

Exchange-Rate Shocks and Swedish Manufacturing:

Evidence from an SVAR and a Small-Open-Economy
New-Keynesian Model

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Abstract: Exchange-rate movements are a key driver of inflation and real activity in small open economies, especially in manufacturing-intensive countries such as Sweden. This thesis studies how a depreciation of the Swedish krona affects producer prices and manufacturing output, and how these responses can be understood in a structural, small open economy New Keynesian (SOE-NK) framework. Empirically, a structural VAR is estimated on quarterly data for 1995Q1–2023Q4. An identified depreciation shock generates a hump-shaped increase in manufacturing output and a persistent rise in producer prices. The cumulative responses imply an exchange-rate pass-through to the PPI and medium-run gains in tradable-sector activity. To interpret these findings, the thesis develops and calibrates a SOE-NK model with imported-input costs. The model reproduces the empirical impulse-response patterns and highlights the roles of import intensity, trade elasticities, and policy stabilization in shaping exchange-rate pass-through to Swedish manufacturing.

Keywords: Exchange Rate Pass-Through, Manufacturing Sector, Small Open Economy, SVAR, New Keynesian Model, Sweden

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AI Disclosure

In this thesis, I used generative AI ChatGPT seeking mostly for technical help e.g. going through the math for solving the theoretical model when having problem and coding regarding how to implement certain steps and correcting syntax error. It is also used to polish text for better readability.

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1 Introduction

Exchange rates shape the prices and productions that matter most for a small open economy. When the domestic currency moves, it alters the relative price of home goods, the cost of imported inputs, and the state of monetary policy through external financing conditions. These channels are particularly salient in *manufacturing*, the backbone of tradable production: firms set prices in concentrated export markets, import a large share of intermediate inputs from abroad, and compete head-to-head with foreign suppliers. Understanding how exchange-rate movements transmit to the manufacturing activity and producer prices is therefore central for forecasting, for evaluating monetary policy, and for judging the competitiveness effects of krona swings.

Two features of modern open-economy make this question especially relevant. First, pass-through from the exchange rate to domestic prices is incomplete and state dependent. Producer prices respond more directly than consumer prices because distribution margins and local costs wedge CPI from border prices (Campa and Goldberg, 2005; Burstein and Gopinath, 2014). Micro evidence shows infrequent price adjustment and currency pricing choices that mute CPI pass-through in the short run (Gopinath and Itskhoki, 2010; Gopinath et al., 2020). Second, for a highly open economy that also relies on imported inputs for production such as Sweden, imported intermediate inputs embed foreign prices deep in domestic cost structures; depreciation can raise marginal costs even as it stimulates export demand, generating an ambiguous effect on output (Halpern et al., 2015; Auer et al., 2019). These mechanisms motivate a joint study of *quantities* and *producer prices* in manufacturing rather than an exclusive focus on consumer inflation.

The paper makes three contributions. *First*, it provides sector-specific evidence on how exchange-rate innovations propagate to manufacturing output and producer prices in Sweden, carefully controlling for global conditions. *Second*, it documents economically meaningful cumulative effects consistent with growth-rate VARs and clarifies the measurement role of PPI. *Third*, it maps the facts to a transparent SOE–NK framework with imported inputs and a permanent exchange-rate component, offering a structural lens for policy counterfactuals (e.g., stronger price stability vs. competitiveness tradeoffs).

For Sweden, it is particularly crucial. According to the U.S. International Trade Administration (2023), Sweden’s manufacturing sector accounts for around 20% of GDP, roughly 75% of exports, and more than one million jobs. On the other hand, the krona has exhibited sizable multi-year swings in the KIX index, and manufacturing remains a large tradable base associated hugely with global markets. Swedish exporters invoice in a mix of currencies and face pricing frictions that affect short-run pass-through (Friberg and Wilander, 2008). At the same time, the monetary policy framework targets inflation, so the exchange rate influences the policy reaction function and imported cost pressures. Against this background, documenting how a depreciation propagates through manufacturing prices and output—and how quickly effects cumulate—is of direct policy interest for a small open economy central bank.

