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Monetary Autonomy and Exchange Rate Pass-Through:
Evidence from Sweden and Denmark

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Abstract: This study examines how monetary regime choice conditions exchange rate pass-through and inflation transmission dynamics in Sweden and Denmark using quarterly data from 2000Q1–2024Q4. While the existing literature has extensively examined shock-dependent exchange rate pass-through (ERPT) and international monetary spillovers separately, less attention has been given to how exchange rate regimes shape inflation transmission across comparable small open economies exposed to common external shocks. Using a Global Vector Autoregressive (GVAR) framework with Cholesky identification, we trace the transmission of domestic, regional, and global shocks across two economies operating under distinct monetary arrangements. Our main finding is that monetary autonomy primarily conditions the speed and short-run magnitude of inflation adjustment rather than its long-run direction. Pass-through and inflation transmission further vary systematically with shock origin, consistent with the shock-dependent ERPT literature. The results suggest that exchange rate flexibility may alter the adjustment path of external shocks by slowing their domestic transmission, even if long-run inflation dynamics converge. These findings contribute to the literature on monetary regime choice and international inflation transmission, with particular relevance for debates concerning monetary autonomy in small open economies.

Keywords: Global Vector Autoregressive model, Monetary Regime, Sweden, Denmark, Exchange Rate Pass-Through
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AI Declaration

Generative artificial intelligence tools have been used in the writing of this thesis for grammatical improvements and rephrasing. Additionally, AI has been used as coding support related to the implementation and debugging of the empirical analysis.

We are responsible for all decisions, empirical work, interpretations, and final text. All AI-assisted material has been reviewed, verified, and edited prior to inclusion in the thesis. Any errors are our own.

Contents

1 Introduction

After lying largely dormant for almost 20 years, the debate concerning a potential euro adoption has re-emerged in Sweden. The debate gained renewed momentum following the Swedish government's announcement of the need for a new euro-membership investigation (Sveriges Riksdag, 2025). An important perspective in the discussion is the extent to which monetary autonomy and exchange rate flexibility matter for domestic inflation dynamics in a highly integrated small open economy such as Sweden. The debate therefore extends beyond the question of euro membership itself and touches more fundamentally on whether exchange rate flexibility acts as an important buffer against external inflationary and monetary disturbances in small open economies.

Exchange rate movements have traditionally been viewed as an important adjustment mechanism in small open economies, transmitting external shocks into domestic prices through import costs, production costs and aggregate demand channels (Colavecchio & Rubene, 2020). However, recent literature increasingly emphasises that Exchange Rate Pass-Through (ERPT) is shock dependent and that the inflationary effects of exchange rate movements depend on the underlying disturbance driving the exchange rate itself (Forbes et al., 2018, 2020). This distinction is particularly important in financially integrated economies, where exchange rates may respond not only to domestic shocks, but also to regional monetary developments and global financial conditions (Miranda-Agrippino & Rey, 2020).

Sweden and Denmark provide a particularly useful comparison in this regard. Both economies are highly integrated with the Euro Area and share similar economic structures, yet differ fundamentally in their monetary arrangements. Sweden operates under an inflation-targeting regime with a floating exchange rate, while Denmark maintains a tightly managed peg to the euro through the European Exchange Rate Mechanism (ERM-II), limiting exchange rate flexibility and domestic monetary autonomy (Spange & Sørensen, 2017). These institutional differences imply potentially different transmission mechanisms for regional and global shocks. In Sweden, external disturbances may partly be absorbed through exchange rate adjustment, whereas in Denmark the exchange rate channel is structurally constrained, potentially shifting a greater share of the adjustment toward domestic prices and imported monetary conditions.

While the existing literature has extensively examined shock-dependent ERPT and international monetary spillovers separately, less attention has been given to how exchange rate regime choice conditions inflation transmission across otherwise comparable small open economies exposed to common external shocks. This distinction is particularly important because exchange rate movements generated directly by exchange rate shocks differ conceptually from exchange rate responses arising endogenously from broader macroeconomic disturbances such as monetary-policy or global price shocks.

To examine this underexplored strand of the literature, this study applies a Global Vector Autoregressive (GVAR) framework following Pesaran et al. (2004) using a Cholesky decomposition. The framework allows us to model international interdependencies explicitly and trace how domestic, regional and global shocks propagate through interconnected economies. Using quarterly data for Sweden, Denmark, the Euro Area, Norway and the

United States over the period 2000Q1–2024Q4, we analyse exchange rate pass-through and inflation transmission in Sweden and Denmark following identified domestic exchange rate and monetary-policy shocks, as well as regional Euro Area and global US monetary-policy and price-level shocks. The thesis therefore aims to analyze how monetary regime choice conditions exchange rate pass-through and inflation transmission in Sweden and Denmark. By comparing two otherwise similar economies operating under different monetary arrangements, this study contributes to the literature on shock-dependent ERPT, international monetary spillovers and the macroeconomic consequences of exchange rate regime choice in small open economies.

Our findings suggest monetary autonomy conditions the speed and short-run magnitude of inflation adjustment rather than its long-run direction, and that the degree of pass-through and inflation transmission varies by shock origin, in line with previous literature on shock-dependence. For regional and global price shocks, Denmark exhibits a stronger and more immediate inflation response. Sweden displays a weaker and more gradual response as the floating krona potentially offsets external price pressures in the short run. For monetary policy shocks, the interest rate responses are consistent with the institutional difference between the regimes, with Denmark's short rate co-moving more closely with the Euro Area while Sweden's adjusts less completely. In light of the previous literature, the results suggest that exchange rate regime choice mainly conditions the short-run adjustment of inflation to external shocks, highlighting the potential role of monetary autonomy as a timing mechanism for inflation transmission in small open economies.

The remainder of the study is structured as follows. Section 2 reviews the literature on exchange rate pass-through, shock-dependent inflation transmission, international monetary spillovers and the GVAR framework. Section 3 describes the data and construction of the foreign variables. Section 4 outlines the empirical methodology, including the country-specific VECM-X specifications, the construction of the GVAR system, the identification strategy and the impulse response framework used to measure exchange rate pass-through and inflation transmission. Section 5 presents the estimation procedure and diagnostic tests. Section 6 reports the empirical results for domestic, regional and global shocks, together with robustness checks. Lastly, Sections 7 and 8 discuss the main findings, limitations of the study and conclude.

2 Literature Review

The literature review is divided into five sections. We begin by describing Exchange Rate Pass Through (ERPT) and how it relates to small open economies. Thereafter, we describe shock-dependent ERPT, followed by a review of the ERPT literature as it relates to Sweden and Denmark. The final section introduces the GVAR framework and how it offers a meaningful comparative framework in the context of ERPT as it relates to monetary regime choice and inflation transmission.

2.1 Exchange Rate Pass Through and Shock Dependence

A country's Exchange Rate Pass Through (ERPT) is defined as the degree to which a country's import, producer and/or consumer prices change in response to a depreciation of the exchange rate. The existing literature on ERPT emphasises three primary channels, laid out by Colavecchio & Rubene (2020). The first channel operates through higher consumer prices as a depreciation of the exchange rate raises prices of imported consumer goods, pushing the level of overall consumer price inflation higher. The extent of this effect is decided by the amount of foreign goods in the consumer basket. The second channel operates through higher producer prices as imported inputs become more expensive, raising production costs and indirectly consumer prices. The third channel follows from the increased global competitiveness of exports following a depreciation. As domestic goods become relatively less expensive, net exports rise which in turn leads to higher output growth, higher labour demand and eventually upward pressure on consumer prices (Colavecchio & Rubene, 2020). In light of this, the relative importance of these channels and the overall magnitude of pass-through depends both on structural features such as trade openness and invoicing currency and on the nature of the underlying shock driving the exchange rate movement (Ortega & Osbat, 2020). The role of the underlying shock is particularly relevant for small open economies such as Sweden and Denmark, which act as price-takers in the global economy and are subject to developments and policy decisions originating abroad, making global and regional spillovers central to understanding both exchange rate movements and domestic inflation dynamics.

A central research question within the study of ERPT has, therefore, become how the origin of the economic shock underlying exchange rate movements affects the degree of pass-through to inflation. In their seminal paper, Forbes et al. (2018) examine shock-dependent ERPT in the UK using a Structural Vector Autoregressive (SVAR) framework. They show that pass-through varies systematically with the source of the exchange rate movement. Domestic demand shocks generate relatively weak pass-through, as stronger domestic demand allows firms to absorb exchange rate movements through mark-up adjustments, whereas monetary policy shocks generate substantially stronger pass-through due to weaker demand conditions and reduced pricing power. Global shocks produce even larger import-price responses, as they simultaneously affect exchange rates and foreign export prices, implying that observed pass-through in small open economies reflects broader international macroeconomic conditions rather than isolated exchange rate movements alone. Within the European context, Comunale & Kunovac (2017) similarly find that ERPT is shock-dependent and varies over time according to the composition of shocks driving exchange rate movements. Using a Bayesian VAR framework for the whole Euro Area and several member states (Germany, France, Italy and Spain), they show that pass-through is strongest following monetary policy and exchange rate shocks, while pass-through to consumer inflation remains relatively small and incomplete despite larger responses in import prices. Building on these findings, Forbes et al. (2020) document similar asymmetries in ERPT across a broader sample of 26 small open economies, showing that monetary-policy-driven exchange rate movements consistently generate higher pass-through than demand-driven movements. They further find that the importance of monetary policy shocks in driving exchange rate fluctuations increased following the Global Financial Crisis, although to a lesser extent in economies constrained by the zero lower bound. ERPT is thus inherently shock-dependent, implying that inflation transmission in small open economies must be analysed within frameworks capable of distinguishing between domestic, regional and global shocks.

2.2 Global Financial Conditions and International Spillovers

The structural factors shaping pass-through have themselves shifted over time. A related strand of the literature documents a decline in ERPT in advanced economies since the Global Financial Crisis, attributed to improved monetary policy credibility, well-anchored inflation expectations, and the dampening effects of global value chains and dominant currency pricing on the sensitivity of import prices to exchange rate movements (Jasova et al., 2016; Burstein & Gopinath, 2014; Gopinath, 2015; Amiti et al., 2019; Carrière-Swallow et al., 2016). Underlying these patterns is a broader observation about the shocks affecting small open economies themselves being increasingly shaped by global financial conditions. Miranda-Agrippino & Rey (2020) document a Global Financial Cycle driven substantially by US monetary policy, through which changes in US financial conditions transmit internationally via globally integrated capital markets, generating co-movement in interest rates, exchange rates and broader macroeconomic conditions across economies. For the Euro Area specifically, they find that US tightening propagates through internationally integrated financial intermediaries into European credit conditions and asset prices, with the ECB adjusting rates in response. For Sweden and Denmark, both deeply trade- and financially-integrated with the Euro Area, this points to a layered transmission structure in which US-originating disturbances shape exchange rate dynamics and inflation outcomes indirectly through the European channel. Within the European context more specifically, Potjagailo (2017) documents significant ECB monetary policy spillovers to fourteen non-Euro Area countries, finding that production, short-term interest rates and financial uncertainty all respond comparably to their Euro Area counterparts, though the size of spillovers varies with country characteristics. Among these, the exchange rate regime emerges as particularly relevant, with the strongest spillover effects found for countries with fixed exchange rates. Ellen et al. (2020) examine this directly for Denmark, Norway and Sweden, finding that while ECB spillovers are significant across all three economies, they impose greater constraints on domestic monetary policy where exchange rate flexibility is limited. This suggests that while external monetary spillovers are significant across small open European economies, the extent to which these disturbances translate into domestic inflation dynamics may depend on how the exchange rate regime conditions the adjustment process.

2.3 Shock dependence and Inflation Transmission in Sweden and Denmark

For Sweden, Corbo & Di Casola (2018, 2022) provide the most comprehensive structural account of CPIF inflation dynamics. Using a structural Bayesian VAR, they find that Swedish CPIF inflation is predominantly conditioned by external shocks rather than domestic factors, with global shocks collectively explaining close to half of its forecast error variance. A key finding is that the relationship between exchange rate movements and CPIF is not stable across shocks. Global demand shocks generate a negative conditional pass-through, as weak demand conditions dominate the exchange rate cost channel. Domestic monetary policy shocks are found to generate the highest positive pass-through to CPIF. When the Riksbank eases, domestic demand strengthens while the krona depreciates simultaneously, creating conditions under which firms both face higher import costs and have the pricing power to pass them on. Furthermore, in an extended model that separately identifies foreign monetary policy shocks, Corbo & Di Casola show that tightening abroad transmits to Swedish CPIF through exchange rate and financial conditions independently of domestic policy. Swedish inflation is therefore not only shaped by Riksbank decisions but by the broader monetary environment in which those decisions are made, with the transmission mechanism fundamentally dependent on the origin of the shock driving the exchange rate.

In contrast, the literature on Denmark emphasises inflation transmission under a fixed exchange rate regime rather than conventional exchange rate pass-through. Denmark's long-standing peg to the euro under ERM-II implies that monetary policy closely follows that of the European Central Bank (ECB), limiting domestic monetary autonomy (Spange & Sørensen, 2017). As a result, exchange rate fluctuations play a limited role in domestic inflation dynamics and price developments are instead largely driven by imported Euro Area monetary conditions. Larsen & Weissert (2024) provide direct empirical evidence of this, finding that a one percentage point increase in ECB policy rates reduces Danish consumer prices by around one percent after one year, with the appreciation of the krone against non-euro currencies playing a key role by lowering the price of imported goods. Furthermore, the credibility of the fixed exchange rate regime has further been shown to dampen pass-through by reducing exchange rate volatility and limiting the role of the exchange rate as an adjustment mechanism (Spange & Toftdahl, 2014). More broadly, Denmark illustrates how exchange rate regime choice fundamentally alters the transmission of external shocks. Under a fixed regime, exchange rate movements do not act as a buffer, and instead shocks are transmitted directly through domestic prices, output, and financial conditions. Inflation and economic activity become strongly influenced by Euro Area developments, reflecting a close alignment of Danish monetary policy with that of the ECB (Spange & Sørensen, 2017; Kristoffersen & Spange, 2016, 2017). The Danish case suggests that exchange rate pass-through is structurally limited under a credible fixed exchange rate regime, with inflation dynamics instead driven by imported monetary conditions and external shocks. Denmark therefore provides a useful benchmark for assessing the role of monetary autonomy in shaping ERPT in small open economies.

The contrast between these two strands of literature points to a broader question regarding the role of monetary autonomy in shaping inflation dynamics. Sweden and Denmark share similar economic structures and deep integration with the Euro Area. Yet, their monetary regimes generate different transmission mechanisms, with the floating krona allowing external shocks to be partly absorbed through exchange rate adjustment, while the Danish peg shifts a greater share of the adjustment toward domestic prices and monetary conditions. Despite this contrast, the existing literature has largely examined each economy in isolation, leaving comparatively underexplored how exchange rate regime choice conditions ERPT and inflation transmission when economies are exposed to common regional and global shocks. Examining this requires an empirical framework capable of jointly modelling international spillovers, common global shocks and heterogeneous transmission dynamics across interconnected economies.

2.4 Global Vector Autoregressive Models

Standard VAR and structural VAR approaches, while well suited to identifying shocks within single economies, e.g. Forbes et al. (2018, 2020), are less able to capture international interdependencies directly. The Global Vector Autoregressive (GVAR) framework developed by Pesaran et al. (2004) addresses this by linking country-specific models through trade-weighted foreign variables, allowing shocks originating in one economy to propagate across countries while preserving heterogeneous domestic dynamics. Feldkircher (2015) and Feldkircher et al. (2016), using a GVAR and Bayesian GVAR, show that US monetary-, demand- and supply shocks generate substantial global spillovers across economies through interconnected trade and financial channels. Within a European context, Hájek & Horváth (2016) apply the GVAR framework to examine Euro Area spillovers to Central and Southeastern European economies, finding that several Central European countries respond almost as strongly to Euro Area shocks as the Euro Area itself. Their 2018 study extends this framework, examining spillovers from both ECB and Fed monetary policy and finding significant effects on output and prices, though more limited transmission of Euro Area price shocks to non-euro economies. While these studies establish the GVAR as a useful framework for analysing monetary spillovers in Europe, they do not examine ERPT as a transmission mechanism, nor do they exploit the contrast between floating and fixed exchange rate regimes as an analytical device. Our study builds on this literature by examining how exchange rate regime choice conditions both exchange rate pass-through and inflation transmission under common regional and global shocks using a GVAR model, outlined in Section 4.

3 Data

To study inflation dynamics in Denmark and Sweden, we use quarterly macroeconomic data following Hájek & Horváth (2016) and Feldkircher (2015), spanning 2000Q1–2024Q4.[1] The data was downloaded for five economies: United States, Euro Area (EA), Sweden, Denmark and Norway. Since our aim is to capture the spillover effects with regard to Sweden and Denmark primarily, our choice of countries/economic regions were selected based on their economic significance in relation to trade and economic integration. Sweden and Denmark trade primarily with countries within the Euro Area which in turn is heavily influenced by the United States. The United States thus acts as a global anchor driving changes in the macro economy. Thus, the United States offers a valuable transmission mechanism of global economic shocks, which can be passed down to the Euro Area and in turn to Sweden and Denmark. An important note is that Euro Area, in accordance with Hájek & Horvàth (2016, 2018) and Dees et al. (2007), is treated as a single entity in order to facilitate a monetary policy shock originating from the Euro Area. The inclusion of Norway is based on two factors. First, the GVAR framework benefits from a broader cross-sectional dimension as this allows the model to better capture foreign influences and regional spillovers affecting Sweden and Denmark, as outlined in section 3.1. Norway is therefore a natural addition given its close economic integration with the Nordic region, its role as a large trade partner for both Sweden and Denmark, and its contribution to the cross-sectional dimension of the model, which improves the stability of the GVAR system, as further discussed in Sections 3.1 and 5.1.

The seasonally adjusted Real Gross Domestic product (GDP) series was downloaded from FRED's data base in domestic currency. In order to maintain cross-country comparability we indexed the GDP-series by setting 2015 as the base year. An important note is that the majority of published GVAR-literature uses the Industrial Production Index (IPI) as the measure of economic output. However, as the economic contribution of the service sector has increased over time, and since the IPI is more closely tied to manufacturing and goods-producing sectors, GDP is a more comprehensive proxy for overall economic activity and is therefore preferred in this study. This choice slightly reduces the direct comparability of our results with earlier studies using IPI, but improves the relevance of the output measure for modern service-oriented economies.

The Consumer Price Index (CPI) series was downloaded from the International Monetary Fund (IMF) database, where the Harmonised index was downloaded for the European economies, in order to increase cross-country comparability. In addition, the CPI-series was log-transformed and seasonally adjusted[2] and rebased on 2015, enabling as-good-as possible cross-country comparison of the CPI series.

The interest rates were retrieved from the OECD database and include the 3-month and 10-year yields, expressed in percent per annum. The short rate functions as a proxy for the monetary policy stance, as it is closely linked to central bank policy rates. The long-

[1] The sample begins in 2000Q1 to ensure data stability following the adoption of the Euro and ERM-II in 1999, as some European economies exhibited increased volatility during the 1990s, noted by Hájek & Horváth (2016)

[2] The seasonal adjustment of the CPI series was done using the X13 package in R (Sax & Eddelbuettel, 2018).

term interest rate, on the other hand, reflects broader financial conditions and embeds market expectations regarding future inflation, economic activity, and the future path of monetary policy. However, as shown in Table 1, the chosen time period includes the zero lower bound period. This covers the period from 2015Q1 to 2022Q2 for Sweden, Denmark, and the Euro Area. The presence of zero lower bound observations is therefore acknowledged as a limitation in Section 7.2.

The nominal bilateral exchange rate series was retrieved from the Bank for International Settlements (BIS) and is measured as the domestic currency vis-à-vis the Euro.[3] Using the euro as the numeraire currency allows us to compare exchange rate pass-through and inflation transmission across economies while preserving the relationship between each domestic currency and a common third currency. This provides a consistent exchange rate measure across the country-specific models and ensures that the estimated responses are interpreted relative to the same external reference currency, following Pesaran et al. (2004), Dees et al. (2007), and Hájek & Horváth (2016, 2018). An important implication is that the resulting pass-through measures are based on bilateral exchange rate movements against the euro, rather than on effective exchange rate movements. The estimates may therefore differ from studies using trade-weighted exchange rate indices, a point we return to in Section 6.

Lastly, crude oil price data were retrieved from FRED and used to construct a global oil price measure. In the baseline specification, we use the average of Brent and West Texas Intermediate (WTI), reflecting their role as key benchmark prices for European and US oil markets, respectively.[4] The resulting series was indexed to 2015 and seasonally adjusted to ensure comparability with the remaining variables and to avoid introducing additional scale differences into the analysis.

[3] The reader should note that the exchange rate is defined such that an increase denotes an appreciation of the domestic currency against the euro.

[4] As a robustness check, we also constructed an alternative average crude oil price series including Dubai crude. The results remained robust.

Variable	Description	Domestic	Foreign	Global	Min.	Max	Mean	Observations
y	Gross Domestic Product, average of 2015=100. Seasonally adjusted, in logarithms.	♦	♦	♢	4.271	4.832	4.568	100
π	Consumer price index, average of 2015=100. Seasonally adjusted, in logarithms.	♦	♦	♢	4.275	4.915	4.568	100
s	Nominal exchange rate vis-à-vis the Euro, in logarithms.	♦	♦	♢	-2.465	0.142	-1.322	100
sr	Short Term Interest Rates (3 month maturity), rates per annum.	♦	♦	♢	-0.777	7.457	2.014	100
lr	Long Term interest Rates (10 year maturity), rates per annum.	♦	♦	♢	-0.493	6.753	2.914	100
oil	Average price of crude oil. Seasonally adjusted, in logarithms.	♢	♢	♦	2.999	4.798	4.082	100

Table 1: Data Description

The table reports the minimum, maximum, and mean values for each variable, together with an outline of the transformation applied before estimation. ♦ indicates that the variable is included in the corresponding block, while ♢ indicates that it is not included. *Source: Authors' rendering of IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

3.1 Trade Weights

In accordance with the GVAR-literature we constructed the foreign variables based on the annual bilateral international trade flows between the economies, in accordance with Hájek & Horváth (2016). The trade data was downloaded from IMF database for bilateral trade by country partner covering the export data and import data. Using the trade data the trade weights at time t are defined as:

$$w_{ij,t} = \frac{Trade_{ij,t}}{TotalTrade_{i,t}}, \qquad \forall i \neq j$$

where the $Trade_{ij,t}$ denotes the bilateral export from country i to country j at time t and $TotalTrade_{i,t}$ denotes country i's total trade with all economies in the GVAR-model.[5]

Based on Figure 8 in Appendix A, the trade weights for each country's trading partners remain stable over time, with the United States and the Euro Area consistently accounting for the largest trade shares in our sample. In accordance with the GVAR methodology of Pesaran et al. (2004) and Hájek & Horváth (2016), we use average trade weights across the entire sample period, as this reduces undesirable year-to-year variation in bilateral

[5]To maintain as consistent comparison between the economies as possible we only created the trade weights from bilateral export data as import data pose the risk of mixing different expenditure approaches.

trade flows. Furthermore, using average trade weights allows the foreign variables to reflect the historically persistent economic relationships between the countries, rather than temporary fluctuations, capturing the medium- to long-run interdependence underlying the GVAR-system. This choice also improves transparency, as the weighting scheme is based on the full sample period which avoids over reliance on a specific sub period.

	US	EA	SE	DK	NO
US	0.000	0.931	0.033	0.018	0.018
EA	0.622	0.000	0.169	0.107	0.102
SE	0.089	0.683	0.000	0.113	0.116
DK	0.077	0.666	0.175	0.000	0.082
NO	0.078	0.651	0.186	0.085	0.000

Table 2: Trade Weight Matrix

The table reports the trade weight matrix used to construct the foreign variables in the GVAR model. Each row shows the weights assigned to foreign economies for a given domestic economy. *Source: Authors' rendering of IMF bilateral trade data (2000–2024).*

Table 2 presents the trade weight matrix, constructed from the average trade weights where each row sums to one, applied in the model. There are two things worth highlighting about the trade weight matrix. Firstly, the matrix highlights the central role of the Euro Area for the Nordic economies, as it represents their largest trading partner in the sample. This captures the strong real-economy link between Sweden, Denmark, and the Euro Area, which is central to studying Euro Area shocks propagating to the economies. At the same time, the Nordic economies constitute a meaningful part of the Euro Area's trade-weighted foreign variables. Secondly, the relatively large weight assigned to the Euro Area in the US equation should also be interpreted in light of the country and region selection in the model. It does not necessarily provide a complete representation of the US trade structure in the global economy. Thus, we chose to limit the foreign influence on US and treating it as the global anchor, reducing the risk that the US block is driven by a narrowly selected set of foreign economies, causing multicollinearity. As outlined by Pesaran et al (2004) expanding the country coverage could resolve the issues with a limited country sample, as it decreases the trade weights. However, the country set is restricted to the economies most relevant for the comparison between Sweden and Denmark.[6] Since the aim of the study is not to provide a fully global representation for the country sample, but to analyse how two Nordic economies with different exchange rate regimes transmit common shocks, we prioritise the Euro Area as the key regional anchor. Although, expanding the country coverage could reduce some issues associated with a narrow trade-weight matrix, it would also increase dimensionality and risk introducing noise unrelated to the Danish-Swedish comparison. We therefore retain the current country selection, with this trade-off, with regard to cross sectional dependence and residual correlation, discussed further in Section 5.1.

