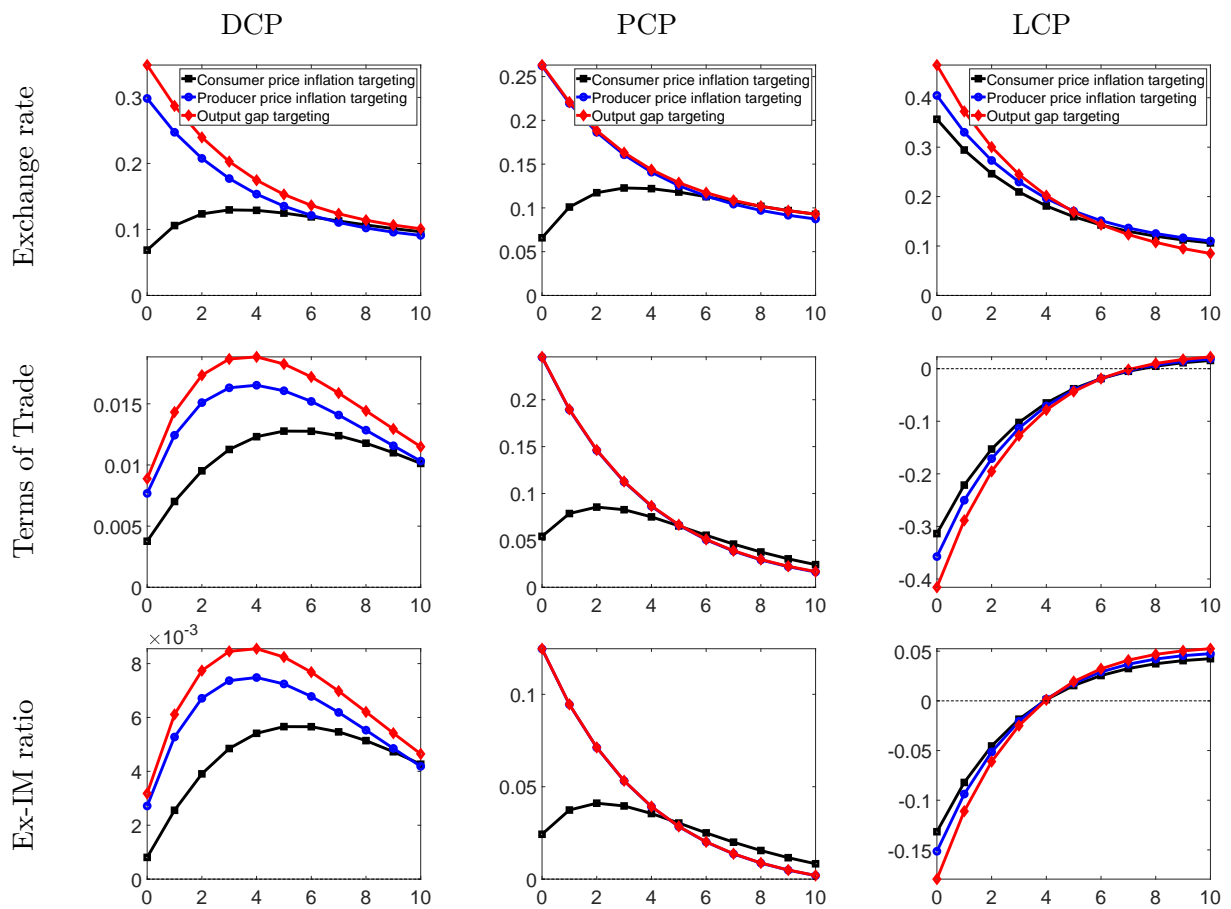
³⁷Under LCP, we consider the same path of Home natural output as under DCP and PCP, that is, we consider a flexible-price equilibrium for the Home economy where the law of one price holds for goods imported from the Foreign economy.

Figure L.1: Adjustment to Foreign monetary policy shock: Alternative pricing regimes



Note: CPI inflation is consumer-price inflation (not annualized), PPI inflation is producer-price inflation (not annualized). Interest rates are expressed in annualized percentage deviations from steady state. Δ Interest rate denotes the difference between the response of the Home and Foreign interest rate.

Figure L.2: Adjustment to Foreign monetary policy shock: Alternative pricing regimes



prices, the output response to a Foreign monetary policy shock under a floating exchange rate is similar in magnitude to the one under an exchange rate peg.

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