This paper combines an empirical and a structural perspective tailored to those questions. Empirically, I estimate a quarterly VAR for 1995–2023 that includes manufacturing value added, the manufacturing producer price index (PPI), the nominal effective exchange rate (KIX; higher = depreciation), and the policy rate, with a compact set of foreign controls (Europe GDP, Euro and US PPIs, and the US policy stance) treated as exogenous. By constructing a exogenous shock which is orthogonal to contemporaneous developments in domestic real activity, domestic monetary policy, and a set of foreign controls, the shocks of interest capture exchange-rate fluctuations that cannot be attributed, on impact, to standard macroeconomic or monetary fundamentals of the Swedish economy. Two measurement choices are deliberate. First, I work

with *producer* prices rather than consumer prices to align with firms’ marginal costs and export pricing; producer prices are the relevant deflator for competitiveness and for the imported-input channel stressed in theory. Second, because most macro series are modeled in log differences, I present both standard and *cumulative* impulse responses; the latter map growth responses into economically meaningful level effects over medium horizons.

I interpret the evidence through a small open economy New Keynesian (SOE–NK) model with imported inputs and producer-currency pricing (PCP) for exports. The model embeds a PPI New Keynesian Phillips curve driven by *real marginal cost in PPI units* and features one-for-one pass-through from the exchange rate into the home-currency price of imported intermediates. A depreciation immediately raises marginal costs via the imported-input share while simultaneously improving foreign-currency price competitiveness; which effect dominates for output depends on demand elasticities, monetary policy, and the persistence of the exchange-rate innovation. My theoretical framework follows Monacelli (2005) and Galí and Monacelli (2005) in spirit, integrates the pass-through and currency-pricing insights surveyed by Burstein and Gopinath (2014), and confronts the cost linkages highlighted by Auer et al. (2019). I also allow for a permanent component in the exchange rate to mirror the data’s medium-run movements and to match the cumulative dynamics uncovered in the VAR.

Manufacturing sits at the intersection of the two main transmission routes of exchange-rate changes. On the *demand* side, depreciation reduces foreign-currency export prices under PCP and raises external demand; classic open-economy models predict an expansion in tradable output (Obstfeld and Rogoff, 1995; Betts and Devereux, 2000). On the *cost* side, depreciation increases the home-currency price of imported inputs embedded in domestic marginal cost; with sticky producer prices, this enters into the PPI-based Phillips curve and can compress markups. The net effect on output is therefore an empirical matter that depends on imported-input shares, pricing frictions, and policy feedback. Studying manufacturing allows us to observe both forces where they are strongest.

My empirical strategy is closest to the SVAR tradition that identifies exchange-rate shocks and traces real and price responses in small open economies (Eichenbaum and Evans, 1995; Kim and Roubini, 2000; Bjørnland, 2009). Relative to that work, I (i) target the traded sector specifically, (ii) use producer prices to align with marginal cost and competitiveness, and (iii) emphasize cumulative responses to interpret growth-rate VARs in levels. On the structural side, I bring together PPI inflation dynamics with imported-input marginal costs and simple currency-pricing assumptions, following Sbordone (2005) and Monacelli (2005), while connecting to evidence on currency choice and input linkages (Gopinath and Itskhoki, 2010; Auer et al., 2019; Gopinath et al., 2020). For Sweden, my setup complements DSGE estimates that allow for incomplete pass-through (Adolfson et al., 2007, 2008) and micro evidence on export pricing (Friberg and Wilander, 2008).

Section 3 describes the data and transformations. Section 4 presents the VAR specification and identification, along with impulse responses and robustness. Section 5 develops the SOE–NK model and calibration. Section 7 interprets the empirical findings through the model and discusses policy implications. Section 8 concludes.