[6]The country selection was further supported by computing the annual average trade with all of Sweden's and Denmark's trade partners, using IMF database, confirming the current set of countries.

4 Methodology

To examine inflation transmission dynamics between Sweden and Denmark, this thesis adopts a GVAR-framework as outlined in Section 2.4. The GVAR enables the modelling of country-specific dynamics while allowing foreign variables to enter each domestic model, thereby capturing international interdependencies without estimating an overly parameterised unrestricted VAR-model. This is particularly important given the limited time-series dimension of macroeconomic data. The framework therefore allows for cross-country comparison and spillover analysis while preserving economic interpretability. In the following sections 4.1–4.3, our methodology is based on Pesaran et al. (2004), Dees et al. (2007) and Hájek & Horváth (2016).

4.1 Single country VECM

As noted in Pesaran et al. (2004), even for a moderate number of countries, data limitations make it infeasible to estimate all parameters jointly in one stacked GVAR system. Therefore, estimation proceeds in a first step by specifying and estimating separate country-specific VECM-X models. For each country i in a global system of $j + 1$ countries, the starting point is a country-specific VECM-X model for the domestic variables, X_{it}, which includes the weakly exogenous foreign vector, X^*_{it}, and an exogenous block, W_{it}. The VECM-X specification captures both the short-run dynamics through variables in first differences and the long-run equilibrium relations through the error-correction terms. Thus, each country model consists of two main blocks: the domestic block, X_{it}, containing k_i endogenous variables, and the foreign block containing h_i weakly exogenous foreign variables, as outlined in Equation (1).

$$\Delta X_{i,t} = a_{i,0} + \sum_{p=1}^{P_i} \Phi_{i,p} \Delta X_{i,t-p} + \sum_{q=0}^{Q_i} \Lambda_{i,q} \Delta X^*_{i,t-q} + \alpha_i ECT_{i,t-1} + \sum_{r=0}^{R_i} \Psi_{i,r} \Delta W_{i,t-r} + \varepsilon_{it} \quad (1)$$

The foreign variables are constructed as weighted averages of the corresponding variables for all other countries:

$$X^*_{it} = \sum \omega_{ij} X_{jt}, \qquad \sum_{i \neq j} \omega_{ij} = 1, \qquad \omega_{ii} = 0$$

This aggregation is the central feature of the GVAR framework. Rather than allowing each foreign variable to enter directly and separately into each country-specific model, which would substantially reduce the degrees of freedom, the weighted foreign variables provide a parsimonious way of capturing cross-country linkages. The weights, ω_{ij}, are collected in the link matrix, where each row summarizes the bilateral economic connections between countries i and j. The foreign block captures country-specific exposure to external macroeconomic conditions and provides the main channel through which shocks are transmitted across economies in the system. For a small open economy such as Sweden, the weighting structure allows external developments to affect domestic variables more strongly than Swedish shocks affect larger economies. This reflects the asymmetric properties of international macroeconomic linkages captured by the GVAR framework, well suited for modelling small open economies.

Furthermore, Equation (1) contains the error correction term (ECT) for each economy i, denoted as $ECT_{i,t-1}$. In economic terms, the ECT represents the extent to which the variables deviate from their long-run equilibrium relation, with the adjustment coefficients determining how these disequilibria are corrected over time. The ECTs are usually determined from Johansen cointegration testing (Johansen, 1988), per Pesaran et al. (2004) and Dees et al. (2007), but as outlined in Section 5.2.1 we impose the ranks based on economic theory. The error correction vector can be decomposed as

$$ECT_{i,t-1} = \beta_i' X_{i,t-1} + d_i(t-1), \qquad ECT_{i,t-1} \in \mathbb{R}^{r_i \times 1}, \qquad \beta_i' X_{i,t-1} \in \mathbb{R}^{r_i \times 1}$$

where β_i contains the cointegrating vector of $X_{i,t-1}$ and $d_i(t-1)$ denotes potential restricted trend and constants in the long-run equilibrium. Thus, the ECT links the short-run dynamics of the VECM-X model to economically motivated long-run equilibrium conditions.

Lastly, the country-specific VECM-X specification in Equation (1) includes a strictly exogenous block, $\sum_{r=0}^{R_i} \Psi_{i,r} \Delta W_{i,t-r}$, containing global variables. In our study we limit it to the average price of oil. Oil prices are treated as strictly exogenous to the individual country models and are allowed to follow an external disturbance process (Pesaran et al., 2004). The oil shock is further discussed in Section 6.5.3.

Equation (1) is estimated for each individual economy, where we let Bayesian Information Criteria (BIC) determine each economy's individual lag order for the domestic and foreign block, before they are stacked into a global systems, outlined in the following section. The individual country variables, lag selection, and model restrictions are further described in Section 5.

4.2 Global Representation

After estimating the country-specific VECM-X models, the estimated parameters are stacked into a global representation. This step is central to the GVAR framework, as it reflects the idea that economies do not adjust in isolation. Domestic variables respond not only to internal disequilibria, but also to developments abroad, while each country's own adjustments may in turn affect other economies through trade and financial linkages.

Formally, linkages allow shocks originating in economy i to propagate to economy j and, in turn, generate feedback effects through the global system. In order to stack the system we start by defining:

$$X_t = \begin{pmatrix} X_{i,t} \\ X_{i+1,t} \\ \vdots \\ X_{j+1,t} \end{pmatrix} \in \mathbb{R}^{\kappa \times 1} \qquad \kappa = \sum_i k_i$$

Then there exists a selection matrix, S_i[7] which can be utilised as an operator to find the economy i, $X_{it} = S_i X_t$. Additionally, the foreign variables can be written as weighted averages of the corresponding variables in the remaining economies:

$$X^*_{it} = \sum_{j \neq i} \omega_{ij} X_{jt}.$$

. Using these definitions we can rewrite Equation (1):

$$\begin{aligned} \Delta X_{i,t} = a_{i,0} + \sum_{p=1}^{P_i} \Phi_{i,p} S_i \Delta X_{t-p} + \sum_{q=0}^{Q} \Lambda_{i,q} \Delta X^*_{i,t-q} \\ + \alpha_i \beta_i' X_{i,t-1} + \alpha_i d_i(t-1) + \sum_{r=0}^{R_i} \Psi_{i,r} \Delta W_{i,t-r} + \varepsilon_{it}. \end{aligned} \tag{2}$$

Equation(2)can then be stacked into the global representation of Equation(1).

$$\Delta X_t = C_0 + \sum_{p=1}^{P} \Phi_p \Delta X_{t-p} + \sum_{q=0}^{Q} G_q \Delta X_{t-q} + \Pi X_{t-1} + \delta(t-1) + \sum_{r=0}^{R} \Psi_r \Delta W_{t-r} + u_t. \tag{3}$$

The global representation in Equation(3) consists of five distinct parts. Firstly, the intercepts, C_0, are stacked as a $\kappa \times 1$ vector of the individual economies' intercepts. Secondly, the domestic block is stacked into the block diagonal matrix

$$\Phi_p = \text{blkdiag}(\Phi_{1,p}, \Phi_{2,p}, \ldots, \Phi_{N,p}), \qquad \Phi_p \in \mathbb{R}^{\kappa \times \kappa}.$$

The matrix Φ_p contains the country-specific coefficients on the lagged domestic differences and captures the short-run domestic dynamics within each economy. Since Φ_p is block diagonal, these dynamics are modelled separately within each country block, while cross-country interactions enter through the stacked foreign-variable block, G_q.

The stacked foreign-variable block, G_q, captures the weighted foreign aggregates entering each country-specific model and is constructed from the bilateral trade weights and the corresponding foreign-variable coefficients, $\Lambda_{i,q}$. Through these trade-weighted foreign variables, movements in one economy enter the foreign-variable blocks of other economies according to the bilateral trade linkages. The G_q matrices therefore constitute the main

[7] Selection matrix is a matrix that picks out the entries of a stacked vector

cross-country transmission mechanism in the GVAR system, allowing domestic shocks to propagate internationally through the estimated responses to foreign developments.

Fourthly, the error-correction terms are stacked accordingly as

$$\Pi X_{t-1} = \begin{pmatrix} \alpha_i \beta_i' S_i \\ \alpha_{i+1} \beta_{i+1}' S_{i+1} \\ \vdots \\ \alpha_{j+1} \beta_{j+1}' S_{j+1} \end{pmatrix} X_{t-1}, \qquad \delta(t-1) = \begin{pmatrix} \alpha_i d_i (t-1) \\ \alpha_{i+1} d_{i+1} (t-1) \\ \vdots \\ \alpha_{j+1} d_{j+1} (t-1) \end{pmatrix},$$

where both ΠX_{t-1} and $\delta(t-1)$ are $\kappa \times 1$ column vectors. This stacked block captures how each economy adjusts when domestic variables deviate from their imposed long-run equilibrium relationships.

Lastly, the exogenous block is stacked into ΔW_{t-r}, where Ψ_r captures how changes in the global exogenous variables affect domestic variables throughout the system.

4.3 Impulse Response Function

To examine how domestic, regional and global shocks propagate through the interconnected economies in the GVAR system, we derive Impulse Response Functions (IRFs) from the stacked global representation in Equation(3). The IRFs allow us to trace the dynamic responses of inflation, exchange rates and interest rates following identified shocks, thereby providing the main framework for analysing exchange rate pass-through and inflation transmission in Sweden and Denmark under different monetary regimes. We utilise both Generalised- and Orthogonal Impulse Response Functions (GIRF and OIRF, respectively). In order to propagate a shock through the system, Equation(3) can be rewritten into the reduced form by multiplying each matrix with $(I - G_0)^{-1}$. Premultiplying with $(I - G_0)^{-1}$ solves out the simultaneity and yields the following reduced form system:

$$\Delta X_t = \tilde{C}_0 + \sum_{p=1}^{P} \tilde{\Phi}_p \Delta X_{t-p} + \sum_{q=1}^{Q} \tilde{G}_q \Delta X_{t-q} + \tilde{\Pi} X_{t-1} + \tilde{\delta}(t-1) + \sum_{r=0}^{R} \tilde{\Psi}_r \Delta W_{t-r} + \tilde{u}_t \quad (4)$$

For simplicity we can ignore the deterministic blocks, and rewrite Equation (4) into the following.

$$\Delta X_t = \sum_{j=1}^{L} B_j \Delta X_{t-j} + \tilde{\Pi} X_{t-1} + v_t \qquad B_j \equiv \tilde{\Phi}_p + \tilde{G}_q, L = max\{P, Q\} \quad (5)$$

To study how a shock affects the system over time, the global model must be rewritten in a form that makes the dynamic propagation explicit. This is done by expressing the model in first-order companion form, where the relevant current and lagged variables are collected in the state vector, $\mathbb{S}_t$.[8] For convenience when deriving impulse response functions, we assume that $L = 1$. Our state vector can then be written $\mathbb{S} = \begin{pmatrix} X_t \\ \Delta X_t \end{pmatrix}$ and by utilising the relation of $X_t = X_{t-1} + \Delta X_t$ we can write Equation(5), when $L = 1$ to:

$$X_t = X_{t-1} + B_1 \Delta X_{t-1} + \tilde{\Pi} X_{t-1} + v_t = (I + \tilde{\Pi}) X_{t-1} + B_1 \Delta X_{t-1} + v_t$$

By using our identified state vector for $L = 1$ we can expand the state vector expression to:

$$\mathbb{S}_t = \begin{pmatrix} X_t \\ \Delta X_t \end{pmatrix} = \underbrace{\begin{pmatrix} I + \tilde{\Pi} & B_1 \\ \tilde{\Pi} & B_1 \end{pmatrix}}_{F} \begin{pmatrix} X_{t-1} \\ \Delta X_{t-1} \end{pmatrix} + \underbrace{\begin{pmatrix} J \\ J \end{pmatrix}}_{\Upsilon} v_t.$$

Hence, the state-space representation becomes

$$\mathbb{S}_t = F \mathbb{S}_{t-1} + \Upsilon v_t \tag{6}$$

Equation(6) consists of the Companion Matrix, F, and the shock loading matrix, Υ. The Companion Matrix [9] is a $2\kappa \times 2\kappa$ block matrix consisting of submatrices $n \times n$ which tells how X_t and ΔX_t jointly determine the current state, $\begin{pmatrix} X_t & \Delta X_t \end{pmatrix}'$. The shock loading matrix, $\Upsilon = \begin{pmatrix} J & J \end{pmatrix}'$, is a $2\kappa \times \kappa$ matrix that works as the bridge for the system and J is an identity matrix of $\kappa \times \kappa$. Consequently, the companion form admits the vector moving average representation:

$$\mathbb{S}_t = \sum_{h=0}^{\infty} F^h \Upsilon v_{t-h}$$

which expresses the current state as the accumulated effect of current and past shocks. This representation forms the basis for the impulse response analysis, since the response at horizon h is obtained from the matrix product of $F^h \Upsilon$.

The companion-form representation in Equation(6) provides the common propagation mechanism for shocks in the global system. The remaining issue for impulse response analysis concerns how the innovations, v_t, are interpreted and transformed. We therefore distinguish between GIRFs, which are invariant to the ordering of variables, and OIRFs, which rely on an orthogonalisation of the reduced-form innovations. The following sections 4.3.1 – 4.3.2 outlines both approaches.

[8] A state vector collects the variables needed to describe the dynamic position of the system at a given point in time. In this case, it contains both the level of the global vector, X_t, and its first difference, ΔX_t, so that the VECM can be written in first-order companion form.

[9] For our results, in Section 6, we have rewritten the companion matrix, F, in terms of a VAR(2) representation, by defining our state vector, $\mathbb{S}_t = \begin{pmatrix} X_t \\ X_{t-1} \end{pmatrix}$. Consequently, the Companion matrix can be written as

$$F = \begin{pmatrix} A_1 & A_2 \\ I & \mathbf{0} \end{pmatrix}, \qquad A_1 = I + \Pi + B_1 \quad A_2 = -B_1$$

4.3.1 Generalised Impulse Response Function

The GIRF is commonly adopted in the GVAR-literature as it is invariant to variable ordering, utilised by Pesaran & Shin (1998) and Pesaran et al. (2004). However, an important caveat is that the GIRF is a reduced-form innovation of the variance-covariance matrix, $\Sigma_v = Var(v_t) = (I - G_0)^{-1}\Sigma_u[(I - G_0)^{-1}]'$, allowing all variables to move contemporaneously. As a result, GIRFs do not permit a structural decomposition of shocks. Thus, while the GIRF captures the interconnected dynamics of small open economies, the contemporaneous correlation of residuals limits its usefulness for identifying the specific transmission mechanisms examined in this study. However, we still use it for two reasons. Firstly, it provides a good informal diagnostic tool for the dynamic behaviour of the model. For example, in a well estimated model a shock in a SOE will, in a GIRF setting, have limited effects on a large open economy (LOE). Secondly, the GIRF is used as a robustness check for the dynamic transmission patterns obtained from the OIRF, rather than as an alternative structural identification strategy.

4.3.2 Orthogonal Impulse Response Function

Although GIRFs are useful for analysing the dynamic behaviour of the system without imposing an ordering structure, they do not distinguish between structurally different shocks. To identify specific transmission channels, we therefore rely on OIRFs, where the contemporaneous structure is identified through a Cholesky decomposition, outlined in Section 4.5. The Cholesky decomposition imposes a recursive contemporaneous structure. Variables ordered earlier may affect variables ordered later within the same quarter, whereas variables ordered later are restricted from contemporaneously affecting variables ordered earlier. Consequently, the imposition of these zero restrictions is not merely a procedural step but a substantive application of economic theory. As Stock & Watson (2001) highlight, the OIRF is highly sensitive to ordering as the chosen ordering imposes specific contemporaneous restrictions that can significantly shape the resulting impulse responses.

From the reduced form companion matrix in Equation (6) we noted with the GIRF components of v_t can be contemporaneously correlated, meaning a shock generally co-moves with shocks to other variables. Thus, in order to identify a shock, we isolate mutually correlated shocks using a Cholesky decomposition:

$$\Sigma_v = PP'$$

where P is lower triangular. This means the first variable is contemporaneously exogenous to the variables ordered after it, while later variables may respond contemporaneously to earlier ones. The reduced-form shock becomes: v_t as $v_t = P\xi_t$, where $var(\xi_t) = I$. Our vector moving average process can be written as:

$$\mathbb{S}_t = \sum_{h=0}^{\infty} F^h \Upsilon P \xi_{t-h} \tag{7}$$

The impulse responses used in Section 4.4 refer generically to the dynamic responses obtained from the stacked GVAR system. Depending on the identification strategy, these responses are computed either as GIRFs or OIRFs.

4.4 Measuring ERPT and Inflation Transmission

The ERPT at horizon h is defined in Equation (8), as the cumulative CPI IRF over horizon h following an exchange rate shock. As discussed in Section 2.3, this measure is straightforward to interpret for Sweden, but less so for Denmark, where the ERM-II peg implies very limited exchange rate movement and can therefore produce mechanically high or difficult-to-interpret ERPT values relative to a floating regime. For Denmark, the relevant external transmission mechanism is instead the direct pass-through of regional or global cost- and price shocks into domestic consumer prices, since the exchange rate channel is largely closed.

$$ERPT(h) = \sum_{t=0}^{h} \Delta\pi_t \tag{8}$$

Thus, an ERPT for Sweden will be straightforward from the definition of ERPT in Equation (8). However, it should be noted that whenever the shock is not an exchange rate shock, the impact no longer only reflects exchange rate changes. Instead, as outlined by Ortega & Osbat (2020), Equation (9) then reflects the co-movement between CPI and the exchange rate through other transmission channels, such as monetary policy shocks. In this case, we refer to the measure as the Price-to-Exchange-Rate Ratio (PERR). However, the exchange shock on itself could also exhibit different levels of persistence, meaning a PERR measure can also be applied (Corbo & Di Casola, 2022). The PERR is defined in Equation (9) as the ratio of the cumulative CPI IRF over horizon h over the cumulative exchange rate IRF over horizon h:

$$PERR(h) = \frac{\sum_{j=0}^{h} IRF_{\pi}^{(h)}}{\sum_{j=0}^{h} IRF_{s}^{(h)}} \tag{9}$$

For Denmark we have to consider the structural difference with respect to the exchange rate. Recall, in a floating regime, ERPT reflects how much exchange-rate movements are absorbed before reaching domestic prices. Consequently, while Denmark's monetary policy autonomy is significantly more restricted than Sweden's, its domestic price levels still remain highly sensitive to monetary policy decisions made in the Euro Area, which are effectively imported through the currency peg. We therefore measure inflation transmission as the relative cumulative response of domestic inflation to a shock originating in economy j, compared with the cumulative inflation response in the shock-originating economy itself. This captures the degree of co-movement between inflation in country i and inflation in economy j following the same shock. In this sense, the measure can be interpreted as an inflation-spillover ratio, in Equation (10).

$$IT_i(h) = \frac{\sum_{j=0}^{h} IRF_{\pi_i}^{h}(\text{j shock})}{\sum_{j=0}^{h} IRF_{\pi_j}^{h}(\text{j shock})} \tag{10}$$

For our results in Section 6 we use Equation (10) for both shocks originating in US and EA. The relevant interpretation of these measures depends on the shock being considered. For Sweden, exchange rate shocks provide the most direct measure of ERPT, whereas other structural shocks reflect broader price-to-exchange-rate co-movements. For Denmark, the fixed exchange rate regime shifts the focus toward inflation transmission from the Euro Area. The next section 4.5 therefore introduces the structural shock identification used to capture these mechanisms within the GVAR framework.

4.5 OIRF Country and Variable Ordering

4.5.1 Country Ordering

The country and variable ordering defines the contemporaneous transmission structure of the GVAR, determining which economies and variables are allowed to respond contemporaneously to each shock. Thus, in order to identify the correct transmission dynamics we consider both country and variable ordering.

Firstly, the country ordering stems from the size of the economy, influence on the global system and economic integration. In our model specification we treat United States as the most exogenous country in accordance with Pesaran et al. (2004) and Dees et al. (2007). Since the Euro Area is the second largest economy and the primary driver of monetary transmission in our system we place it after the US. Aligned with SOE assumptions outlined by Forbes et al. (2018), we treat the Nordic countries as price takers and therefore place them last. However, among the small open economies, Sweden and Denmark are ordered before Norway, aligned with Ellen et al. (2020) findings that Norway is least integrated. Sweden, the largest of the three economies, while inflation-targeting, maintains deep trade and financial linkages with the Euro Area and is a primary case of interest in this study and therefore ordered first. Although Norway's nominal GDP exceeds that of Denmark, our ordering must also reflect the degree of monetary and financial integration with the Euro Area. Denmark's participation in ERM-II renders its monetary policy endogenous to ECB decisions, making it the most tightly integrated between the two. Norway, whose macroeconomic dynamics are significantly shaped by commodity revenues and a floating exchange rate, is the least integrated of the three and is consequently ordered last.

This ordering is also supported by the trade weights reported in Table 2. Sweden has the strongest trade linkages with both the Euro Area and the United States among the Nordic economies, followed by Denmark and Norway. The ordering therefore reflects the expected direction of contemporaneous transmission in the system: shocks from larger and more central economies are allowed to affect smaller open economies contemporaneously, while feedback from the Nordic economies to the larger economies is assumed to occur only with a lag. Thus, our baseline country ordering is:

$$US \rightarrow EA \rightarrow SE \rightarrow DK \rightarrow NO$$

Furthermore, we consider two alternative specifications to our baseline country ordering. First, although Sweden is placed before Denmark in the baseline specification due to its larger economy and stronger trade weights, Denmark's ERM-II participation provides an alternative rationale for ordering Denmark first among the Nordic economies, given its strong nominal linkages to the Euro Area. Secondly, aligned with the literature SOE:s we consider a variable-by-variable ordering between the three Nordic economies, allowing contemporaneous effects between each other. The results of the different orderings are further discussed in Section 6.5.

The next step is to define the ordering of the variables within each country block. The established country ordering governs the contemporaneous transmission of shocks across economies, while the variable ordering determines the within-country structure. We consider two different recursive orderings.

4.5.2 Specification 1: Exchange Rate Pass-Through Identification

The first specification is constructed in order to study how exchange rate fluctuations transmit onto domestic prices. We order the domestic variables as:

$$\text{GDP} \rightarrow \text{SR} \rightarrow \text{LR} \rightarrow \text{Exchange Rate} \rightarrow \text{CPI}$$

GDP is ordered first, as real economic activity is conventionally assumed to adjust slowly and is therefore not contemporaneously affected by financial or nominal variables within a quarter, a restriction standard in the VAR literature. The short-rate (SR) and long-rate (LR) follow, consistent with Ito & Sato (2008) and Sims & Zha (2006), who allow policy rates to respond contemporaneously to output developments. The long rates follow that of the short rates, in accordance with the term structure (Campbell & Shiller, 1984; Engle & Granger, 1987). The bilateral exchange rate is placed after the policy rates, permitting monetary policy shocks to feed immediately into the exchange rate. This sequencing is appropriate for isolating the pass-through channel from exchange rate to prices. CPI is ordered last, reflecting the well-established empirical regularity that price levels respond to monetary and exchange rate shocks with a lag (Ito & Sato, 2008). This ordering allows us to trace the complete transmission chain from interest rates through the exchange rate to domestic inflation.

4.5.3 Specification 2: Monetary Policy Shock Identification

The second specification is constructed to identify monetary policy and price shocks. Here, the ordering follows:

$$\text{GDP} \rightarrow \text{CPI} \rightarrow \text{SR} \rightarrow \text{LR} \rightarrow \text{Exchange Rate}$$

In this specification, GDP and CPI are placed before the policy rates, reflecting the assumption that the central bank observes current output and inflation conditions when setting the interest rate, following the convention of standard monetary VAR literature (see Christiano et al., 1998). The short rate is treated as the instrument of monetary policy and responds contemporaneously to macroeconomic conditions but not to the exchange rate within the same period (McCarthy, 2007). The long rate and the exchange rate are ordered last, as they are assumed to respond contemporaneously to the policy rate signal. This ordering ensures that the identified monetary policy shock is orthogonal to contemporaneous information in output and prices, thereby satisfying standard exogeneity requirements for policy shock identification.

4.6 Identifying Shocks

In order to capture the ERPT, PERR and inflation dynamics the analysis distinguishes between shock origin based on both country and macroeconomic variables. Following Hájek & Horváth (2016), we classify the identified disturbances into four categories: domestic-, regional-, global- and oil shocks. The first three categories correspond to shocks originating within the domestic economy, the Euro Area and the United States, respectively. Oil shocks are considered separately and primarily serve as a diagnostic benchmark for evaluating the model's transmission dynamics.