2 Literature Review

This thesis builds on the empirical literature that uses structural vector autoregressions (SVARs) to study the effects of exchange-rate shocks on real activity and prices in small open economies. Classical SVAR studies for large advanced economies identify monetary policy or exchange-rate innovations and trace their dynamic effects on output, interest rates and inflation (Eichenbaum and Evans, 1995; Kim and Roubini, 2000). A common finding is a hump-shaped response of output and a gradual but persistent adjustment of prices. This thesis adopts their basic SVAR logic—using reduced-form VARs with identifying restrictions on the contemporaneous impact matrix—but applies it to a Swedish setting with a narrow focus on manufacturing GDP and producer prices. A key departure is that the exchange rate shock is treated as the main object of interest rather than as a by-product of monetary shocks, and foreign activity and prices are explicitly controlled for, which is less common in the early SVAR literature.

A second strand of work that this thesis draws on is the DSGE-VAR and SVAR evidence for Nordic and European small open economies. Estimated open-economy DSGE models for Sweden and the euro area embed exchange-rate, foreign demand and foreign price shocks and show that the combination of external demand and imported cost pressures is crucial for understanding CPI and PPI dynamics (Adolfson et al., 2007, 2008). Similarly, SVARs for Norway find that exchange-rate innovations generate medium-run gains in tradables output and persistent changes in price indices when foreign conditions are taken into account (Bjørnland, 2009). This thesis follows these papers by including exogenous foreign blocks—Europe real GDP, foreign producer prices and the US policy rate—to isolate genuinely Swedish shocks. Relative to the DSGE-VAR literature, however, the specification is deliberately parsimonious, with a small four-variable domestic system designed to facilitate transparent identification and direct comparison with a theoretical SOE-NK model.

The theoretical side of the thesis is closely related to open-economy New Keynesian (NK) models for small open economies. Clarida, Galí and Gertler (Clarida et al., 2001) and Galí and Monacelli (2005) develop SOE-NK frameworks in which a forward-looking Phillips curve, a consumption Euler equation and an interest-rate rule jointly characterize the transmission of monetary and exchange-rate shocks. These models introduce the key objects used in this thesis: a CPI-based New Keynesian IS curve linking the real interest rate to the consumption gap, and Taylor-type policy rules with interest-rate smoothing. The theoretical model in this thesis adopts this core structure but adapts it in two directions. First, the Phillips curve is written in terms of PPI inflation rather than CPI inflation, consistent with the empirical focus on producer prices. Second, the model introduces an explicit imported-input cost channel and allows the nominal exchange rate to have a highly persistent, quasi-permanent component, so that level effects on PPI can be matched to the cumulative IRFs from the SVAR.

Within the price-setting block, the thesis is inspired by work that derives Phillips curves in real-marginal-cost form and emphasizes the role of imported intermediates. Sbordone (Sbordone, 2005) shows that, with Calvo pricing and Dixit-Stiglitz demand, inflation can be written as a function of expected future inflation and real marginal costs, while Monacelli (2005) embeds this logic in an open-economy environment with incomplete pass-through. This thesis adopts the same real-marginal-cost formulation but modifies the marginal cost to include an imported-input component: a depreciation raises the home-currency cost of foreign intermediates, thereby shifting the PPI Phillips curve. This choice is directly motivated by the empirical setting—manufacturing in Sweden is highly import-intensive—and allows the model to mirror the strong and persistent response of PPI to exchange-rate shocks found in the SVAR.

The exchange-rate pass-through (ERPT) literature provides the main guidance for how to treat prices and margins empirically. Border and import prices are found to react more quickly and strongly to exchange-rate movements than consumer prices, reflecting incomplete pass-through and the presence of local costs and distribution margins (Campa and Goldberg, 2005; Burstein and Gopinath, 2014). Micro evidence on infrequent and heterogeneous price

adjustment (Gopinath and Itskhoki, 2010) and models of pricing-to-market and international price discrimination (Corsetti and Dedola, 2005; Corsetti et al., 2008) help explain why short-run CPI pass-through is low even when the exchange rate is volatile. This thesis follows these insights by treating PPI as the key measure of competitiveness in the empirical model and by focusing the theoretical analysis on a PPI-based NKPC. A deliberate departure from much of the ERPT literature is that consumer prices are not modeled explicitly; instead, the thesis concentrates on the border/manufacturing margin that is most directly affected by the exchange rate.

Recent work on the currency of invoicing and the “dominant currency paradigm” further informs the interpretation of the exchange-rate shock. Gopinath et al. (2020) argue that a small set of vehicle currencies shapes the short-run response of trade prices and quantities to exchange-rate fluctuations, while firm-level evidence for Swedish exporters shows substantial heterogeneity in invoicing and pricing-to-market behaviour (Friberg and Wilander, 2008). This literature suggests that, in the short run, quantities may respond more than prices if a large share of trade is invoiced in dominant currencies. The thesis incorporates this perspective by calibrating the export demand elasticity and the exchange-rate coefficient in the export demand equation so that the model’s quantity responses are consistent with the medium-run hump-shaped output responses observed in the SVAR, while still allowing for sizeable PPI movements driven by imported-input costs.

Expenditure switching in the theoretical model is governed by Armington-type trade elasticities. Macro and micro estimates of these elasticities vary widely and are sensitive to aggregation and product differentiation (Broda and Weinstein, 2006; Imbs and Mejean, 2015). Work that combines detailed trade data with structural models of variety and quality provides more disciplined estimates for import and export demand (Hooper et al., 2000; Feenstra et al., 2018; Bussière et al., 2013). This thesis uses this literature to choose plausible benchmark values for the Armington elasticity and the export elasticities in the calibration, but departs from fully micro-founded estimation. Instead of estimating elasticities directly from trade data, the model parameters are selected so that the theoretical IRFs match the shape and magnitude of the empirical responses for Swedish manufacturing.

The role of imported inputs and global value chains is inspired by evidence that import intensity in production amplifies pass-through and changes the mapping from exchange-rate shocks to domestic costs. Firm-level and sectoral studies show that sectors with higher import shares exhibit larger and faster price adjustments (Amiti et al., 2014), and that input-output linkages propagate foreign cost shocks into domestic inflation (Auer et al., 2019). The thesis incorporates these insights by modelling the manufacturing sector as using an imported intermediate with Cobb-Douglas technology, and by calibrating the imported-input share using evidence on foreign value-added in exports and Swedish I-O data. Relative to the multi-sector input-output literature, the model is intentionally stylised: a single composite imported input is used to capture the main cost channel, so that the link between the exchange rate and PPI marginal cost remains transparent.

Monetary policy and regime-dependence provide a further set of connections to the literature. Time-varying pass-through and state-dependent pricing have been linked to the credibility of inflation targeting and to the behaviour of monetary policy rules (Taylor, 2000; Batini et al., 2005). In estimated SOE-NK models for Sweden, interest-rate smoothing and a strong response to CPI inflation help reproduce the persistence of output and price dynamics after external shocks (Adolfson et al., 2007, 2008). The policy rule in this thesis follows this tradition by combining a CPI-based Taylor rule with gradual adjustment, but differs in two respects: the domestic rule is applied in a model where PPI plays the central role for competitiveness, and the empirical SVAR uses a policy-rate trend that is filtered from the zero lower bound episode rather than the raw policy rate, in order to maintain stationarity and comparability with the theoretical real-rate gap.

Finally, the thesis connects to work that emphasises persistence and permanent components

in exchange-rate dynamics. Empirical VARs and DSGE estimations often find that exchange-rate innovations are highly persistent, and that allowing for a permanent or near-unit-root component helps reconcile durable price-level shifts with relatively transitory output responses (e.g. Bussière et al., 2013). In the SVAR, this thesis interprets the orthogonalized NEER shock as capturing such a persistent component and studies its cumulative effects on manufacturing GDP and PPI. On the theoretical side, the nominal exchange rate is decomposed into a stationary part and a random-walk-like permanent component, so that a shock to the latter generates long-lasting movements in the real exchange rate and PPI, mirroring the empirical cumulative IRFs. This explicit focus on the permanent component is a key departure from many earlier SOE-NK applications, where the exchange rate is often purely stationary.