For the domestic specification, we consider two shocks: an exchange rate appreciation and a monetary tightening shock. As outlined in Section 4.4 these only apply to Sweden and the respective ERPT/PERR measures are based on Equations (8) and Equation (9). The domestic analysis serves two purposes: firstly, we aim to validate our model in relation to the previous literature's findings. Secondly, to create a comparative framework for the succeeding PERR estimates following the regional and global shocks. Based on previous findings, e.g. Corbo & Di Casola (2022), Forbes et al. (2018, 2020), we expect Sweden to exhibit incomplete pass-through following both an exogenous appreciation of the exchange rate and the shock-dependent pass-through following a monetary policy tightening.

Secondly, the regional specification focuses on shocks originating in the Euro Area and their transmission to Sweden and Denmark through the GVAR system. Following Hájek & Horváth (2016), we examine two regional disturbances: a Euro Area monetary-policy tightening and a Euro Area CPI shock. These shocks allow us to compare Sweden's and Denmark's responses to a common regional anchor within the same international framework. The regional results serve two purposes. First, they allow us to examine whether exchange rate regime choice conditions inflation transmission from the Euro Area, where the literature suggests stronger and more immediate transmission under fixed exchange rate regimes due to closer monetary alignment with the ECB (Spange & Sørensen, 2017; Ellen et al., 2020). Consequently, we expect Denmark to exhibit stronger and faster CPI transmission than Sweden following Euro Area shocks. Second, regional shocks extend the shock-dependent ERPT literature by allowing comparison between domestically and externally originating monetary disturbances. In line with Forbes et al. (2018, 2020), we therefore expect the PERR following Euro Area shocks to be weaker than following domestic monetary-policy shocks.

Thirdly, the global shocks are defined as originating from the United States, consistent with the layered international transmission structure described by Miranda-Agrippino & Rey (2020). We examine two global disturbances: a Federal Reserve monetary policy tightening and a United States CPI shock. Both shocks allow us to examine whether the shock-dependent transmission mechanisms identified at the regional level also hold when the origin of the disturbance is global. In addition, global shocks contextualise the relationship of Sweden and Denmark with the Euro Area by treating it as a regional intermediary. This allows us to assess not only whether Sweden and Denmark respond differently to the same global impulse, but also how their regime-specific relationship to the Euro Area shapes the transmission of shocks originating outside the region. Given Denmark's tighter monetary and financial integration with the Euro Area, we expect the global shocks to generate responses similar to the regional shocks, with stronger inflation transmission than Sweden. Additionally, we expect the similar results of PERR as in the regional shock.

Lastly, we consider oil shocks as a model diagnostic benchmark for two reasons. First, oil-price shocks are of clear macroeconomic relevance given their broad effects on global output, inflation and financial conditions (Pesaran et al., 2004). Second, since the transmission of oil shocks is well documented in the literature, they provide a useful benchmark against which to evaluate the plausibility of the impulse responses generated by the GVAR system.

5 Estimation

5.1 Pre-estimation Diagnostics

Before estimating the country-specific VECM-X models, the variables must first undergo a series of diagnostic tests. In accordance with the established GVAR-literature we conducted multiple diagnostic tests considering stationarity, cross-sectional dependence and multicollinearity.

Firstly, we tested the stationarity of the individual variables by adopting the Augmented Dickey Fuller (ADF) tests. This constitutes an important diagnostic step, since the inclusion of unit-root variables in the stacked system may lead to explosive eigenvalues. The ADF-test presented in Table 8 and 9, in Appendix A, generally indicate that the variables are integrated of order one, with Denmark's exchange rate being the main exception. In the Danish case, ERM-II forces the exchange rate to be stationary around a policy-implied central parity. This implies that some caution is warranted when differencing the Danish exchange rate, since differencing an already stationary variable might remove valuable short-run variation. Nevertheless, we retain the differenced specification for this variable in the stacked system for consistency with the remaining country models and to facilitate the construction of the global representation. Given the institutional stability of the Danish peg, this modelling choice is unlikely to materially affect the interpretation of the Danish exchange rate channel. To asses this concern, we also estimated the same model without the Danish exchange rate variable. The main impulse responses were unchanged when excluding the Danish exchange rate variable, suggesting that the findings are not driven by the inclusion of the differenced Danish exchange rate.

Secondly, we computed the average pair-wise cross country correlation[10] for our economies. This correlation displays the average contemporaneous correlation between a country's series and the same series across all other countries. Our results from the correlation for each economy's endogenous variables in levels and differences are displayed in Table 10 in Appendix A. The results show a high general correlation for the variables in levels, underlining the high degree of economic integration for our economies. Previous studies have noted that the correlation between output and price levels is expected due to strong common trends (Pesaran et al., 2004). For example, global technology shocks, commodity prices and financial conditions constitute common trends which simultaneously affect all series. After differencing the correlation drops, but remains somewhat elevated which may be due to the moderate number of economies included in the model, a point we return to in Section 7.

Since strong cross-sectional dependence may remain in the residuals if common factors are not adequately captured, we examine the cross-country residual correlations. Table 11, in Appendix A, reports cross-country residual correlations for each variable across the five

[10]The general formula for average pair-wise cross country correlation for N countries is defined as

$$\frac{1}{N-1}\sum_{j\neq i}\operatorname{corr}(x_{i,t}, x_{j,t}),$$

country models. The results are heterogeneous across variable types, and warrant careful interpretation. For real GDP, residual correlations remain high, particularly between the US and the Euro Area and between the Euro Area and Sweden. This reflects the presence of global business cycle factors, like technology shocks, global demand shifts, and commodity price dynamics, that are not fully absorbed by the bilateral trade-weighted foreign star variables, further discussed in 5.2. However, the relatively low GDP correlations involving Norway are consistent with the oil sector's role in decoupling Norwegian output from the broader European cycle. The high GDP correlation between the US and Euro Area implies some caution is warranted when interpreting impulse responses to US versus EA output shocks, as the two economies share a residual common factor that has to be considered in the model orthogonalisation. In contrast, residual correlations for interest rates are generally low, indicating that the foreign star conditioning successfully removes common monetary policy factors from the rate equations. The negative short-rate correlation between Sweden and Denmark potentially reflects the divergent monetary policy paths and its presence in the residuals rather than being absorbed by the model confirms that idiosyncratic monetary policy is being correctly attributed to country-specific shocks. Exchange rate residuals show uniformly low cross-country correlations, consistent with the bilateral nature of the series and the absence of a common stochastic trend. Additionally, we conducted a Variance Inflation Factor (VIF) test on the foreign variables for each single country equation. The results indicate low levels of multicollinearity, except for the GDP showing moderate multicollinearity levels, with all VIF values remaining well below commonly used thresholds.

5.2 Country-specific Model Specification and Cointegration Ranks

This section outlines the empirical specification of our GVAR model used for our results in Section 6. We begin by discussing the domestic, foreign, and global variables entering each country-specific VECM-X model, followed by the lag structure and treatment of exchange rate variables. We then discuss the imposed cointegration ranks and the diagnostic tests used to evaluate the adequacy of the country-specific specifications. The resulting single country VECM-X specifications are presented in Appendix B.

As outlined in Section 3 the variables considered are standard macroeconomic variables, each economy $i \in \{\mathrm{US}, \mathrm{EA}, \mathrm{SE}, \mathrm{DK}, \mathrm{NO}\}$, with the exception of Euro Area, includes the following variables in the domestic block:

$$X_{i,t} = \begin{pmatrix} y_{i,t} \\ \pi_{i,t} \\ sr_{i,t} \\ lr_{i,t} \\ s_{i,t} \end{pmatrix} \in \mathbb{R}^{5\times 1} \qquad i \neq EA$$

However, since the exchange rate is vis-à-vis the Euro, the Euro Area's exchange rate channel is zero, leaving the Euro Area with four domestic variables:

$$X_{EA,t} = \begin{pmatrix} y_{EA,t} \\ \pi_{EA,t} \\ sr_{EA,t} \\ lr_{eA,t} \end{pmatrix} \in \mathbb{R}^{4\times 1}$$

For each individual country specification in Equation (1) the lag selection was chosen based on Bayesian information Criteria (BIC). BIC is preferred as it favours the parsimonious model specification, by penalising the inclusion of additional parameters, mitigating the degrees-of-freedom constraint in our sample. The BIC results are presented in Table 12 in Appendix A and it favoured two domestic lags for each country specification.[11]

Furthermore, in order to maintain a similar dynamic to Hájek & Horváth (2016) and Pesaran et al. (2004), we limit the economies to contain only one contemporaneous differenced foreign variable, with GDP and CPI entering with a lag. For the United States, however, we restrict the contemporaneous foreign block to zero, leaving all foreign variables to enter with a lag. This choice reflects both the dominant role of the United States in the global economy and our interest in keeping the model as parsimonious as possible, while focusing on the transmission channels most relevant for the smaller open economies in the system.[12] Additionally, it helps addressing the multicollinearity problems imposed from the weight-matrix in Table 2. Since all bilateral exchange rates are expressed vis-à-vis the Euro, including a trade-weighted foreign exchange rate in the weakly exogenous block of the non-euro economies would introduce near-redundancy, as such a variable would be highly collinear with the domestic bilateral rate and the foreign price variables already present in the model. The Euro Area is treated differently in this respect since it has no domestic bilateral exchange rate by construction, the trade-weighted foreign exchange rate entering its weakly exogenous block captures the aggregate movement of trading partner currencies against the Euro, providing independent information about external price pressures not otherwise available in the Euro Area model. This asymmetric treatment follows the logic of Hájek & Horváth (2016), who similarly restrict the foreign exchange rate. Furthermore, as we treat oil as a global exogenous variable in our system, we matched its number of lags to the foreign block for each country, except for Norway.[13]

Additionally, we also investigated the single country VECM-X serial correlations for each variable, using the Ljung-Box White noise test. The results suggest that each country specification exhibits limited serial correlation except for Sweden's and Norway's long term interest rates. This finding is consistent with the broader GVAR literature, where some remaining serial correlation is often present, as noted by Hájek & Horváth (2016). All level-variables are plotted in Figures 9–13, in Appendix A, along with the White noise tests in Table 13.

Lastly, the error-correction terms are central to the VECM-X framework, as they rep-

[11] For Sweden and Norway, the BIC suggested one lag when applied to the variables in levels. However, because the VECM is specified in first differences, a VAR lag order of at least two in levels is required to obtain at least one lag of the differenced variables in the VECM representation.

[12] For the United States, we also excluded foreign GDP from the foreign block. This restriction was imposed to address multicollinearity arising from the GDP series and to reduce residual correlation problems in the model, both confirmed by VIF tests and residual correlations.

[13] For Norway, we allow for a different lag structure for the oil variable, reflecting their relatively stronger exposure to crude oil price developments, due to its role as oil exporter.

resent deviations from long-run equilibrium relationships to which the system adjusts over time. These terms are often specified after determining the cointegration rank using tests such as the Johansen procedure, see Pesaran et al. (2004) and Hájek & Horváth (2016). However, the empirically suggested cointegration ranks proved sensitive across specifications over a sample period characterised by substantial macroeconomic and financial disruptions, including the Global Financial Crisis, prolonged zero lower bound periods and the post-pandemic inflation surge. Given the importance of maintaining economically interpretable long-run relationships within the system, we therefore impose theoretically motivated cointegration structures consistent with the broader literature. The following section outlines the imposed error-correction terms and the corresponding country-specific specifications.[14]

5.2.1 Cointegration Ranks

A central issue in cointegrated systems is not only whether long-run relations exist, but how these relations should be identified and interpreted. Pesaran & Shin (2002) emphasise that long-run relations imposed from cointegration tests are often chosen for mathematical convenience rather than economic meaning. This motivates a more structural approach in which restrictions implied by economic theory are imposed on the cointegrating vectors, as argued by Pesaran & Shin (2002). Following this logic we adopt economically imposed cointegrating relations. In the GVAR-framework, cointegrating vectors can be interpreted as long-run equilibrium relations between primarily domestic variables. Below we outline the imposed ECTs and their specification. We then assess the empirical relevance of the imposed ECTs using structural break tests, stationarity tests, and information criteria.

All our economies include the short- and long term interest rates which provides the basis of our first cointegrating relationship, the term spread, which has been widely covered in literature per Campbell & Shiller (1984) and Engle & Granger (1987). The restriction is motivated by the expectations hypothesis of the term structure, according to which the long rate is approximately the average of current and expected future short rates plus a constant term premium. Consequently, following a shock pushing long- and short-term rates away from their long-run equilibrium, the correction term allows them to adjust over time so that the spread returns toward its equilibrium level. Thus, we impose this cointegrating relation for all economies except for Denmark. A Danish term-spread relation could also be motivated by the expectations hypothesis. However, since Denmark's monetary regime minimises the Danish central bank's monetary autonomy the short rate has to follow the Euro Area's short rate, in order to maintain a pegged exchange rate to the Euro. We therefore exclude the Danish term spread to avoid imposing a redundant long-run restriction and instead impose a cointegrating relationship between the Danish short rate and the ECB short rate, in accordance with Denmark's monetary regime.

The second long-run relation reflects Purchasing Power Parity (PPP). In its long-run form, PPP implies that the exchange rate is tied to relative price levels across economies, meaning persistent deviations from this equilibrium are corrected. Because the euro is

[14] We also confirmed the stability of the companion matrix in the stacked system. All eigenvalues were non-explosive, and the number of unit roots matched the implied number of common stochastic trends.

used as the numeraire currency, we specify the long-run PPP relationship such that the domestic CPI, the Euro Area CPI and the nominal exchange rate are linked through a common long-run equilibrium relation. This means that any deviations from the PPP generate error-correction dynamics, e.g. following an exchange rate shock the error-correction term includes mean reversion in prices and exchange rates. We impose a PPP cointegrating relation for Norway and Sweden, but exclude Denmark and US. First, Denmark is excluded because its ERM-II relation already captures the relevant long-run exchange rate adjustment through the first error-correction term. Consequently, the ERM-II is the primary driver of the exchange rate, implying that adding PPP relation would add little economic meaning and risk duplicating dynamics already accounted for in the model. Second, US is also excluded, as it is treated as the most exogenous economy in the model and the US dollar functions as the dominant global reserve and invoicing currency. Imposing a PPP relation on the US would therefore be less economically meaningful and would weaken the intended role of the US block as a largely exogenous source of global shocks.[15]

In order to impose the long-run relations we follow Johansen Case III, outlined in Johansen (1995), when constructing our economically imposed error correction terms. The Johansen Case III allows for unrestricted and restricted intercepts as well as unrestricted deterministics. The restricted constants in the relationship ensures that the long-run equilibria are constant instead of drifting over time, i.e. the long- and short rate share a common trend over time. On the other hand, we do not include unrestricted trends in the model, because the variables in the short-run dynamics do not trend over time, as noted in Johansen (1995). Lastly, we let the crisis dummies enter in the short-run dynamics, which allows for temporary level shifts during crises, without permanently shifting the long-run equilibrium. Moreover, the cointegration requires that the residual series for each identified long-run relation are stationary, which we tested through ADF-tests. All error-correction terms were freely estimated in order to avoid imposing too strict relations, as noted in Corbae & Ouliaris (1998) and Johansen & Juselius (1992) where evidence of strict one-to-one PPP-relation was not supported. The constructed ECTs are presented in Table 15 in the Appendix B along with the full country specification.

We justify each of the economically imposed ECTs by structural break tests, stationarity testing and information criteria. For the structural break tests we implemented the Bai and Perron break test,[16] which ensured the imposing of economically meaningful dummies in the short run dynamics for each country specification. Given the limited number of observations and the risk that excessive dummy-variable controls may absorb economically relevant variation, we adopt a restrictive approach and include only two event dummies detected in the break test, one for the Global Financial Crisis and one for the COVID-19 period. Additionally, the stationarity test for each ECT, under a Johansen Case-III, is supposed to be a zero mean process. The ADF-test results indicate that all ECTs are stationary around zero, suggesting that the imposed long-run relations are mean-reverting and therefore consistent with the VECM-X specification.

[15] For reasons of structural coherence, we also deviate from Pesaran et al. (2004) and Hájek & Horváth (2016) by excluding oil from the cointegrating relations.

[16] For this structural break test we used the Bai-Perron test, as outlined by Bai & Perron (1998). The Bai-Perron break test is an endogenous test that tells when a structural break occurred in the data. The identified breakpoints are then evaluated and used to construct dummy variables for relevant short-run disruptions in the country-specific models.

Lastly, in order to assure that the addition of the ECTs actually are economically meaningful for our model specification we compute the Aikaike Information Criterion (AIC) for each single country VECM-X. The results confirmed that the imposed long-run relations contribute where they capture meaningful adjustment dynamics, rather than merely adding parameters to the model.

5.2.2 Weak exogeneity test

Lastly, the weak exogeneity test is a central diagnostic in the GVAR framework, as it assesses whether the foreign variables can be treated as external conditioning variables in the country-specific models. We follow the methodology of testing for weak exogeneity[17] of the foreign variables by Pesaran et al. (2004) and Harbo et al. (1998) where we check the joint significance of the estimated error correction. Our test results are presented in Table 14 in Appendix A and show that all foreign variables are weakly exogenous. This is reassuring for the validity of the GVAR specification, particularly given the relatively high cross-country residual correlations observed in parts of the system. The weak exogeneity results suggest that, despite remaining residual interdependence, the foreign aggregates can still be treated as given in the country-specific models, supporting the construction of the global model and the interpretation of cross-country shock transmission.

[17]This is the Auxiliary Foreign variable feedback diagnostic, outlined in Pesaran et al. (2004) and Harbo et al. (1998). The test involves regressing l^{th} element the foreign variable we run, $x^*_{it,l} = a_{i,l} + \alpha_{il} ECT_{i,t-l} + \sum_{j=1}^{p_{il}} \delta'_{il} \Delta v_{i,t-j} + \zeta_{il}$. Where $\Delta v_{i,t-j}$ is the domestic-, control- and foreign variables. We additionally tested for multicollinearity in the auxiliary feedback regressions and found no major indications of high collinearity.

6 Results

Our results are divided into five sections. The first three sections cover domestic-, regional- and global shocks, outlined in Section 4.6. The domestic shocks are centered around Sweden's ERPT and PERR measures from a contractionary monetary policy shock of 25 basis points and a one percent exchange rate appreciation, analysed in the short (1 year), medium (2-3 years) and long run (4-5 years). As outlined in section 4.4, Denmark is excluded as the pegged currency limits the ERPT transmission channels vis-à-vis the Euro. The aim of the domestic analysis is to provide a benchmark for the succeeding regional- and global shocks. The regional sections 6.2.1– 6.2.2 evaluate the inflation transmission patterns from a monetary policy tightening shock of 25 basis points and a one percent CPI increase in the Euro Area. The third section is centred around a global monetary policy tightening shock of 25 basis points from the United States Federal Reserve and a one percent CPI increase in the United States. In the fourth section, 6.4, we outline the Forecast Error Variance Decomposition (FEVD) of our shocks. Lastly, as a robustness exercise we consider the corresponding GIRFs, Generalised FEVD and oil price shocks to all domestic variables in section 6.5.

The impulse responses reported in this section are based on Specification 2 and the corresponding Cholesky ordering. The only exception is the domestic exchange rate shock in Section 6.1.1, which is based on Specification 1. The full country responses for each shock are found in Appendix A. All impulse responses are presented in 68% and 90% Confidence Intervals. [18]

6.1 Domestic Shocks

6.1.1 Domestic Exchange Rate Shock

In order to study the domestic ERPT we propagate a one percent appreciation shock to the bilateral exchange rate of Sweden vis-à-vis the Euro. In Figure 1 the response of Swedish CPI and exchange rate is shown based on Specification 1. Following the appreciation of the bilateral exchange rate Sweden's CPI falls on impact by 0.05% and gradually decreases by 0.17% after 20 quarters, with the exchange rate settling at around 0.5% of the initial 1 percent appreciation after 20 quarters. These responses are aligned with theory and the expected ERPT path presented by Colavecchio & Rubene (2020) and our own expectation, see Section 4.6. The appreciation of the krona creates a delayed and significant response with respect to CPI, which the literature associates with reduced import prices, in turn reducing production costs and the cost of importing goods, leading to a gradual decrease of the CPI along the pricing channel.

[18] Confidence bands are based on 5,000 residual-based bootstrap replications.

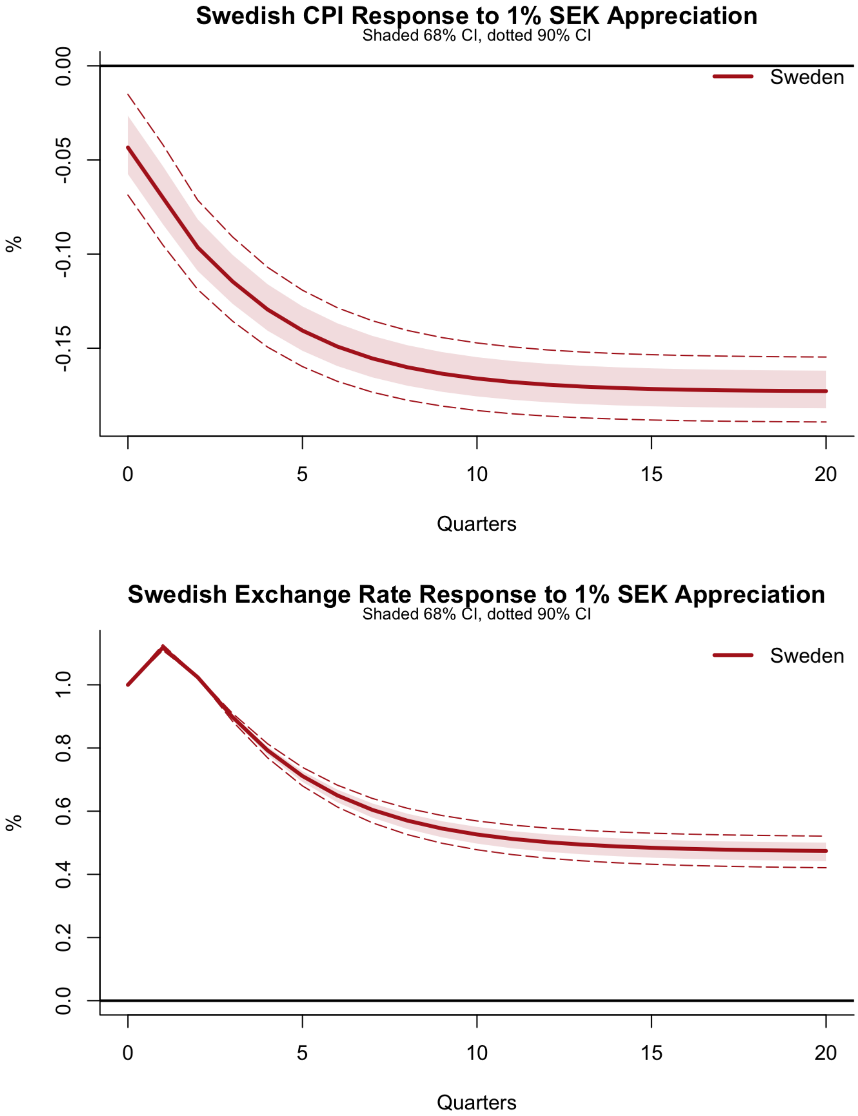

Figure 1: Sweden's Impulse Reponses (levels) to 1% SEK appreciation

The figure shows the impulse responses of Swedish CPI and the bilateral exchange rate following a 1% appreciation of the Swedish krona vis-à-vis the euro. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

The pass-through estimates are presented in Table 3 where both the ERPT and PERR, see Equation (8) and (9), are presented. Using the definition of Equation (8) yields a short-run pass through of 13%, with a medium- to long-run level stabilising around 17%. The medium- and long-run estimates are aligned with the findings of Corbo & Di Casola (2018; 2022) and Linderoth & Mueller (2024) whereas the short-run estimates are slightly elevated. The PERR, Equation (9), capturing the dynamic path of both the exchange rate and the CPI, shows the one year pass-through settles at 16% and in the medium run at 28-34%, with a long run pass-trough of around 36%.[19] These results are also elevated with respect to the literature. However, as outlined in Section

[19] A one percent depreciation produces symmetric responses in the opposite direction.

3 we use a bilateral exchange rate, standard to the GVAR literature, making direct comparisons of point-estimates with other studies challenging, but the overall response should remain directionally and economically consistent. The PERR results are consistent with the linear responses reported by Corbo & Di Casola (2022), Forbes et al. (2020) and Linderoth & Mueller (2024), but differ in magnitude. One reason for the difference in magnitude is that these studies use effective exchange rates, whereas our specification relies on a bilateral rate. Effective exchange rates average movements across multiple currencies, while bilateral rates reflect movements against a specific counterpart, often more closely linked to import pricing. This difference in measurement may contribute to higher pass-through estimates in bilateral specifications, even when the qualitative responses are comparable. Furthermore, while the recursive identification is intended to isolate the initial exchange rate shock, the subsequent responses reflect its propagation through the cross-country linkages of the GVAR system. The estimated pass-through therefore captures both the direct effect of the exchange rate movement and the broader general equilibrium adjustment that follows. The reported pass-through should therefore be interpreted in the context of a system-wide response rather than a narrow exchange rate elasticity.

6.1.2 Domestic Contractionary Monetary Policy

Figure 2 outlines the responses of a 25 bp increase in the domestic policy rate and its effect on the exchange rate and CPI, illustrating the shock-dependent pass-through (PERR). The krona appreciates immediately by around 0.7% following the monetary policy shock and gradually falls. This initial appreciation is consistent with standard monetary theory, as a higher domestic policy rate would typically be expected to increase the demand for the domestic currency. The subsequent CPI response is also consistent with monetary theory, as the rate hike would be expected to dampen aggregate demand and reduce inflationary pressures, leading CPI to settle around -0.06% in the medium- to long run. However, the response from the 25 basis point shock is statistically insignificant at the 10 percent level, albeit directionally consistent.

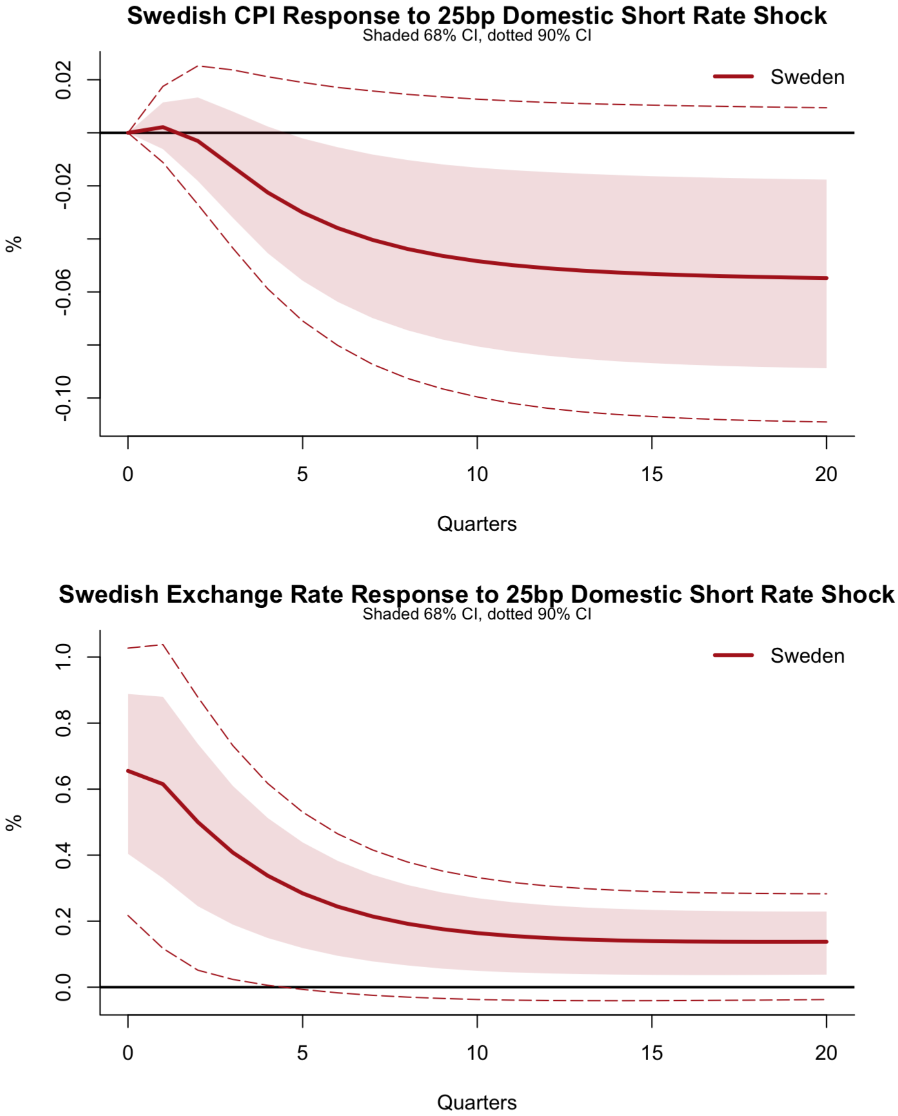

Figure 2: Swedish Impulse Response (levels) to 25bp Domestic Short Rate shock

The figure shows the impulse responses of Swedish CPI and the bilateral exchange rate vis-à-vis the euro following a 25 basis points increase of the Swedish short rate. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

After one year the PERR is around 7%, rising to 23% in the medium run and settles at 39% after 20 quarters, see Table 3. These results align with the findings of Corbo & Di Casola (2022) and Forbes et al. (2020). Economically, a positive shock to the short rate means firms face lower demand, since the contractionary monetary policy reduces economic activity. The demand effect allows them to lower prices. Moreover, they face lower costs for foreign inputs due to the appreciation of the Krona and transfer (some of) the decrease in costs to the consumers (Corbo & Di Casola, 2022). Both of these factors lead firms to lower consumer prices. Corbo & Di Casola (2022) find a shock-dependent pass-through of 15 percent following a monetary policy shock in the short to medium run, aligning with our estimate of 23% after two years. Ha et al. (2020) and Forbes et al. (2017) find a long run median pass-through of between 20-30%, more in line with our long run estimate. However, once again it is worth noting that our point estimate may deviate because of our use of a bilateral exchange rate, as outlined in section 6.1.1.

Quarter	**4**	**8**	**12**	**16**	**20**
PERR (Short Rate)	0.07	0.23	0.34	0.38	0.39
PERR (Exchange Rate)	0.16	0.28	0.34	0.36	0.36
ERPT	0.13	0.16	0.17	0.17	0.17

Table 3: Exchange rate pass-through and Price-to-Exchange-Rate Ratio

The table reports the Price-to-Exchange-Rate Ratio, from Equation (9) and ERPT, from Equation (8), for Sweden. PERR (Short Rate) denotes the cumulative CPI response relative to the cumulative exchange rate response following a Swedish short-rate shock. PERR (Exchange Rate) denotes the same ratio following a Swedish exchange rate shock. ERPT denotes the cumulative CPI response to the exchange rate. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Overall, the ERPT and PERR results provide a useful benchmark against which the transmission of regional and global shocks in the following sections can be interpreted. By quantifying the role of exchange rate movements in domestic price dynamics, they provide a benchmark to assess whether external shocks propagate primarily through direct price channels or indirectly via exchange rate adjustments. Making this distinction clear is particularly important for comparing the transmission and inflation spillover effects between Sweden and Denmark, as the floating krona allows exchange rate movements to act as an additional transmission channel in Sweden, whereas Denmark's peg largely suppresses this mechanism.

6.2 Regional Shocks

Before turning to the regional shocks, it is useful to briefly highlight the role of the GVAR framework in structuring the analysis. By linking country-specific models through trade-weighted foreign variables and our use of recursive ordering in Specification 2, the framework allows shocks originating in the Euro Area to propagate through a common global system (Pesaran et al., 2004; Hájek & Horváth, 2016). This is central in the present context, as it allows Sweden and Denmark to be exposed to the same underlying disturbance while allowing their domestic responses to differ. In contrast to single-country VAR and panel approaches (e.g. Forbes et al., 2018, 2020), where shocks are identified within each economy separately, this setup enables a more direct comparison of transmission mechanisms across exchange rate regimes. The responses in this section can therefore be interpreted as differences in how a common regional shock is transmitted, rather than differences in the shocks themselves.

6.2.1 ECB Contractionary Monetary Policy

Figure 3 shows that a 25 basis point increase in the Euro Area short rate is followed by a contractionary CPI response in both Denmark and Sweden, though the magnitudes and mechanisms differ across regimes. Danish CPI declines more sharply, reaching a minimum of around -0.10%, while the Swedish response remains near zero throughout the forecast horizon. This pattern is consistent with the transmission logic of ERM-II. Because Denmark's monetary policy is constrained to track ECB decisions, a tightening of Euro Area rates is effectively equivalent to a domestic tightening for Denmark, transmitting to domestic prices without the exchange rate acting as a buffer. Sweden, by contrast, retains the exchange rate as an adjustment margin, which as discussed in Section 2.3 and formalised by Corbo & Di Casola (2018), tends to dampen CPI responses to externally originating shocks. Our finding that Denmark exhibits the stronger CPI response therefore aligns more closely with regime-theoretic priors than the result in Hájek & Horváth (2016), who find the opposite ordering despite Denmark's fixed exchange rate.

The short-rate responses, in Figure 3, are consistent with this interpretation. Both economies tighten significantly at the 10 percent level, but the Danish short rate closely mirrors the Euro Area path shown in Figure 14 in Appendix A, reflecting the cointegrating relationship between Danish and ECB rates imposed in the GVAR specification and documented empirically by Spange & Sørensen (2017). Sweden's short rate also rises, but less completely, consistent with the Riksbank retaining discretion over its policy response. The contrast illustrates what Section 2.3 describes as the fundamental asymmetry between the two regimes. For Denmark, Euro Area monetary policy shocks are largely imported as domestic monetary conditions. On the other hand, for Sweden they are transmitted through a combination of financial spillovers and an endogenous policy response that the Riksbank partly controls. However, although the point estimates are directionally aligned with our predictions, the CPI responses are not statistically significant, implying that the estimated differences in inflation adjustment remain suggestive rather than conclusive.

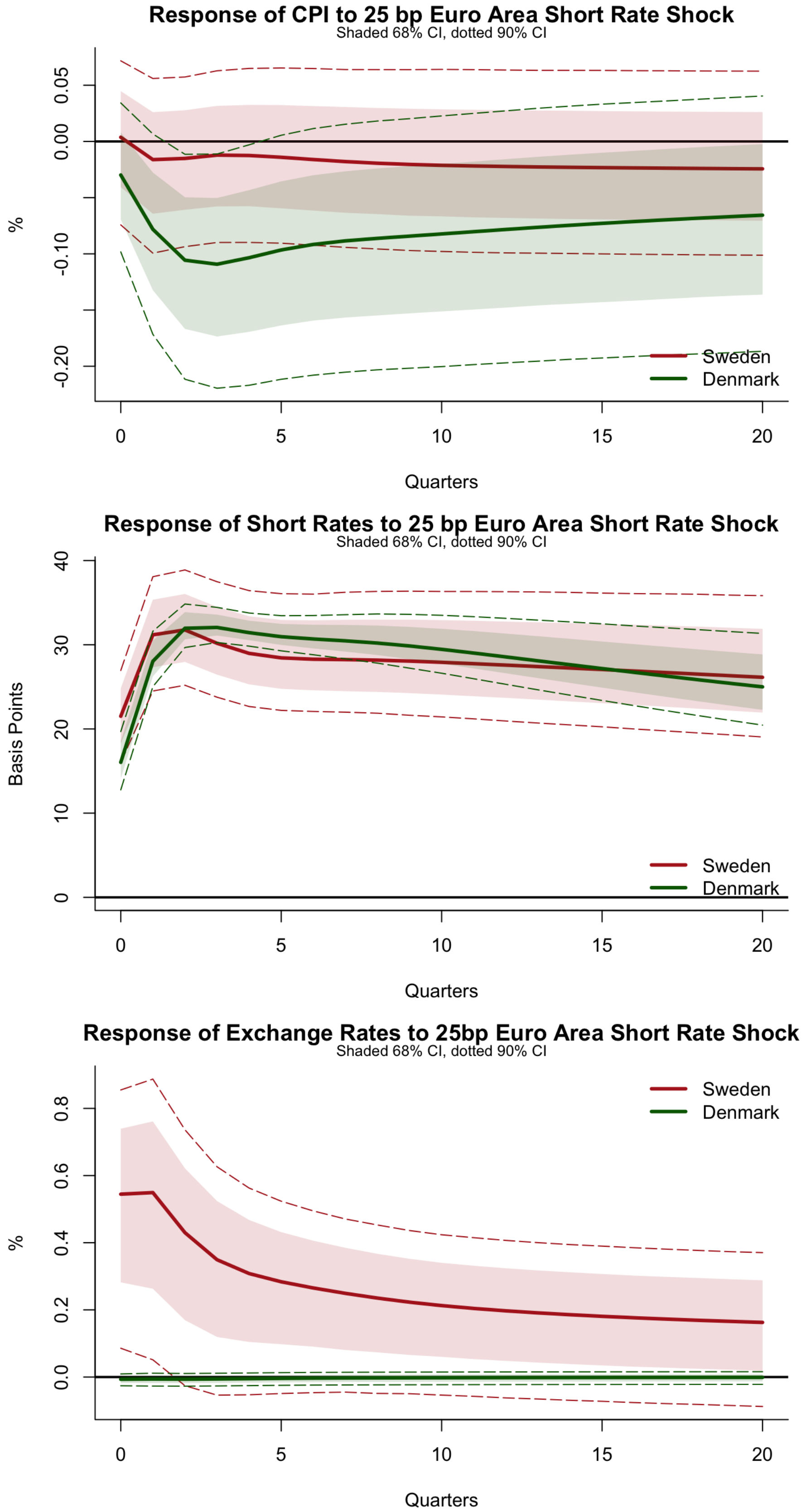

Figure 3: Denmark and Sweden Impulse Responses (levels) to 25bp Euro Area Short Rate shock

The figure shows the impulse responses of Swedish and Danish CPI, short rate, and bilateral exchange rate vis-à-vis the euro following a 25 basis point increase in the Euro Area short rate. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Lastly, the exchange rate responses reflect this asymmetry directly. Denmark's bilateral rate against the euro is unchanged, as the peg limits the exchange rate as a transmission channel. Sweden's krona appreciates by approximately 0.4–0.5% on impact, which is unexpected under a standard interest rate parity logic as an ECB rate hike should put depreciatory pressure on the krona relative to the euro. There are two plausible explanations for this response. Firstly, the appreciation instead may reflect the dominance of the endogenous Riksbank response as the Swedish short rate rises in response to the ECB shock, the interest rate differential narrows or reverses, supporting the krona. Secondly, the krona appreciation may partly be an artifact from the PPP error correction term and the Euro Area price response. As visible in Figure 14 in Appendix A, Euro Area CPI is near zero and slightly positive on impact following the tightening. With Swedish CPI remaining near zero, the relative price differential shifts in Sweden's favour, generating appreciation pressure through the error correction mechanism. This is consistent with the appreciation appearing under both OIRF and GIRF identification. Given statistical insignificance at the 10 percent level, this result should not be over-interpreted.

Quarter	**4**	**8**	**12**	**16**	**20**
PERR (Short Rate)	0.02	0.05	0.08	0.10	0.11

Table 4: Price-to-Exchange-Rate Ratio: Euro Area Short Rate shock

The table shows the Price-to-Exchange-Rate Ratio for Sweden following a 25bp Euro Area Short Rate shock. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Table 4 reports the PERR for Sweden across the forecast horizon. The short-run pass-through of 2% is substantially below the 7% observed after a domestic monetary policy shock of the same size, with the gap narrowing but persisting to around 10–11% in the long run versus 39% domestically. This is consistent with Forbes et al. (2020) findings that exchange rate movements driven by external shocks generate weaker pass-through than those driven by domestic monetary policy, because the underlying macroeconomic environment to the shock differs. In the domestic case, the exchange rate appreciation occurs alongside demand compression and tighter financial conditions, all of which reinforce disinflationary pressure on CPI. In the EA shock case, the Swedish exchange rate moves for similar reasons but the accompanying demand conditions are shaped by Euro Area rather than domestic dynamics, producing a weaker and less synchronised price response. The low PERR therefore potentially reflects weak price adjustment relative to the exchange rate movement, not a weak exchange rate response. In other words, Sweden's krona moves substantially, but domestic prices do not follow at the same speed or magnitude. The insignificant CPI and exchange rate responses imply that the estimated PERR should be interpreted with caution, as the underlying transmission dynamics are not precisely estimated despite the direction of the point estimates aligning with the predicted mechanism

For Denmark, the PERR concept is less informative because the exchange rate response is mechanically suppressed by the peg. The relevant comparison is therefore not pass-through from the exchange rate to prices, but the direct CPI response relative to the Euro Area monetary shock, as outlined in Section 4.4. The clearest finding from the Euro Area monetary policy shock is that both economies follow the ECB rate decision, consistent with the theoretical prediction that small open economies adjust domestic monetary conditions in response to shocks from dominant trading partners (Pesaran et al., 2004). Denmark's near-mechanical mirroring reflects the ERM-II constraint, while Sweden's less complete response is consistent with the Riksbank retaining monetary autonomy. The CPI responses, though directionally consistent, are muted and statistically insignificant for both countries, suggesting that interest rate transmission alone generates limited direct price-level effects at this shock size. Therefore, the following section turns to a direct Euro Area price shock to examine how Denmark and Sweden differ in absorbing external inflation pressures through their respective exchange rate regimes.

6.2.2 CPI Shock

Figure 4 shows that a one percent increase in Euro Area CPI generates a positive and statistically significant CPI response in both Denmark and Sweden at the 10 percent level, indicating that Euro Area price-level shocks transmit directly to domestic consumer prices regardless of exchange rate regime. This contrasts sharply with the muted and insignificant CPI responses observed after the Euro Area interest rate shock in Section 6.2.1, and establishes an important hierarchy in how Euro Area shocks may affect Nordic inflation. The price channel, being more direct, highlights that regime difference does not seem to determine whether transmission occurs, rather it seems to shape how completely and persistently it transmits.

Denmark's CPI response is stronger after one quarter, peaking at approximately 1.2% around quarter three, and more persistent than Sweden's throughout the forecast horizon. This is consistent with the transmission logic of ERM-II outlined in Section 2.3. Because the exchange rate is fixed against the euro, all three transmission channels identified by Colavecchio & Rubene (2020), the direct import price channel, the input cost channel, and the competitiveness channel, operate through domestic prices without any currency buffer available to absorb the impulse. The result is a strong co-movement between Danish and Euro Area price developments, consistent with the empirical evidence in Kristoffersen & Spange (2016, 2017) and the broader finding in Comunale & Kunovac (2017) that the speed and completeness of Euro Area inflation transmission to neighbouring economies increases with the degree of monetary integration. Denmark, whose monetary conditions are effectively set by the ECB through the peg, represents the limiting case of this relationship.

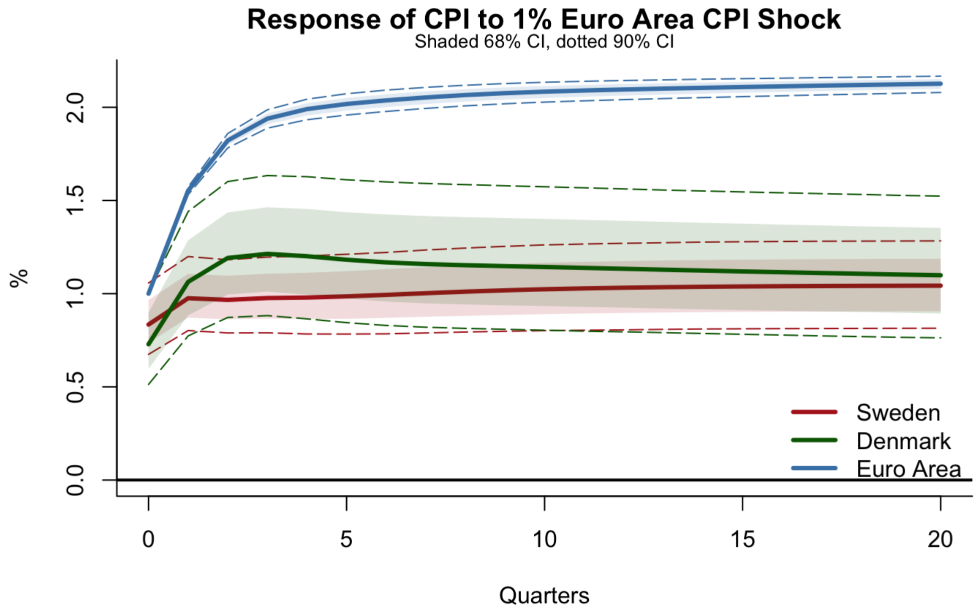

Figure 4: Impulse Responses (levels) to 1% Euro Area CPI shock

The figure shows the impulse responses of Swedish, Danish and Euro Area's CPI following a 1% increase in the Euro Area CPI. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Sweden's response, on the other hand, rises to around 1% but remains flatter and less persistent than Denmark's, reflecting the possible insulation provided by the floating krona. The Euro Area CPI shock raises short rates across the system, including in both Denmark and Sweden. However, the implications of this monetary response differ across regimes. In Denmark, the higher short rate is transmitted under the peg without an offsetting exchange rate adjustment, reinforcing the direct pass-through of Euro Area prices into domestic CPI. In Sweden, by contrast, the rise in the short rate supports an appreciation of the krona, as shown in Figure 15 in Appendix A. This appreciation reduces the domestic-currency price of imported consumer goods and intermediate inputs, partially offsetting the direct transmission of the Euro Area price impulse through the import price and input cost channels following the interpretation of Colavecchio & Rubene (2020).

This mechanism is the mirror image of the dynamic documented by Corbo & Di Casola (2022), who show that demand shocks generating exchange rate depreciation produce weak or negative ERPT for Sweden because the currency movement and the price impulse work in opposing directions. Here, the Euro Area price shock produces a Swedish monetary response that appreciates the krona, so the exchange rate dampens rather than amplifies the domestic CPI response. The floating exchange rate therefore acts as an automatic stabiliser for Swedish inflation, not by preventing transmission, but by changing how the accompanying short-rate adjustment is absorbed. This is consistent with the broader literature on monetary policy credibility and ERPT, which finds that well-anchored inflation expectations under inflation targeting regimes reduce the sensitivity of domestic prices to external shocks (Carrière-Swallow et al., 2016).

Quarter	**4**	**8**	**12**	**16**	**20**
IT SE	0.492	0.491	0.494	0.494	0.492
IT DK	0.591	0.547	0.530	0.516	0.505

Table 5: Inflation Transmission (IT) Comparison: Euro Area CPI Shock

The table shows the Inflation Transmission for Sweden (IT SE) and Denmark (IT DK) following a 1% CPI increase in Euro Area. The Inflation Transmission is computed using Equation (10), based on the Euro Area CPI shock. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

The inflation transmission ratios in Table 5 quantify this regime difference. Denmark's ratio of 0.591 against Sweden's 0.492 supports stronger short-run co-movement under the peg, while the convergence in the long run, with both ratios approaching 0.49–0.51, suggests that the floating exchange rate delays rather than prevents transmission. This pattern is consistent with the view in Section 2.2 that the Euro Area functions as the dominant regional inflation anchor for both Nordic economies, with the exchange rate regime potentially determining the speed of adjustment rather than the long-run direction. It also extends the findings of Hájek & Horváth (2016), who document strong short-run Euro Area inflation spillovers to European economies but do not exploit the regime contrast systematically.

Our results show that the regime difference is most visible precisely where theory predicts it should be, in the short-run speed and completeness of transmission, and that it diminishes as the long run and the exchange rate buffer is gradually absorbed into domestic prices. These findings may therefore indicate a timing mechanism rather than full insulation: monetary autonomy gives the Riksbank and the exchange rate time to absorb the impulse before it is fully reflected in domestic prices.

6.3 Global Shocks

Having established how Sweden and Denmark respond to shocks originating within the Euro Area, we now turn to global shocks emanating from the United States. This extension serves two purposes. First, it tests whether the regime differences documented in Section 6.2 persist when the shock originates further up the transmission chain, where both economies are exposed to the same US impulse filtered through the Euro Area rather than receiving it directly. Second, it allows us to assess the relative importance of regional versus global drivers of Nordic inflation, a distinction central to understanding how deeply Euro Area integration shapes domestic price dynamics in both economies.

6.3.1 Federal Reserve Contractionary Monetary Policy

Figure 5 reports the responses following a 25 basis point contractionary monetary policy shock from the Federal Reserve. In the GVAR framework the shock propagates to Sweden and Denmark primarily through the Euro Area block which responds to the Fed's monetary tightening decision. This transmission structure is consistent with Miranda-Agrippino & Rey (2020), who document US monetary policy as the central driver of the global financial cycle, propagating to small open economies through tightening financial conditions and exchange rate responses. Potjagailo (2017), Comunale & Kunovac (2017) provide the regional counterpart to this mechanism, emphasising that global financial conditions affect Euro Area inflation dynamics before spilling over to closely integrated neighbouring economies. In the GVAR, this regional propagation is captured through the trade-weighted link matrix, with the Euro Area acting as the main intermediary between the US shock and the Nordic economies.

The CPI responses are directionally consistent with this transmission chain but statistically insignificant at the $10-\%$ level, mirroring the pattern observed after the ECB shock. Both economies experience a modest decline, with Sweden settling at around 0.04% and Denmark at 0.05% after ten quarters. Denmark's slightly larger response may reflect the mechanical transmission chain from Federal Reserve to ECB to Nationalbanken under ERM-II, which leaves Danish monetary conditions with less scope for exchange rate adjustment to cushion the effect on prices. Sweden's response is marginally more pronounced relative to the ECB shock, consistent with the Riksbank retaining some autonomy to shape the domestic outcome independently of the Euro Area channel.