These strands of literature provide both the building blocks and the benchmarks for the thesis. The empirical SVAR inherits identification and measurement choices from the SVAR and ERPT literatures but adapts them to a small, manufacturing-focused Swedish system with external controls. The theoretical SOE-NK model builds on standard open-economy blocks while emphasising imported-input marginal costs and a persistent exchange-rate component. The main contribution is to use this combined empirical-theoretical framework to quantify how a persistent nominal depreciation affects manufacturing output and producer prices in Sweden, and to assess which structural mechanisms—trade elasticities, imported-input shares, and monetary policy responses—are most consistent with the estimated impulse-response functions.

3 Data

The empirical analysis uses quarterly Swedish data from 1995Q1–2023Q4 with 115 observations in total. This window covers the inflation-targeting era and offers consistent coverage for both domestic and external series while keeping the time span homogeneous. The VAR contains a compact domestic block that jointly tracks real activity and producer prices in manufacturing, together with the exchange rate and the policy rate capturing the monetary policy effect, and an external block that is treated as exogenous to Sweden.

The domestic variables are (i) real manufacturing value added at constant prices, denoted *manufacturing GDP* (GDP, in SCB is the SNI code C10-C33); (ii) the producer price index for manufactured products, a factory-gate deflator that governs firms’ pricing and cost pass-through (PPI); (iii) the KIX nominal effective exchange rate (NEER), constructed as a trade-weighted index where a higher value indicates a depreciation of the krona (Alsterlind, 2006); and (iv) the Riksbank policy rate represented by its smooth trend component (*Policy Rate*). I focus on PPI rather than CPI to align the measurement with the producer-side mechanisms emphasized in the model (marginal cost and competitiveness are naturally deflated by producer prices).

The external environment is summarized by Europe real GDP (*Europe_GDP*) as a proxy for foreign demand for most of the biggest trade partners of Sweden are European countries, the Euro-area and US producer price indices (*Euro_PPI*, *US_PPI*) as global cost shifters, and the trend in the US effective federal funds rate (*EFFR*) as a parsimonious indicator of the global monetary environment with dollar being most frequently used currency across the world. Given that Sweden is a small-open-economy and cannot exert large influence on global environment, these foreign variables are taken as *exogenous* in the VAR. This treatment isolates the domestic propagation of exchange-rate movements while controlling for the movement and shocks of international surroundings.

To ensure stationarity, all non-interest-rate series are transformed by taking the natural logarithm and first difference, so the VAR is estimated on quarterly growth rates $\Delta \log X_t$. Interest rates can be zero or negative; instead of logging, I extract their trends using the Hodrick–Prescott filter with $\lambda = 1600$ at the quarterly frequency (Hodrick and Prescott, 1997). The resulting transformed series display stable means and variances over the sample, which are all plotted in figure 1. In addition, I used Augmented Dickey–Fuller tests (with SIC-selected lags)

for all series to check if I can reject unit roots in all transformed variables, corroborating the chosen preprocessing of series. For the exchange rate, I preserve the KIX convention (higher = depreciation), so a positive innovation to $\mathbf{NEEr}$ corresponds to a depreciation shock in the VAR.

Data sources are standard: manufacturing value added and PPI are from Statistics Sweden (SCB); KIX and the policy rate are from Sveriges Riksbank; European series all come from Eurostat; while US PPI and the effective federal funds rate are from the BLS and the Federal Reserve (FRED).