The short rate responses are statistically significant for both economies, with Denmark reacting more strongly of approximately 10 basis points on impact compared to Sweden's 5 basis points. As shown in Figure 16 in Appendix A, Denmark's short rate tracks the Euro Area response closely, replicating the pattern observed after the ECB shock and suggests that the Fed-ECB-Nationalbank transmission chain operates consistently regardless of where the global shock originates. Sweden's less complete response again reflects the Riksbank's retained monetary autonomy. Both observations are therefore consistent with the Spange & Sørensen (2017) argument of higher Danish alignment with ECB monetary policy and Ellen et al. (2020) findings regarding stronger financial spillovers from the Euro Area onto Denmark than Sweden.

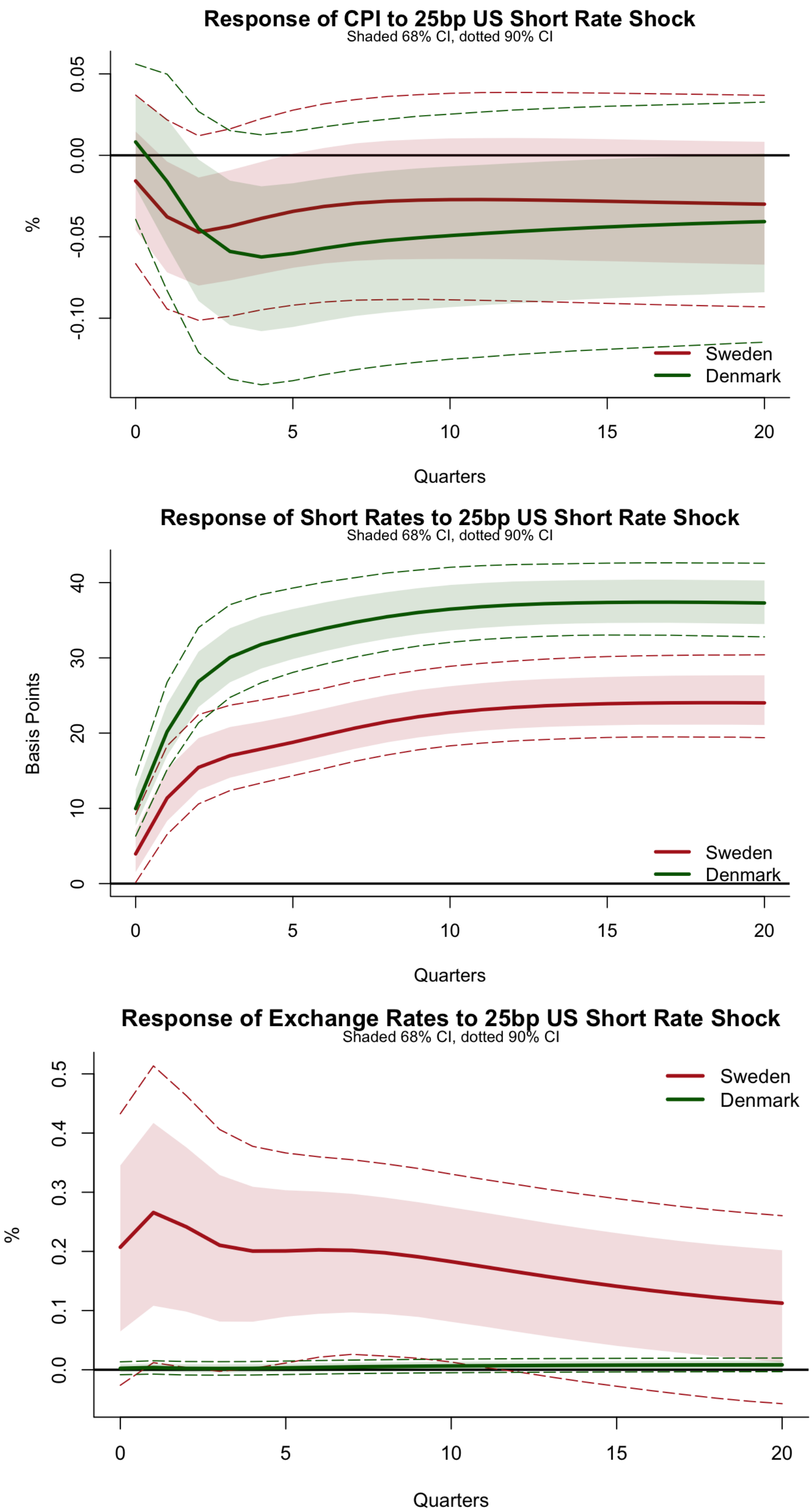

Figure 5: Impulse Responses (levels) to 25bp US Short Rate shock

The figure shows the impulse responses of Swedish and Danish CPI, bilateral exchange rate vis-á-vis the euro and short rate following a 25 basis points increase in the US short rate. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

The responses of the exchange rates are also in line with the expected dampening from the indirect transmission. The SEK appreciates vis-à-vis the euro by 0.25% on impact but is insignificant, similarly to after the ECB rate hike. In line with the peg, the Danish exchange rate response remains flat, confirming that the model consistently captures the ERM-II mechanism.

Quarter	**4**	**8**	**12**	**16**	**20**
PERR (Short Rate)	0.19	0.14	0.16	0.21	0.26

Table 6: Price-to-Exchange-Rate Ratio: US Short Rate shock

The table shows the Price-to-Exchange-Rate Ratio for Sweden following a US 25bp short rate shock. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Table 6 reports the PERR for Sweden. The values are non-monotonic, beginning at 19% after one year, falling to 14% after two years, and recovering to 26% by quarter twenty. The PERR is higher than after the ECB shock, reflecting that the exchange rate response is more attenuated than the CPI response. This is visible in Figure 5 where the Krona moves less, but prices respond relatively more, producing a higher ratio. This is consistent with the Fed shock reaching Sweden through overlapping channels, where direct demand and cost spillovers transmitted through the Euro Area may contribute to the CPI response partly independently of the exchange rate movement. As outlined in Section 4.4, the PERR from externally originating shocks therefore captures broader co-movement between prices and the exchange rate rather than a single directional pass-through relationship, the ratio should, however, be interpreted cautiously as both the exchange rate and CPI response is insignificant, albeit directionally consistent. The overall response across most horizons is lower than the ECB rate shock, in line with Forbes et al. (2020) findings that more distant shocks are associated with dampened pass-through because of the intermediary steps. This is also confirmed across the domestic, regional and global responses as the pass-through is most complete when the shock originates domestically, where exchange rate movements and domestic demand conditions reinforce each other, and becomes less predictable as the shock origin becomes more distant and the transmission chain more indirect.

6.3.2 CPI Shock

Figure 6 shows the CPI responses of Sweden and Denmark following a one percent increase in US price levels. Both economies respond positively and statistically significantly at the 10%-level, indicating that global price shocks transmit to Nordic consumer prices regardless of exchange rate regime. The pattern mirrors that observed after the Euro Area CPI shock in Section 6.2.2, Denmark responds more strongly and persistently than Sweden, but the magnitudes are substantially smaller, with Denmark settling at approximately 0.5% and Sweden at 0.35% in the long run compared to approximately 1.1% and 1.0%, respectively, after the Euro Area shock. This attenuation is consistent with the additional intermediary step through which the US shock reaches the Nordic economies, and supports the interpretation from Section 2.2 that regional Euro Area price shocks are the dominant external drivers of Nordic inflation, with global shocks playing a secondary role transmitted through the regional block (Comunale & Kunovac, 2017; Miranda-Agrippino & Rey, 2020).

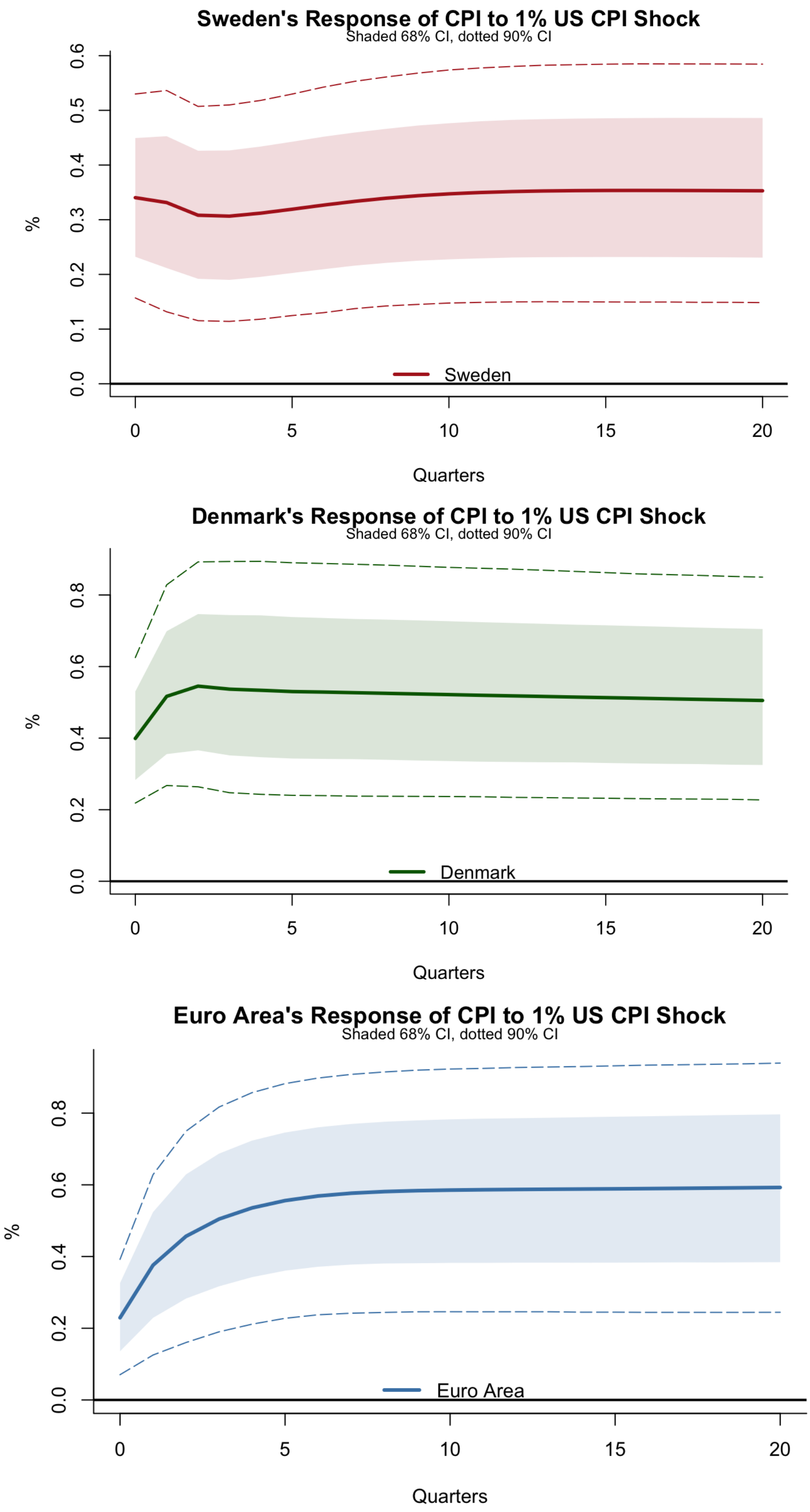

Figure 6: Impulse Responses (levels) to 1% US CPI shock

The figure shows the impulse responses of Swedish, Danish and Euro Area CPI following a 1% CPI increase in the US. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

The inflation transmission ratios in Table 7 allow a more precise comparison across regimes and shock origins. Denmark's ratio of 0.389 at quarter four sits close to the Euro Area's own ratio of 0.384, suggesting that Denmark absorbs the US price shock at a rate broadly similar to the Euro Area itself. This pattern is consistent with the ERM-II arrangement limiting Denmark's ability to absorb external price pressures independently of the Euro Area, with adjustment occurring through domestic prices rather than the exchange rate. Sweden's ratio of 0.228 at the same horizon is considerably lower, reflecting a weaker co-movement in prices with the Euro Area and Denmark. This could potentially reflect a partial insulation associated with the floating krona. Sweden's inflation transmission ratio remains at around 0.60 of the Euro Area's own response throughout the forecast horizon, compared with Denmark's long run ratio of 0.87. The gap between the two economies narrows only modestly at longer horizons, in contrast to the EA CPI shock where convergence was more apparent, suggesting that the regime difference is relatively more persistent under global than regional price shocks. That said, the similarity between Denmark and the Euro Area may partly reflect structural economic ties rather than the exchange rate regime alone, and the result should be read as consistent with the peg mechanism rather than as direct evidence of it. In combination with the Euro Area CPI results in Section 6.2.2, these patterns suggest that monetary regime choice conditions the transmission of external price shocks to domestic inflation across both regional and global shock origins, with the exchange rate providing meaningful though incomplete insulation for Sweden and Denmark's peg preserving a closer alignment with Euro Area price dynamics in both cases.

Quarter	**4**	**8**	**12**	**16**	**20**
Panel A: CPI response relative to US CPI response					
IT SE	0.228	0.243	0.251	0.252	0.250
IT DK	0.389	0.375	0.369	0.363	0.357
IT EA	0.384	0.408	0.411	0.411	0.412
Panel B: CPI response relative to EA CPI response					
IT SE	0.594	0.596	0.611	0.612	0.608
IT DK	1.013	0.919	0.898	0.883	0.868

Table 7: Inflation Transmission (IT) Comparison: US CPI Shock

The table reports inflation transmission (IT) following a 1% increase in US CPI. Panel A reports the CPI responses of Sweden (SE), Denmark (DK) and the Euro Area (EA) relative to the US CPI response. Panel B reports the CPI responses of Sweden and Denmark relative to the Euro Area CPI response. Inflation transmission is computed using Equation (10). *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

6.4 Forecast Error Variance Decomposition

Figure 7 presents the forecast error variance decomposition at the country level, reporting the average variance contribution of each shock source across all domestic variables across twenty quarters. Beyond summarising the relative importance of external versus domestic drivers, this aggregated perspective provides evidence that the model has captured the small open economy relationships reasonably well, confirming the expected pattern, that larger economies are more self-driven and smaller open economies showing greater external dependence.

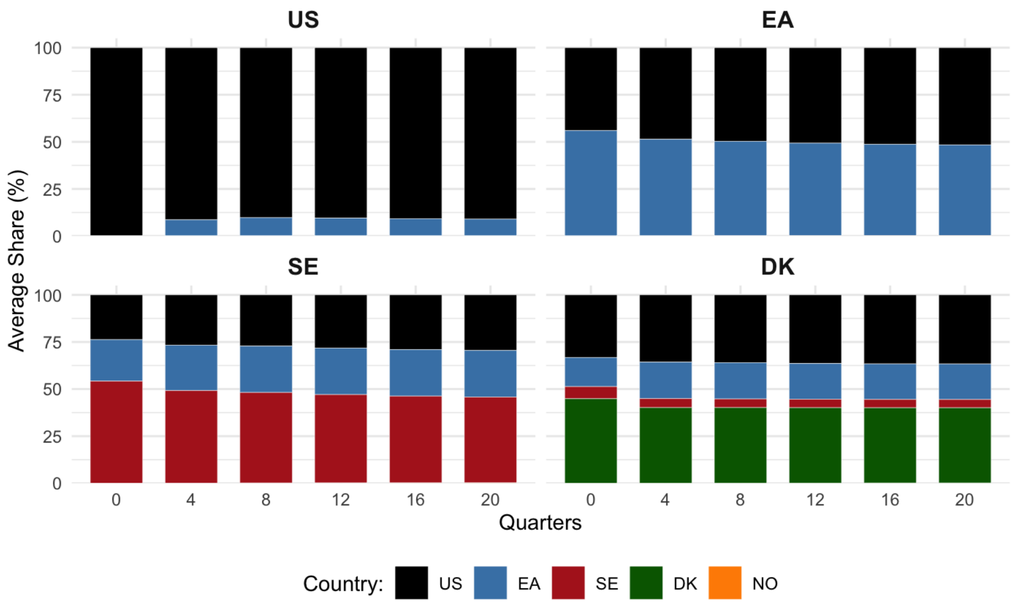

Figure 7: Forecast Error Variance Decomposition from OIRF

The Figure shows the Forecast Error Variance Decomposition for United States, Euro Area, Sweden, Denmark and Norway as a country average. Note the variable ordering applied is the Specification 2. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

The FEVD were computed following Feldkircher (2016) and the results provide evidence that the United States is almost entirely self-driven across all horizons, confirming its role as the exogenous global anchor in the system. The Euro Area shows a greater global exposure, with US shocks accounting for a meaningful share of variance consistent with Miranda-Agrippino & Rey (2020), but domestic factors remain dominant. Sweden and Denmark, on the other hand, present a significantly more regional and global exposure, with external factors, particularly Euro Area shocks, accounting for a substantial share of total variance throughout the forecast horizon. This is consistent with their specification as small open economies heavily integrated with the Euro Area (Pesaran et al., 2004; Hájek & Horváth, 2016). It is also aligned with Forbes et al. (2018, 2022) and Ellen et al. (2020), who emphasise that small open economies are exposed to global and regional shocks.

Furthermore, the regime comparison between Sweden and Denmark is also visible in the decomposition. For Sweden, domestic shocks retain a more meaningful share alongside the Euro Area contribution, consistent with the Riksbank's monetary autonomy allowing some independent domestic variation. For Denmark, the Euro Area together with the US block share the largest external contribution, with the US share comparatively larger, consistent with global shocks reaching Denmark through the Euro Area intermediary under ERM-II and the Euro Area being significantly influenced by the United States. Together these patterns support the broader transmission narrative developed throughout Sections 6.1–6.3, and suggests that the Euro Area functions as an external driver of variance in both economies, with global shocks playing a meaningful role in driving both the Euro Area and the small open economies.

6.5 Robustness

For Robustness checks of our results we consider three exercises. Firstly, assess the robustness of our results with respect to our country and variable ordering in Section 6.5.1. Secondly, in Section 6.5.2 we assess the FEVD under a GIRF-specification, assessing whether the variance attribution in the baseline FEVD is sensitive to the recursive identification structure. Lastly, in section 6.5.3 we consider the model validity by propagating an oil shock through the system.

6.5.1 GIRF and Variable Ordering

For the first robustness exercise, we complement the baseline OIRF analysis with structural GIRFs, as discussed in Section 4.3.1, and alternative recursive orderings, to the one outlined in Section 4.5.

The GIRF allows us to assess whether the results are sensitive to the recursive ordering imposed in the structural identification. As seen in FIgures 18–23 in Appendix A the general direction and timing of the responses remain largely unchanged, except for the short rate responses which are slightly elevated. This is expected in a GIRF as it may generate stronger responses due to contemporaneous co-movements between variables, e.g. if Swedish rate hikes historically have coincided with the global financial cycle, then increases will be associated with other countries increasing their interest rates, meaning contemporaneous spillover effects become larger. The recursive ordering of OIRFs mitigate this and are therefore a better approximative tool with regard to our research question when propagating individual shocks as we aim to isolate domestic-, regional- and global shocks.

Lastly, as outlined in Section 4.5.1, we test two alternative orderings to the ordering in Specification 2. Firstly, in the baseline specification, Sweden is ordered before Denmark and Norway, reflecting its larger economy and trade linkages in the weight matrix. However, Denmark's ERM-II participation provides an alternative institutional rationale for ordering Denmark before Sweden, due to Denmark's strong nominal links to the Euro Area. Re-estimating the model with Denmark ordered first among the Nordic economies leaves the main impulse responses and transmission ratios materially unchanged. Secondly, In addition, we test a variable-by-variable ordering across the small open economies, providing a contemporaneous interactions among the same macroeconomic variables across the Nordic economies. The results remain robust with this alternative specification as well.

6.5.2 Generalised Forecast Error Variance Decomposition

As a robustness check, Figure 24 in Appendix A presents the forecast error variance decomposition based on GIRF identification. Unlike the Cholesky-based OIRF FEVD, which attributes variance according to the recursive ordering imposed in Section 4.3.2, the GIRF-based decomposition is invariant to variable ordering and reflects the historical co-movement structure of the reduced-form residuals rather than orthogonal structural shocks. The comparison therefore does not provide an alternative structural decomposition, but allows us to assess whether the qualitative variance attribution in the baseline FEVD is sensitive to the recursive identification structure. The results are broadly consistent with the baseline findings: the Euro Area remains the dominant external driver of variance in both Sweden and Denmark, while the United States is largely self-driven across all horizons.

However, as discussed in Section 4.3.1, GIRFs do not isolate structural shocks, since each innovation reflects the contemporaneous correlation structure of the reduced-form residuals. As a result, variance attribution is more evenly distributed across shock sources, particularly for larger economies such as the United States and the Euro Area, where cross-country residual correlations are non-negligible (see Table 11). This more diffuse attribution should therefore be interpreted as a mechanical consequence of correlated shocks rather than as evidence of greater external openness.

Despite this, the qualitative hierarchy underlying the model validity argument in Section 6.4 remains intact. Larger economies remain predominantly self-driven, while smaller open economies exhibit greater external dependence. Sweden and Denmark continue to display a higher external share than the United States, and the Euro Area remains the primary external contributor to Nordic variance. This consistency suggests that the main conclusions are not primarily driven by the recursive identification structure and provide additional support for the transmission patterns documented in Sections 6.1–6.3.

6.5.3 Oil Price Shock

As a robustness exercise, we assess the validity of the model specification by propagating an oil price shock through the system. Oil shocks provide a useful benchmark for this purpose, as their macroeconomic transmission has been extensively studied in the literature (Pesaran et al., 2004; Hájek & Horváth, 2016). The exercise therefore allows us to evaluate whether the model generates responses that are broadly consistent with established empirical and theoretical expectations.

As oil enters the GVAR system as an exogenous variable, it is not included in the companion matrix in the stacked system. This means that oil shocks will propagate through the system via an external disturbance path in Equation (3). Following Pesaran et al. (2004), we specify the oil series as follows.

$$\Delta oil_t = a_0 + \gamma_1 \Delta oil_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim iid(0, \Sigma_{\Delta oil}) \tag{11}$$

Where a_0 is the intercept, γ the coefficient of lagged effects and ε_t is the shocks to the exogenous variable, oil. $\Sigma_{\Delta oil}$ is the covariance matrix of shocks.[20]

The results, seen in Figure 25 in Appendix A, shows the responses for all domestic variables across all countries following a standard deviation oil price shock. The results overall mirror what is expected following an oil price increase, resulting in higher CPI and interest rates. However, two deviations from the standard interpretation emerge with regard to the GDP- and exchange rate responses. First, all countries display a positive GDP response. This is surprising, given that Norway is the only net oil exporter in the sample, while the remaining economies are net oil importers. However, since the external disturbance path does not identify the structural origin of the oil price shock it becomes more difficult to disentangle the nature of the shock. As emphasised by Pesaran et al. (2004), Hájek & Horváth (2016), and Cashin et al. (2014), reduced-form oil price innovations do not distinguish cleanly between oil supply and oil demand shocks. The positive GDP responses should therefore be interpreted as reflecting the reduced-form nature of the shock, where the estimated impulse responses are influenced by historical co-movements between oil prices and output, rather than the causal effect of a pure adverse oil supply disturbance. In light of this the CPI response becomes more important given that both oil supply and oil demand shocks are associated with higher oil prices and should exert upward pressure on inflation, consistent with our findings. Second, the exchange rate responses are mostly consistent with the standard interpretation of an oil-price increase. Norway, as a net oil exporter, experiences an appreciation, while the US, as a net oil importer, sees a depreciation. However, the Swedish exchange rate also appreciates slightly following the shock, despite being a net oil importer. This response is consistent with the reduced-form interpretation of the oil-price innovation, implying that the estimated exchange rate response may reflect the empirical covariance structure of the data rather than the isolated effect of an adverse oil supply shock.

[20] The lag structure is selected using the Bayesian Information Criterion (BIC) and the resulting external disturbance path is stationary.

7 Discussion

7.1 Review of Results

The main finding of this study is that the monetary regime has an important role in shaping inflation dynamics and exchange rate pass through in Sweden and Denmark, primarily affecting the short term dynamics speed and degree of transmission. However, the degree of long run transmission appears to be less affected by the monetary regime. Furthermore, the degree of pass-through and inflation transmission is also shown to vary by shock origin, in line with previous literature on shock-dependent ERPT (Forbes et al. 2018, 2020). Our GVAR model provides a framework wherein international spillovers and heterogeneous transmission dynamics from common shocks can be estimated; however direct causal mechanisms are hard to infer. Our analysis can therefore offer possible explanations based on the broader ERPT literature and empirical evidence as it relates to small open economies, monetary regime and inflation dynamics.

Fundamentally, the monetary regime conditions central banks autonomy in response to common shocks. Denmark's ERM II peg-mechanism means that Nationalbanken must maintain the krone's stability and therefore adjust monetary policy accordingly, whereas the Swedish Riksbank has greater freedom in its monetary policy response, leaving the Krona floating. This has important implications for the transmission of common exogenous shocks affecting both economies and more particularly which macroeconomic channels dominate the response: when the exchange rate is free to move, it constitutes an additional adjustment margin through which external impulses may be partially absorbed before reaching domestic prices, whereas where it is fixed, the burden of adjustment falls on domestic prices and interest rates directly. Which of these channels dominates the response is likely to vary further with the origin of the shock itself.

The shock-dependent ERPT literature has established that pass-through varies systematically with the shock origin, and the regime literature has documented how fixed and floating arrangements condition domestic transmission separately. Forbes et al. (2018, 2020) find that monetary policy shocks generate substantially stronger pass-through than demand-driven movements because the macroeconomic environment accompanying the shock reinforces the price response, while Spange & Sørensen (2017) and Ellen et al. (2020) show that fixed exchange rate arrangements amplify the transmission of external monetary conditions by removing the exchange rate as an absorbing channel. Our results are broadly consistent with the view that the regime and the shock origin condition each other: the regime determines which channels are available to carry the transmission, and the shock origin conditions how those available channels respond. For Sweden, the PERR varies substantially across shock origins, from 7% after a domestic tightening to 2% after an equivalent Euro Area shock, consistent with Corbo & Di Casola (2022), who find that the demand and financial conditions accompanying the exchange rate movement determine the degree of pass-through rather than the movement itself. For Denmark, where the exchange rate channel is largely closed under ERM-II, the shock origin instead conditions how directly Euro Area monetary conditions are imported, consistent with Ellen et al. (2020), who find that ECB spillovers impose greater constraints precisely where exchange rate flexibility is limited. Regime choice and shock origin are therefore best understood as complementary dimensions of inflation transmission, jointly conditioning which channels are available and how strongly they respond.

A related insight from the regional results concerns the potential insulation that monetary autonomy provides. Spange & Toftdahl (2014) show that the credibility of a fixed exchange rate regime lowers pass-through by reducing exchange rate volatility, while the broader literature on Sweden and Denmark suggests that the floating krona allows external shocks to be partly absorbed through exchange rate adjustment whereas the peg shifts a greater share of adjustment toward domestic prices and imported monetary conditions. Our results are broadly consistent with the latter but add a dimension of nuance: the floating krona appears to delay rather than prevent transmission of Euro Area price impulses. Denmark's short-run inflation co-movement of 59% with the Euro Area against Sweden's 49% following the EA CPI shock indicates a potentially stronger transmission to Denmark, consistent with Comunale & Kunovac (2017) and Kristoffersen & Spange (2016, 2017) who find that transmission speed and completeness increase with the degree of monetary integration. The convergence of both ratios toward 49 to 51% in the long run, however, suggests that the exchange rate buffer is gradually absorbed into domestic prices over time rather than providing lasting insulation. The regime difference, in the context of Sweden and Denmark, therefore appears primarily to act as a timing mechanism, shaping the speed and short-run magnitude of adjustment rather than its long-run direction. This distinction may carry some relevance for how monetary autonomy is understood in the context of the Swedish euro debate. The results suggest that exchange rate flexibility may provide temporary insulation by slowing the domestic transmission of external shocks, even where long-run inflation dynamics ultimately converge. In this sense, the primary benefit of monetary autonomy may lie less in permanently avoiding external inflationary pressures and more in shaping the timing and short-run adjustment process through which those pressures affect the domestic economy.

The results following the global shocks suggest that the mechanisms identified above persist as the transmission chain becomes more indirect. Sweden's non-monotonic PERR following the Fed shock is consistent with the exchange rate buffer becoming less predictable as the shock passes through an additional intermediary step. This reinforces the view that monetary autonomy provides a margin of adjustment whose effectiveness varies with how directly the shock reaches the domestic economy. Denmark's inflation transmission ratio following the US CPI shock sits close to the Euro Area's own, which is consistent with Spange & Sørensen (2017), suggesting the peg appears to anchor Denmark to Euro Area conditions regardless of shock origin. Thus the exchange rate regime may shape not only how regional impulses transmit but how deeply global ones are embedded.

7.2 Limitations and Future Research

While the estimated GVAR provides a useful framework for analysing international spillovers, the results should be contextualised within the scope of the modelling choices and data constraints underlying the analysis. In particular, the country and data coverage, recursive ordering, and imposed long-run restrictions shape both the estimated dynamics and the interpretation of the results.

The country selection was guided by the aim of capturing the most important financial partners of Sweden and Denmark, which necessarily limits the country coverage. The limited country coverage contributes to some residual correlation and cross sectional dependence in the model (Pesaran et al., 2004). However, considering the modelling choice of US as an exogenous driver reduces some of the concerns tied to the correlations, outlined in Section 5, but is worth noting. Furthermore, the limited time-series dimension of the data restricts the number of additional features that can be included, such as more flexible lag structures, additional deterministic terms, or controls for lower-bound periods in interest rates, leaving limited scope for more parameter-rich specifications,

A second limitation concerns the economically motivated cointegration ranks. Theoretically imposed ECTs may increase parsimony and interpretability but also risk influencing the adjustment dynamics of the model. In particular, some of the responses might be partly influenced by the adjustment paths implied by the imposed error-correction structure. However, given that the adjustment coefficients are well behaved, the GVAR system being stable and the error-correction terms stationary, we do not consider this to materially affect the main results. Nevertheless, it remains a potential limitation worth noting.

Thirdly, although the results are robust to alternative recursive orderings and broadly consistent with the generalized impulse response functions, some caution is still warranted regarding the use of Cholesky identification (Stock & Watson, 2001). However, even with these robustness checks, the recursive ordering may not fully rule out the risk that some shocks are less precisely identified, which may affect the interpretation of individual responses.

This limitation points directly to a natural extension of the study. For future research we propose expanding on the structural identification inferred in the study. Established ERPT literature commonly uses sign restrictions in order to facilitate the identification of a shock as a demand-, supply- or monetary policy shock (Forbes et al. 2018, 2022). Although implementing such restrictions in a GVAR is considered less straightforward, a potential extension would be to adopt sign-restrictions to a selected set of key shocks, in order to provide an alternative structural interpretation of the transmission mechanism. Additionally, future research could extend the analysis including the import prices, which is covered by ERPT literature (Ortega & Osbat, 2020). This would allow for decomposing where in the pricing chain the regime difference operates, at the border-price stage or through the subsequent transmission from import prices to consumer prices.

8 Conclusion

This study investigates monetary regime-dependent differences in exchange rate pass-through (ERPT) and inflation transmission dynamics between Sweden and Denmark between 2000Q1–2024Q4. To capture international interdependencies, we adopt a Global Vector Autoregressive Model (GVAR) with a Cholesky decomposition. The modelling approach contributes to the literature by providing a coherent framework in which identical external shocks can be propagated across both economies, enabling a stronger comparison of how regime-specific dynamics can affect the transmission to domestic inflation. Using domestic (Sweden), regional (Euro Area) and global (United States) exchange rate-, monetary policy- and price-level shocks we identify meaningful differences in inflation transmission between both countries. Our findings suggest that monetary autonomy appears to condition the speed and short-run magnitude of adjustment rather than its long-run direction. Furthermore, the degree of pass-through and inflation transmission is shown to vary by shock origin, in line with previous literature on shock-dependence.

For regional and global price shocks, Denmark exhibits a stronger and more immediate inflation response than Sweden, consistent with a more limited role of the exchange rate as an adjustment mechanism under ERM-II and the broader finding in the literature that transmission speed and completeness increase with the degree of monetary integration. Sweden by contrast displays a weaker and more gradual response, as the floating krona partially offsets external price pressures in the short run, in line with the existing evidence on Swedish inflation dynamics. For monetary policy shocks, the interest rate responses confirm the institutional difference between the regimes. Denmark's short rate co-moves closely with the Euro Area while Sweden's less complete adjustment reflects retained Riksbank discretion. The results are robust to alternative recursive orderings and Generalised Impulse Response Specifications.

In summary, the results, in combination with evidence from previous literature, suggest that exchange rate regime choice conditions the speed and short-run magnitude of inflation adjustment rather than its long-run direction. This distinction may carry relevance for how the costs and benefits of monetary autonomy are assessed in highly integrated small open economies such as Sweden and Denmark.

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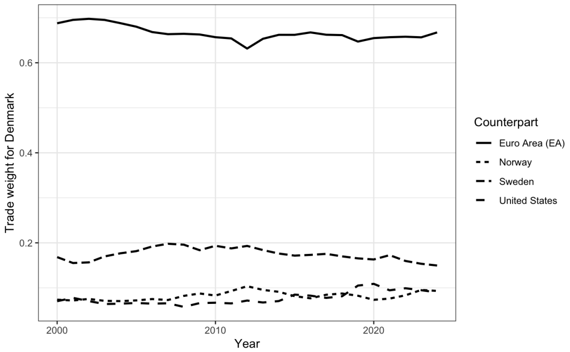
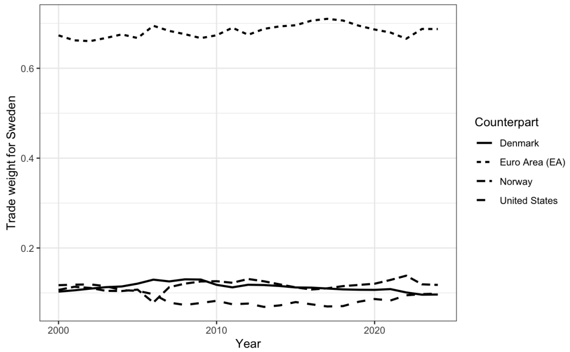
10 Appendix

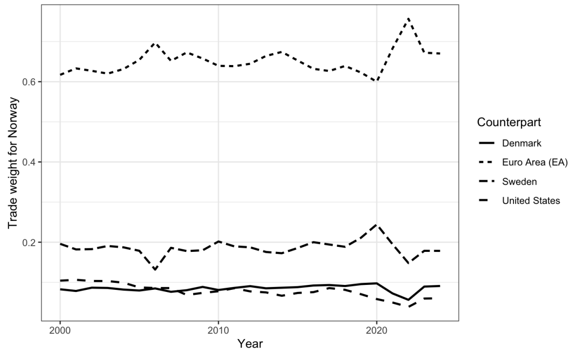
10.1 Appendix A: Tables and Figures



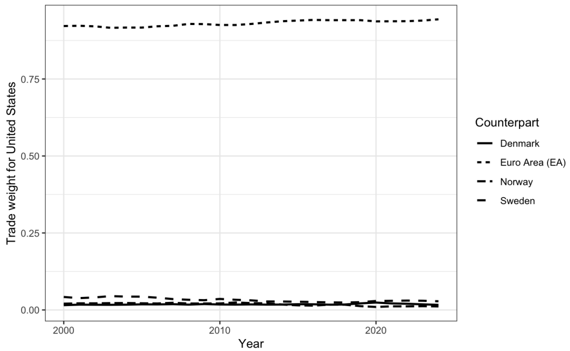
(a) Denmark



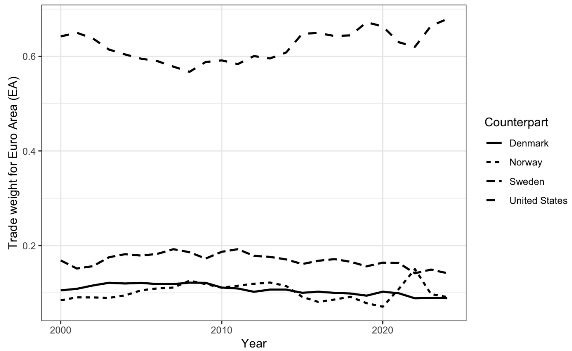
(b) Sweden



(c) Norway



(d) United States



(e) Euro Area

Figure 8: Trade weights

The figure shows the annual trade weights, outlined in Section 3.1, for the United States, Euro Area, Sweden, Denmark and Norway. *Source: Authors' rendering of IMF bilateral trade data (2000–2024).*

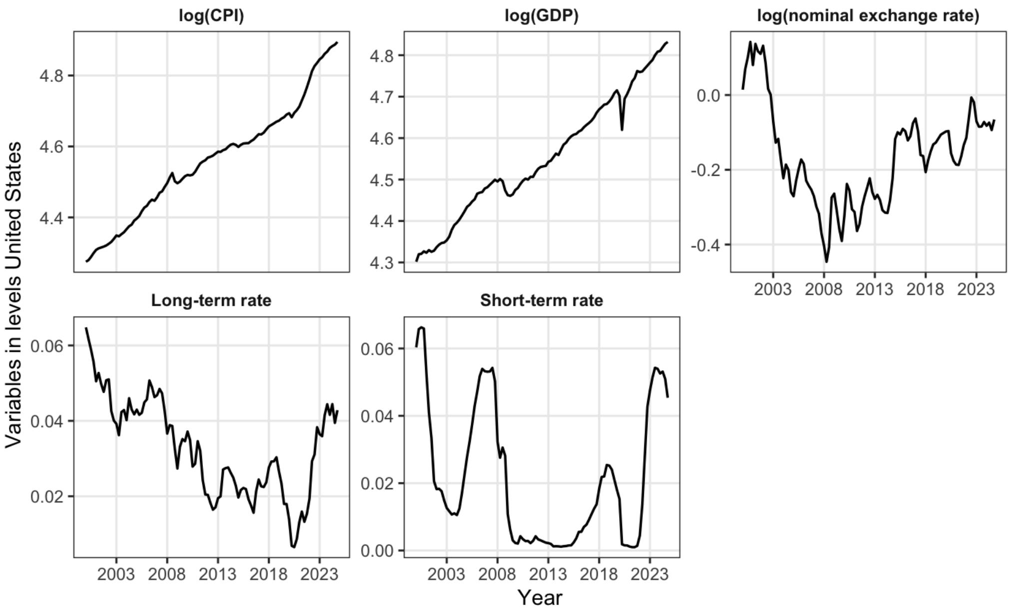


Figure 9: Plot of United States' Domestic variables (levels)

The figure shows the level plots for United States domestic variables; CPI, GDP, exchange rate, short term interest rate and long term interest rate, with the transformations outlined in Table 1. *Source: Authors' rendering of IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

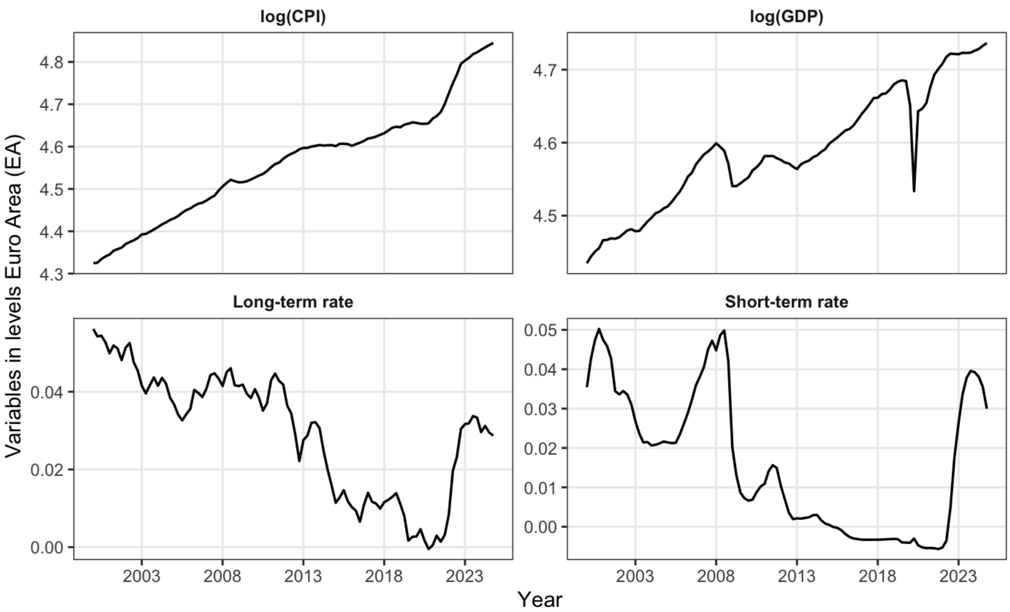


Figure 10: Plot of Euro Area's Domestic variables (levels)

The figure shows the level plots for Euro Area domestic variables; CPI, GDP, short term interest rate and long term interest rate, with the transformations outlined in Table 1. *Source: Authors' rendering of IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

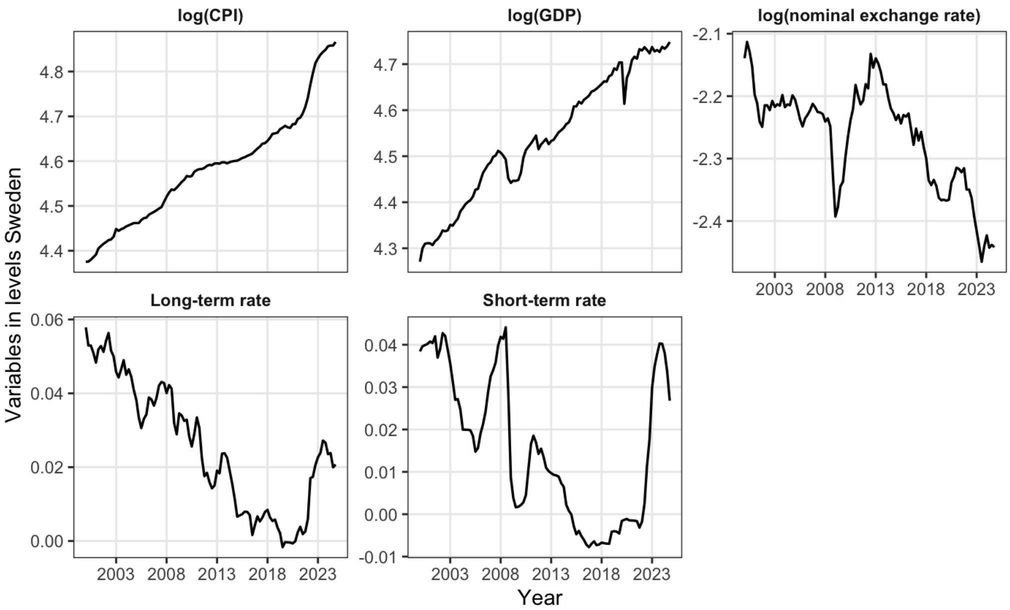


Figure 11: Plot of Sweden's Domestic variables (levels)

The figure shows the level plots for Sweden domestic variables; CPI, GDP, exchange rate, short term interest rate and long term interest rate, with the transformations outlined in Table 1. *Source: Authors' rendering of IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

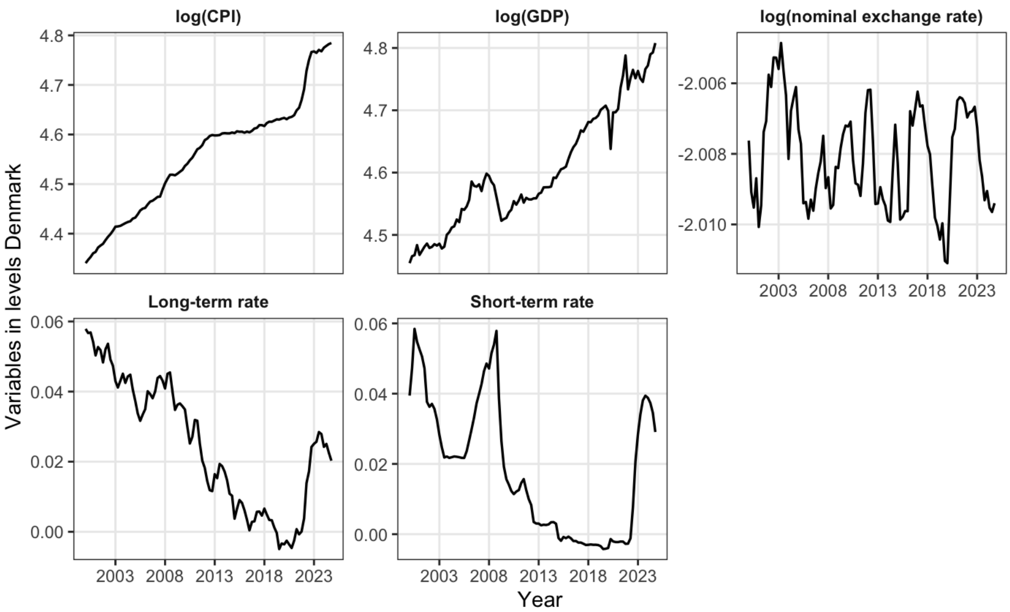


Figure 12: Plot of Denmark's Domestic variables (levels)

The figure shows the level plots for Denmark domestic variables; CPI, GDP, exchange rate, short term interest rate and long term interest rate, with the transformations outlined in Table 1. *Source: Authors' rendering of IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

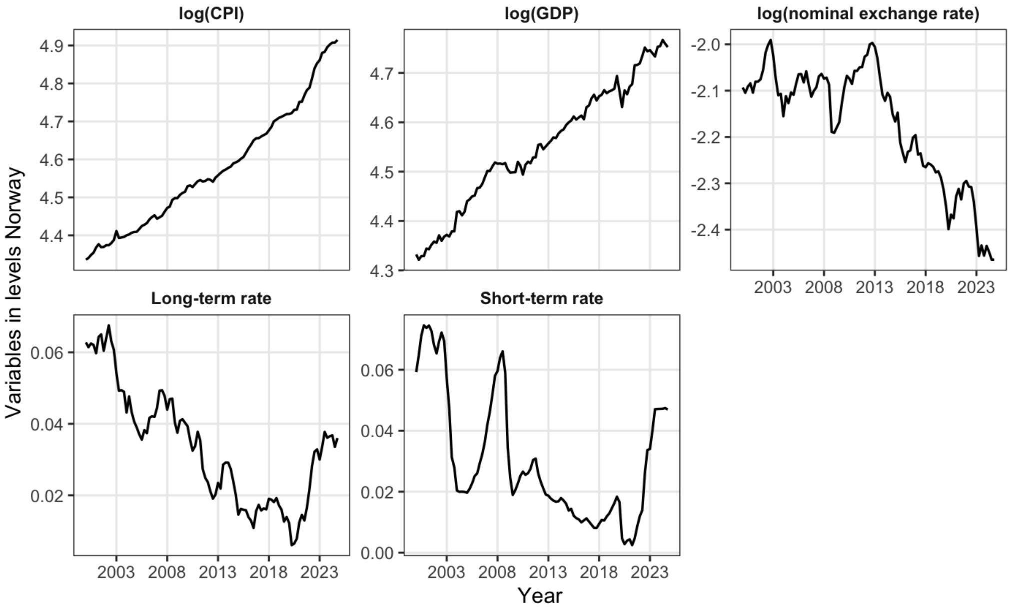


Figure 13: Plot of Norway's Domestic variables (levels)

The figure shows the level plots for Norway domestic variables; CPI, GDP, exchange rate, short term interest rate and long term interest rate, with the transformations outlined in Table 1. *Source: Authors' rendering of IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Country	lr^*	lr	sr^*	sr	oil	π	π^*	y	y^*	s	s^*
Sweden	-1.821	-1.646	-2.960	-2.604	-2.420	-0.795	-1.721	-2.901	-2.853	-1.519	-2.013
Denmark	-1.779	-1.792	-3.010	-2.537	-2.420	-2.255	-1.485	-1.565	-3.085	-3.666	-1.536
Norway	-1.775	-1.827	-3.012	-2.762	-2.420	-0.103	-1.805	-2.843	-2.991	-0.174	-2.518
Euro Area	-2.128	-1.782	-3.147	-2.937	-2.420	-1.880	-0.935	-3.132	-2.400	-	-2.745
United States	-1.771	-2.361	-2.953	-3.299	-2.420	-1.097	-1.856	-2.241	-3.106	-2.434	-0.591

Table 8: ADF-test for Domestic and Foreign Variables in Levels

The table reports critical values from ADF tests applied to the variables in levels for each country. Both domestic variables and their corresponding foreign aggregates are included. Here, y denotes log GDP, π denotes log CPI, sr and lr denote the short- and long-term interest rates, and s denotes the log nominal exchange rate vis-à-vis the Euro. The foreign corresponding variables are noted with *. For output and inflation the ADF regressions include both an intercept and a deterministic trend (critical value of -3.45), while the remaining variables are tested with an intercept only (critical value of -2.89). The oil price series is common across countries and is therefore reported with the same value in each row. The symbol "–" indicates that the variable is not included in the corresponding country model. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Country	Δlr	Δlr^*	Δsr	Δsr^*	Δoil	$\Delta\pi$	$\Delta\pi^*$	Δy	Δy^*	Δs	Δs^*
Sweden	-6.926	-6.240	-4.797	-4.814	-7.463	-5.043	-4.218	-10.214	-10.956	-7.449	-7.552
Denmark	-6.716	-6.385	-4.699	-4.830	-7.463	-4.675	-4.268	-10.487	-10.822	-8.510	-5.902
Norway	-7.302	-6.376	-4.765	-4.819	-7.463	-8.684	-4.026	-11.948	-10.698	-5.953	-8.408
Euro Area (EA)	-5.891	-7.511	-4.751	-4.765	-7.463	-4.090	-5.705	-10.964	-10.767	-	-7.203
United States	-6.961	-5.833	-4.407	-4.767	-6.870	-5.362	-3.290	-8.132	-8.280	-6.875	-5.161