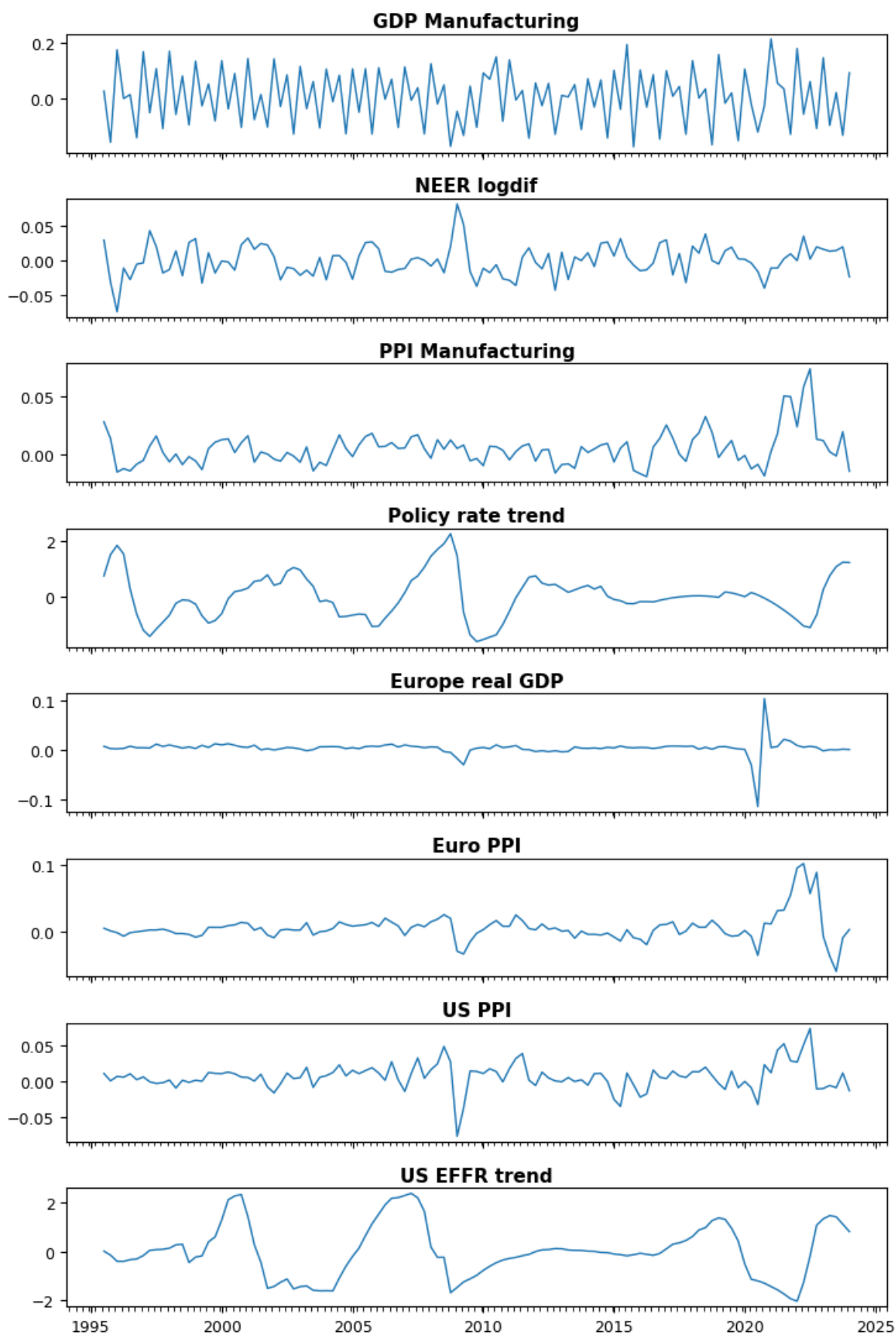


Figure 1: Series of endogenous and exogenous variables

Notes: All series are shown after the transformations used in the VAR. Real GDP in manufacturing, Swedish NEER, manufacturing PPI, Europe real GDP, Euro-area PPI and U.S. PPI are expressed as first differences of natural logarithms (approximate quarterly percentage changes). The Swedish policy rate and the U.S. effective federal funds rate are HP-filtered trend components (adjusted for the quarterly frequency following Ravn and Uhlig (2002)), measured in percentage points. The sample spans 1995Q1–2023Q4.