Table 9: ADF-test for Domestic and Foreign Variables in First Differences

The table reports critical values from ADF tests applied to the variables in differences for each country. Both domestic variables and their corresponding foreign aggregates are included. For all variables the ADF regressions include an intercept only (critical value of -2.89). The oil price series is common across countries and is therefore reported with the same value in each row. The symbol "–" indicates that the variable is not included in the corresponding country model. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Country	y	π	sr	lr	s	Δy	$\Delta \pi$	Δsr	Δlr	Δs
United States	0.98	0.99	0.70	0.88	-0.08	0.71	0.56	0.55	0.75	-0.01
Euro Area (EA)	0.97	0.99	0.91	0.91	-	0.72	0.69	0.78	0.74	-
Sweden	0.98	0.99	0.87	0.95	0.28	0.62	0.70	0.64	0.81	0.11
Denmark	0.97	0.99	0.89	0.95	0.13	0.58	0.64	0.70	0.81	0.09
Norway	0.98	0.98	0.84	0.94	0.26	0.41	0.46	0.66	0.77	0.17

Table 10: Average pair-wise cross-country correlation

The table reports average pair-wise cross-country correlations for variables in levels and first differences. Here, y denotes GDP, π denotes CPI, sr and lr denote the short- and long-term interest rates, and s denotes the bilateral exchange rate vis-à-vis the euro. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

	US	EA	SE	DK	NO
Panel A: Real GDP					
US	1.000	0.795	0.546	0.556	0.389
EA	0.795	1.000	0.646	0.523	0.456
SE	0.546	0.646	1.000	0.457	0.243
DK	0.556	0.523	0.457	1.000	0.387
NO	0.389	0.456	0.243	0.387	1.000
Panel B: CPI Inflation					
US	1.000	0.243	0.258	0.317	0.151
EA	0.243	1.000	0.624	0.512	0.271
SE	0.258	0.624	1.000	0.455	0.639
DK	0.317	0.512	0.455	1.000	0.206
NO	0.151	0.271	0.639	0.206	1.000
Panel C: Short-Term Interest Rates					
US	1.000	0.024	-0.228	0.044	0.117
EA	0.024	1.000	0.274	-0.170	0.070
SE	-0.228	0.274	1.000	-0.440	-0.074
DK	0.044	-0.170	-0.440	1.000	-0.068
NO	0.117	0.070	-0.074	-0.068	1.000
Panel D: Long-Term Interest Rates					
US	1.000	0.003	0.070	0.084	0.207
EA	0.003	1.000	-0.410	-0.317	-0.398
SE	0.070	-0.410	1.000	0.349	0.334
DK	0.084	-0.317	0.349	1.000	0.217
NO	0.207	-0.398	0.334	0.217	1.000
Panel E: Nominal Exchange Rates					
US	1.000	NA	0.106	0.094	0.188
SE	0.106	NA	1.000	0.104	0.258
DK	0.094	NA	0.104	1.000	0.150
NO	0.188	NA	0.258	0.150	1.000

Table 11: Cross-Country Residual Correlations

The table reports the cross-country residual correlation for single country VECM-X equation, from Equation (1). Panel A to E denotes what variable residual correlation between the variables. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Country	BIC (p=1)	BIC (p=2)	BIC (p=3)	BIC (p=4)
United States	-28.4609	-28.7524	-27.8892	-27.1271
Euro Area	-22.6438	-23.2291	-22.6622	-22.1397
Sweden	-30.3796	-30.3481	-29.7663	-28.9249
Denmark	-36.5877	-36.7511	-35.8550	-35.0822
Norway	-29.3360	-28.9747	-28.2257	-27.3709

Table 12: Lag Selection Criteria: Bayesian Information Criterion (BIC) by Country
The table reports BIC values for lag orders $p = 1, 2, 3, 4$ in each country specification. The selected lag order corresponds to the lowest BIC value. Tests are performed on variables in levels. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Country	Variable	p-value
US	Δy	0.08
US	$\Delta \pi$	0.47
US	Δsr	0.75
US	Δlr	0.92
US	Δs	0.19
EA	Δy	0.30
EA	$\Delta \pi$	0.19
EA	Δsr	0.57
EA	Δlr	0.10
SE	Δy	0.90
SE	$\Delta \pi$	0.47
SE	Δs	0.17
SE	Δsr	0.62
SE	Δlr	0.05
DK	Δy	0.80
DK	$\Delta \pi$	0.52
DK	Δs	0.24
DK	Δsr	0.23
DK	Δlr	0.47
NO	Δy	0.12
NO	$\Delta \pi$	0.52
NO	Δs	0.17
NO	Δsr	0.15
NO	Δlr	0.05

Table 13: Ljung-Box White Noise test

The table reports P-values following a Ljung-box test for each country equation. Here Δy denotes the differenced output, $\Delta \pi$ the differenced inflation, Δsr and Δlr denote the differenced short- and long term interest rate. Lastly, Δs denotes the differenced bilateral exchange rate series vis-à-vis the euro. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

Country	Foreign variable	F-statistic
United States	Δy^*	0.1157
United States	$\Delta \pi^*$	0.1260
United States	Δsr^*	0.1184
United States	Δlr^*	2.5715
Euro Area	Δy^*	0.0175
Euro Area	$\Delta \pi^*$	1.7634
Euro Area	Δsr^*	0.9752
Euro Area	Δlr^*	3.0305
Euro Area	Δs^*	0.0049
Sweden	Δy^*	0.3115
Sweden	$\Delta \pi^*$	0.1110
Sweden	Δsr^*	0.7006
Sweden	Δlr^*	0.0274
Denmark	Δy^*	0.2574
Denmark	$\Delta \pi^*$	1.4177
Denmark	Δsr^*	0.5575
Denmark	Δlr^*	0.1918
Norway	Δy^*	0.5518
Norway	$\Delta \pi^*$	0.9703
Norway	Δsr^*	1.2609
Norway	Δlr^*	0.1795

Table 14: Weak Exogeneity Test Results for Foreign Variables

The table reports weak exogeneity test results for the foreign variables included in each country-specific model. Here, y^* denotes foreign log GDP, π^* denotes foreign log CPI, sr^* and lr^* denote the foreign short- and long-term interest rates, and s^* denotes the foreign log nominal exchange rate. Δ denotes first differences. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

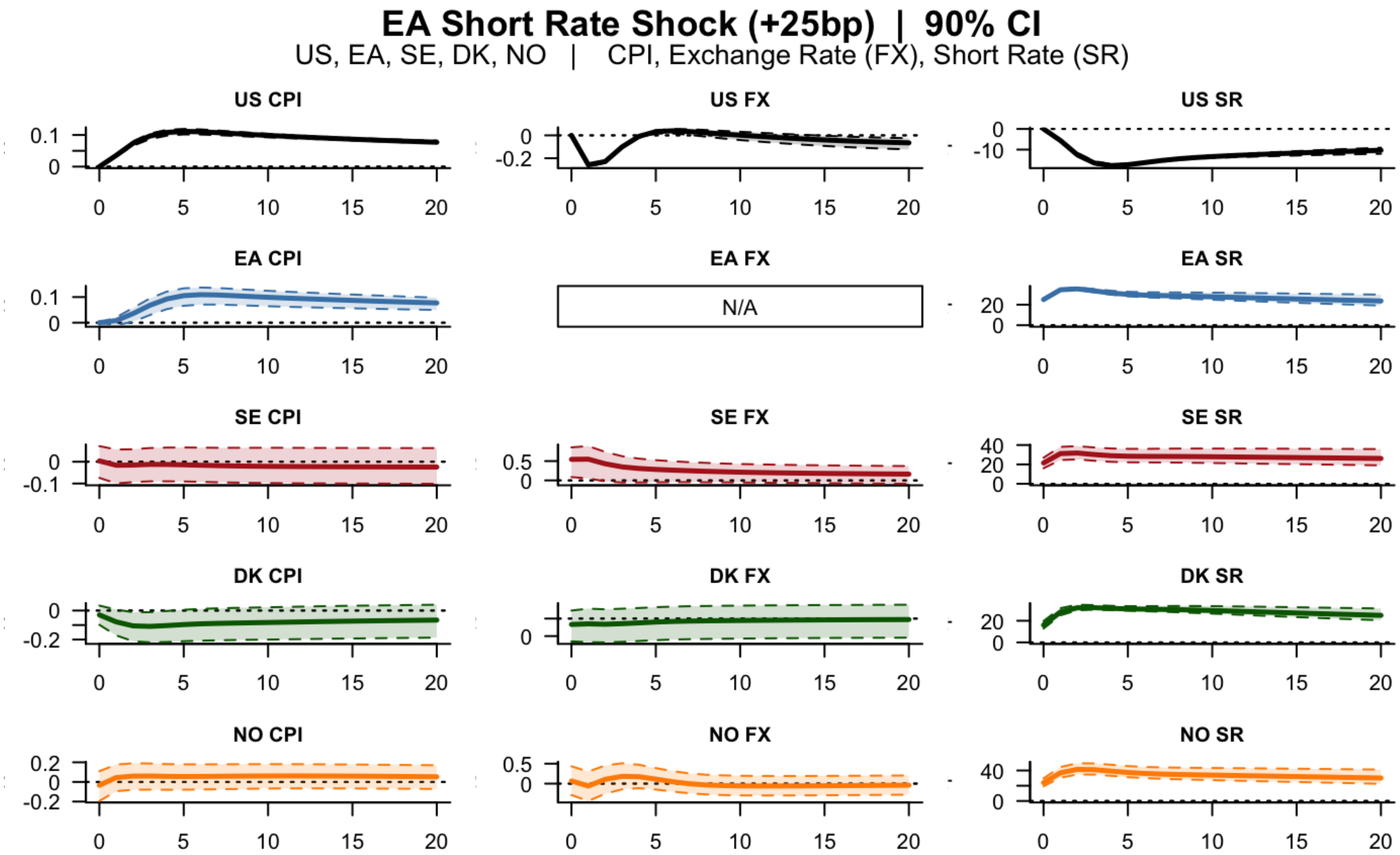


Figure 14: Impulse responses to a Euro Area Short-Rate shock

The figure displays each countries' response of CPI, bilateral exchange rate vis-á-vis the euro and short term interest rates following a 25 basis points Euro Area short rate increase. Confidence intervals from 5,000 bootstrap replications, with 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

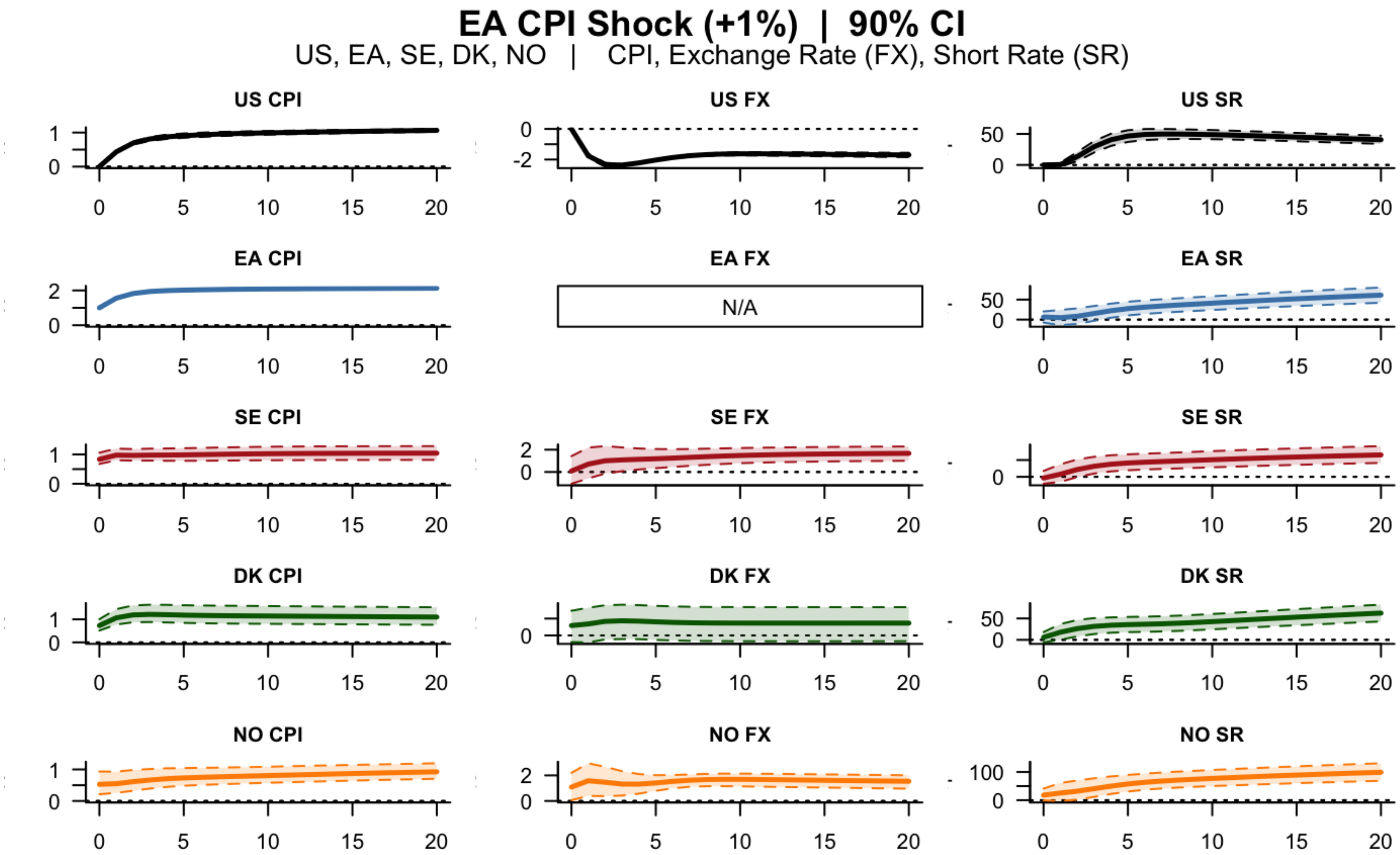


Figure 15: Impulse responses to a 1% Euro Area CPI shock

The figure displays each countries' response of CPI, bilateral exchange rate vis-á-vis the euro and short term interest rates following a one percent Euro Area CPI increase. Confidence intervals from 5,000 bootstrap replications, with 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

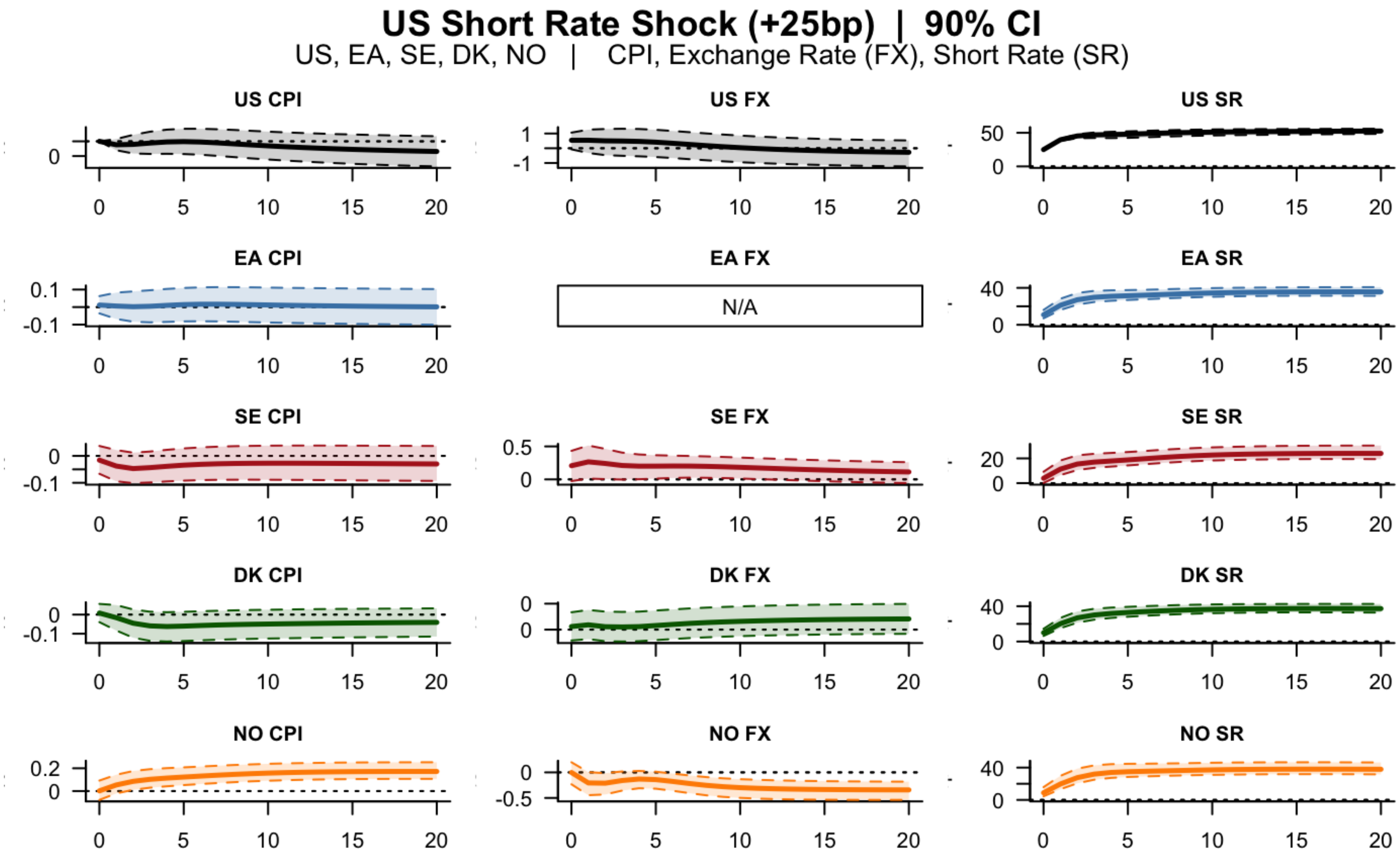


Figure 16: Impulse responses to a 25bp US short-rate shock

The figure displays each countries' response of CPI, bilateral exchange rate vis-á-vis the euro and short term interest rates following a 25 basis points United States short rate increase. Confidence intervals from 5,000 bootstrap replications, with 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

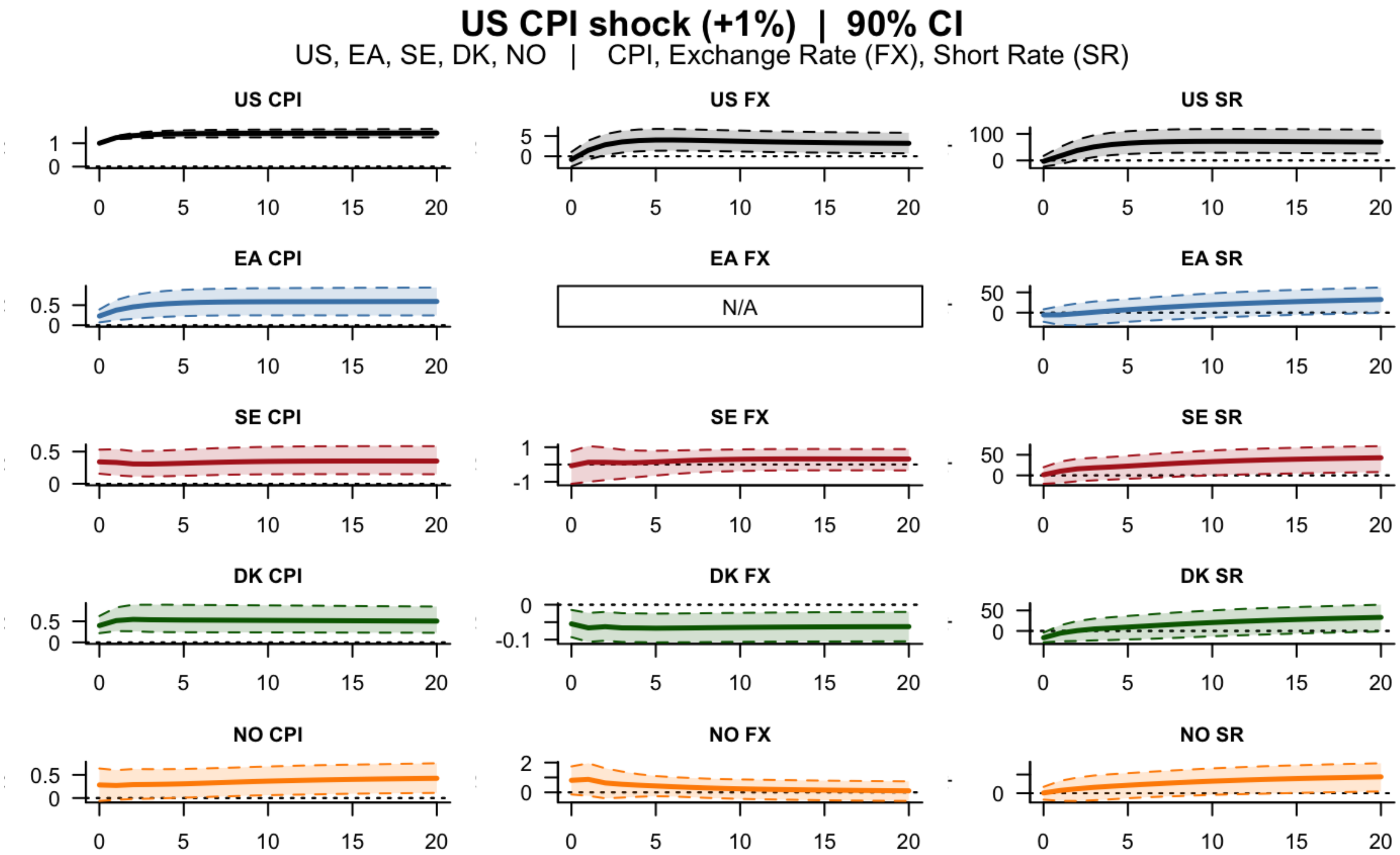
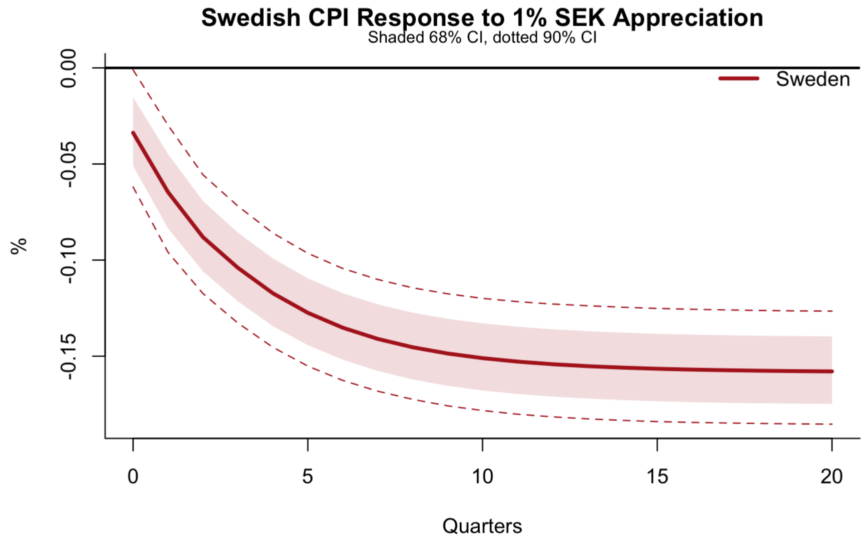


Figure 17: Impulse responses to a 1% US CPI shock

The figure displays each countries' response of CPI, bilateral exchange rate vis-á-vis the euro and short term interest rates following a 1% United States CPI increase. Confidence intervals from 5,000 bootstrap replications, with 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*



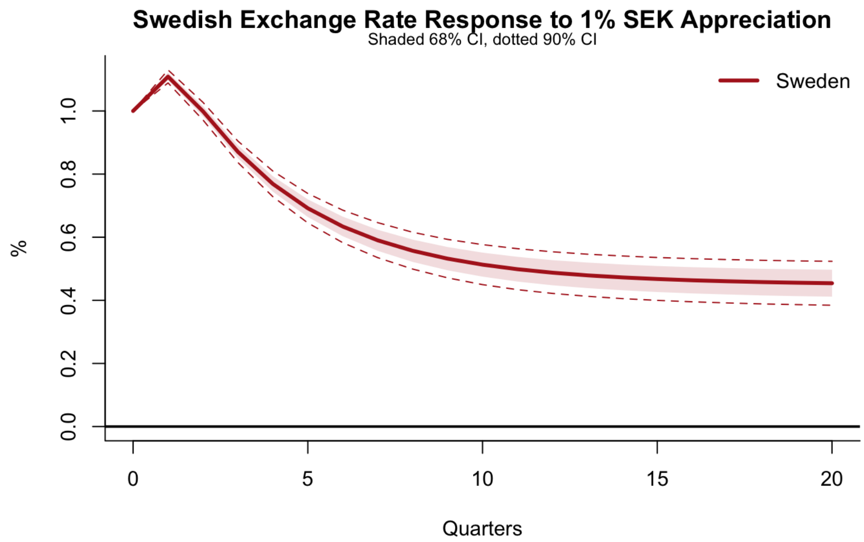


Figure 18: Generalised Impulse Responses (levels) following a 1% SEK appreciation

The figure shows the Generalised impulse responses of Swedish CPI and the bilateral exchange rate following a 1% appreciation of the Swedish krona vis-à-vis the euro. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

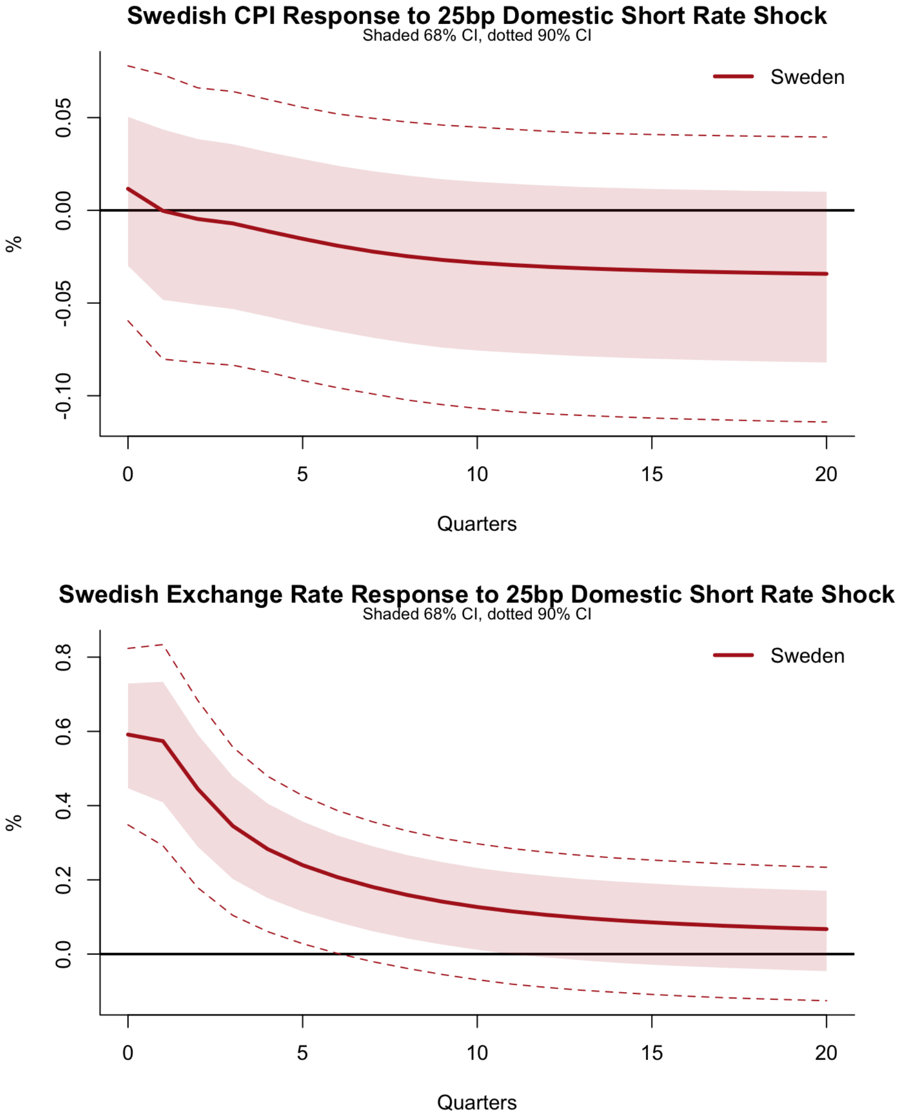


Figure 19: Swedish Generalised Impulse Responses (levels) following Domestic 25bp Short Rate shock.

The figure shows the Generalised impulse responses of Swedish CPI and the bilateral exchange rate vis-à-vis the euro following a 25 basis points increase of the Swedish short rate. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

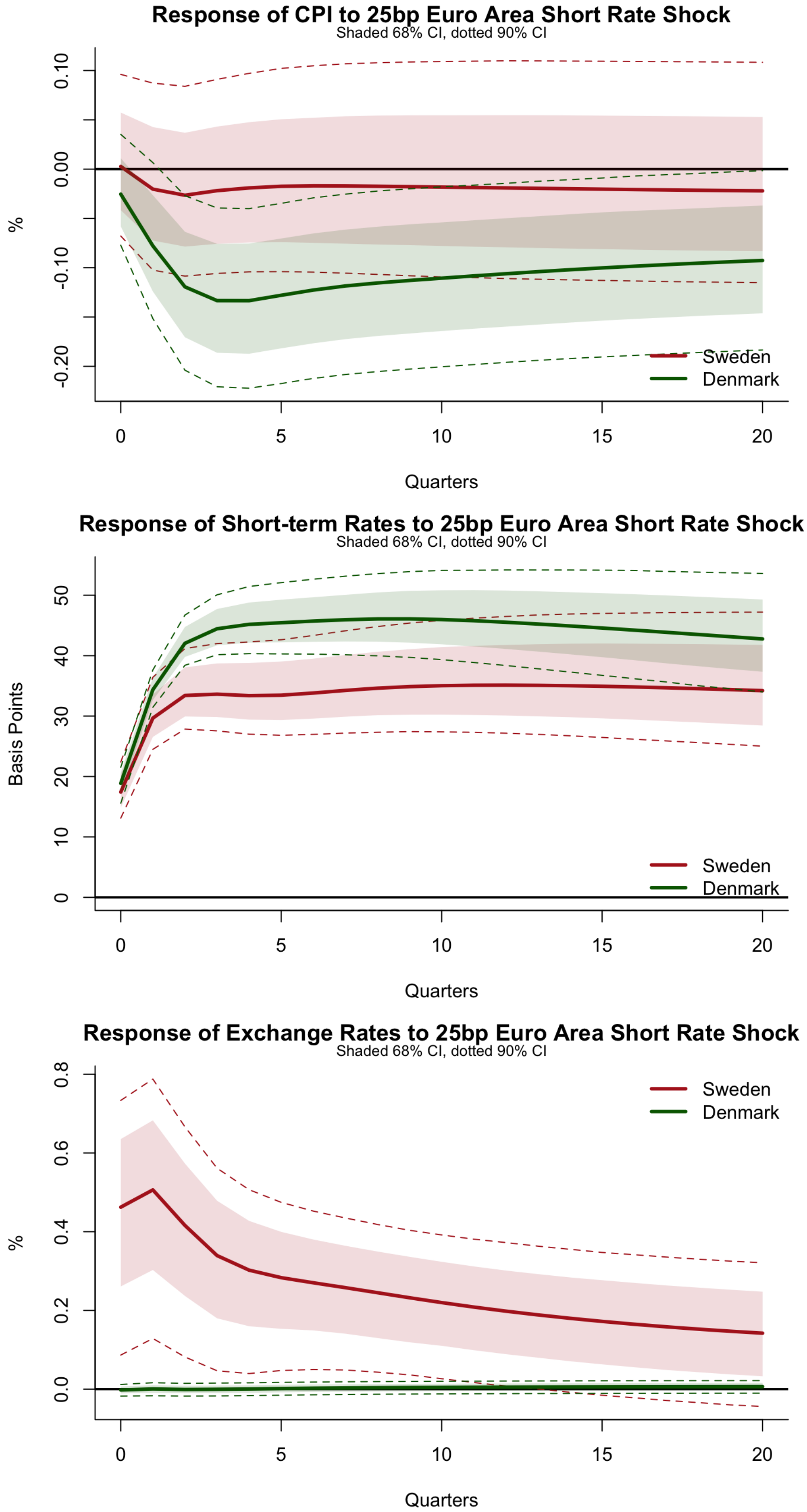


Figure 20: Generalised Impulse Responses (levels) following 25bp Euro Area Short Rate shock

The figure shows the Generalised impulse responses of Swedish and Danish CPI, short rates, and bilateral exchange rates vis-à-vis the euro following a 25 basis point increase in the Euro Area short rate. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

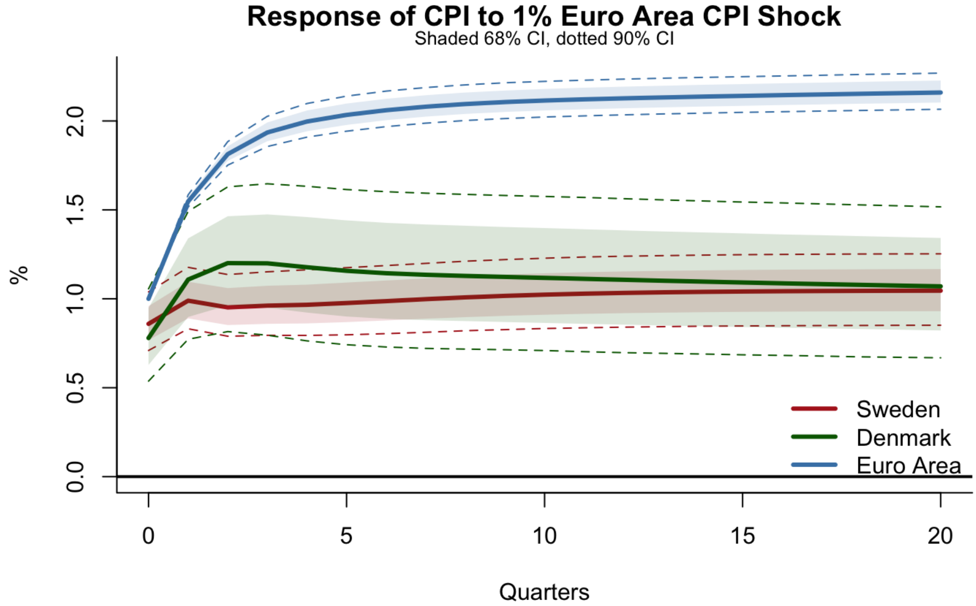


Figure 21: Generalised Impulse Responses (levels) following 1% Euro Area CPI shock

The figure shows the Generalised impulse responses of Swedish, Danish and Euro Area's CPI following a 1% increase in the Euro Area CPI. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

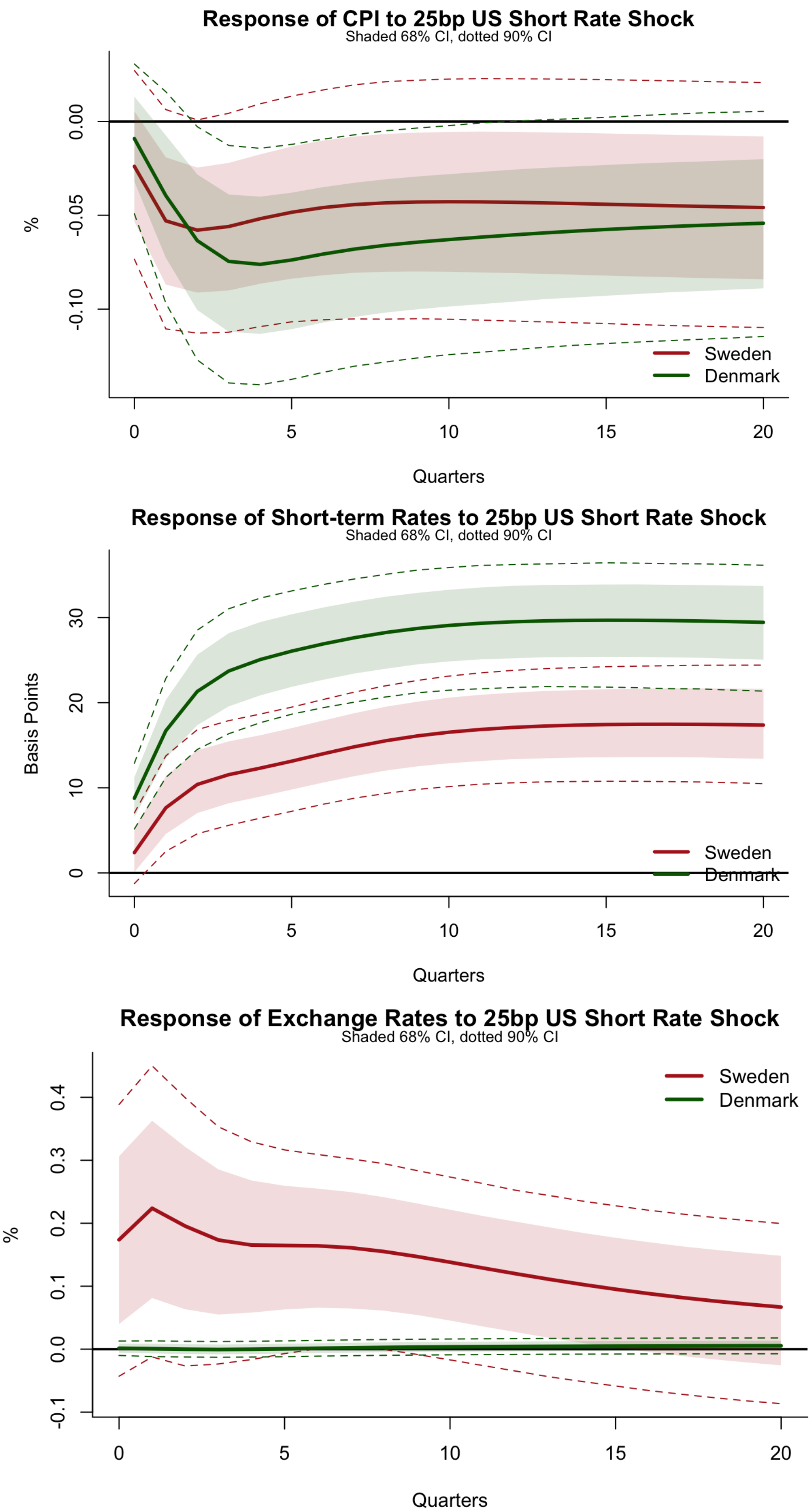


Figure 22: Generalised Impulse Responses (levels) following 25bp US Short Rate shock

The figure shows the Generalised impulse responses of Swedish and Danish CPI, exchange rate vis-à-vis the euro and short rate following a 25 basis points increase in the US short rate. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

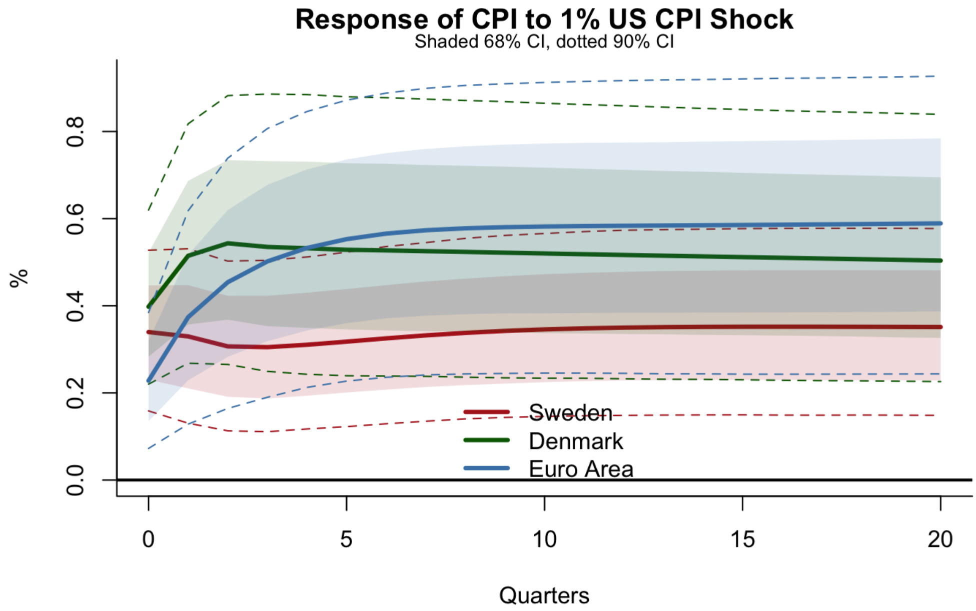


Figure 23: Generalised Impulse Responses (levels) following US 1% CPI shock

The figure shows the Generalised impulse responses of Swedish, Danish and Euro Area CPI following a 1% CPI increase in the US. Confidence intervals from 5,000 bootstrap replications, with shaded areas indicating 68% confidence intervals and dotted lines indicating 90% confidence intervals. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

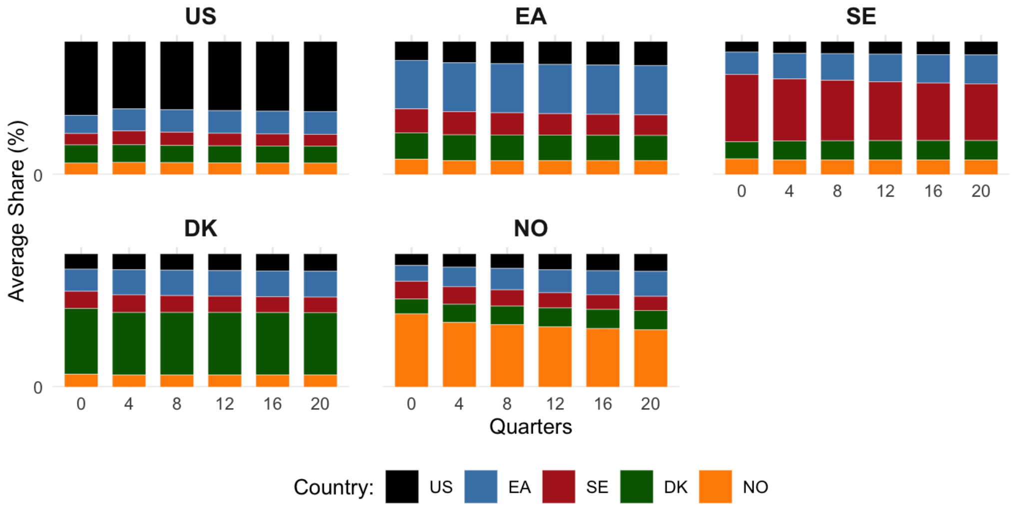


Figure 24: Generalised Forecast Error Variance Decomposition

The figure shows the Forecast Error Variance Decomposition following a GIRF for Sweden, Denmark, Norway, United States and Euro Area expressed in average percentage. Note: the Generalised FEVD for each country is normalised to 1. *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

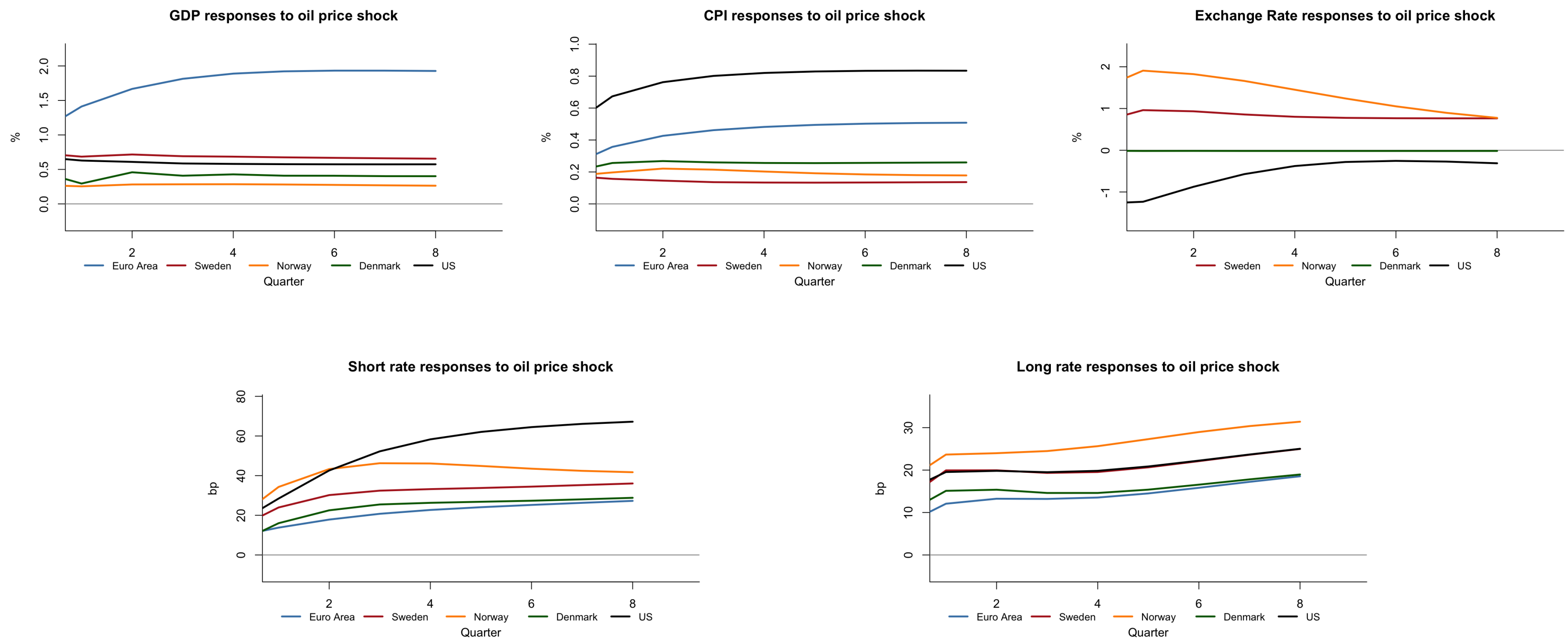


Figure 25: Impulse Responses to oil price shock

The Figure shows level responses of GDP, CPI, Bilateral Exchange rate, Short Rate and Long rate for Sweden, Denmark, Norway, United States and Euro Area following a one standard deviation oil price shock. The oil price shock is propagated in the system via the external disturbance path, Equation (11). *Source: Authors' calculations based on IMF, FRED, OECD and BIS data (2000Q1–2024Q4).*

10.2 Appendix B: Single-country VECM-X specifications

In this appendix, we present the country-specific VECM-X models used in the empirical analysis. The specifications follow Johansen Case III, where the intercept enters the cointegrating relationship, while the crisis dummies enter only the short-run dynamics. The included deterministic controls are the Global Financial Crisis dummy, D_{GFC}, and the COVID-19 dummy, D_{COVID}. The country specific models is summarised in Table 15.

Country	Domestic variables	Contemporaneous foreign variables	Lagged foreign variables	Oil lags	Error-correction terms	Dummies
US	y, π, s, sr, lr		$\Delta\pi^*, \Delta sr^*, \Delta lr^*$	Δoil_t	$ECT_1 : lr_{US,t} - c_{US} - \beta_{US} sr_{US,t}$	D_{GFC}, D_{COVID}
EA	y, π, sr, lr	$\Delta sr^*, \Delta lr^*, \Delta s^*$	$\Delta y^*, \Delta\pi^*$	Δoil_t	$ECT_1 : lr_{EA,t} - c_{EA} - \beta_{EA} sr_{EA,t}$	D_{GFC}, D_{COVID}
SE	y, π, s, sr, lr	$\Delta sr^*, \Delta lr^*$	$\Delta y^*, \Delta\pi^*$	Δoil_t	$ECT_1 : lr_{SE,t} - c_{1,SE} - \beta_{1,SE} sr_{SE,t}$; $ECT_2 : s_{SE,t} - c_{2,SE} - \beta_{2,EA}\pi_{EA,t} - \beta_{2,SE}\pi_{SE,t}$	D_{GFC}, D_{COVID}
DK	y, π, s, sr, lr	$\Delta sr^*, \Delta lr^*$	$\Delta y^*, \Delta\pi^*$	Δoil_t	$ECT_1 : sr_{DK,t} - c_{DK} - \beta_{DK} sr_{EA,t}$	D_{GFC}, D_{COVID}
NO	y, π, s, sr, lr	$\Delta sr^*, \Delta lr^*$	$\Delta y^*, \Delta\pi^*$	$\Delta oil_t, \Delta oil_{t-1}$	$ECT_1 : lr_{NO,t} - c_{1,NO} - \beta_{1,NO} sr_{NO,t}$; $ECT_2 : s_{NO,t} - c_{2,NO} - \beta_{2,EA}\pi_{EA,t} - \beta_{2,NO}\pi_{NO,t}$	D_{GFC}, D_{COVID}

Table 15: Country-specific VECM-X specifications

The table summarises the country-specific VECM-X specifications. Domestic variables are included in first differences and through the imposed error-correction terms. Foreign variables enter either contemporaneously or with one lag, depending on the country-specific specification. The oil price is treated as a global exogenous variable.