4 Empirical Model

4.1 Structural and reduced forms

Let $\mathbf{Y}_t$ be the vector of all endogenous variables (manufacturing GDP, NEER, PPI, and the policy rate), and let $\mathbf{W}_t$ stack strictly exogenous controls (foreign activity and prices, US rate). Define the regressor vector

$$\mathbf{X}_t \equiv [\mathbf{y}'_{t-1}, \dots, \mathbf{y}'_{t-p}, \mathbf{w}'_t]'$$

The structural VAR (SVAR) is written compactly as

$$\mathbf{A}_0 \mathbf{Y}_t = \mathbf{B}(L) \mathbf{X}_t + \boldsymbol{\varepsilon}_t, \quad \boldsymbol{\varepsilon}_t \sim \text{i.i.d. } (\mathbf{0}, \boldsymbol{\Sigma}_\varepsilon), \quad (1)$$

where $\mathbf{A}_0$ is the $k \times k$ matrix of contemporaneous relations (invertible, with diagonal normalized to one), and

$$\mathbf{B}(L) \equiv \mathbf{B}_1 + \mathbf{B}_2 L + \dots + \mathbf{B}_p L^{p-1}$$

collects the lag coefficients on $\mathbf{y}$ (and possibly contemporaneous coefficients on the exogenous controls). The structural shocks $\boldsymbol{\varepsilon}_t$ are assumed mutually uncorrelated (diagonal $\boldsymbol{\Sigma}_\varepsilon$) and serially uncorrelated. This representation isolates contemporaneous economic structure in $\mathbf{A}_0$ while pushing dynamics to the lag polynomial $\mathbf{B}(L)$ (see Lütkepohl, 2005; Kilian and Lütkepohl, 2017).

Premultiplying (1) by $\mathbf{A}_0^{-1}$ yields the reduced form

$$\mathbf{y}_t = \boldsymbol{\Pi}(L) \mathbf{x}_t + \mathbf{u}_t, \quad \boldsymbol{\Pi}(L) \equiv \mathbf{A}_0^{-1} \mathbf{B}(L), \quad \mathbf{u}_t \equiv \mathbf{A}_0^{-1} \boldsymbol{\varepsilon}_t. \quad (2)$$

By construction,

$$\boldsymbol{\Sigma}_u \equiv \mathbb{E}[\mathbf{u}_t \mathbf{u}_t'] = \mathbf{A}_0^{-1} \boldsymbol{\Sigma}_\varepsilon (\mathbf{A}_0^{-1})', \quad (3)$$

which is the key mapping between reduced-form and structural objects. Equation (2) is estimated equation-by-equation with OLS; constants are omitted because the series are transformed to stationarity (log-differences for most variables and HP-detrended rate), so the unconditional mean is close to zero in practice. Identification proceeds by imposing $k(k-1)/2$ restrictions on $\mathbf{A}_0$ so that (3) can be inverted to recover $\mathbf{A}_0$ and hence the structural shocks (Kilian and Lütkepohl, 2017).

4.2 Identification via recursive ordering

Structural identification is achieved with a recursive (Cholesky) scheme applied to the domestic block of the VAR, which orthogonalizes the reduced-form residuals by imposing a lower-triangular contemporaneous impact matrix (Sims, 1980; Lütkepohl, 2005; Kilian and Lütkepohl, 2017). The choice of ordering encodes economically motivated timing restrictions and is central for interpretation. I adopt the ordering

$$\mathbf{Y}_t = [\Delta GDP, \quad \Delta NEER, \quad \Delta PPI, \quad POLICY RATE]'$$

and treat the global controls as strictly exogenous. This configuration follows the prevailing practice in exchange-rate pass-through (ERPT) and small-open-economy VARs (e.g. McCarthy, 2000; Ito and Sato, 2006; Bjørnland, 2009; Sims and Zha, 2006) while aligning with quarterly data compilation.

Placing real manufacturing activity first assumes that within a quarter it is predetermined with respect to the other domestic variables. The measurement of value added in industry aggregates production and inventories over the quarter and is typically closed with a publication lag; contemporaneous feedback from prices, the policy rate, or the exchange rate to measured output is therefore weak at the quarterly frequency. Econometrically, this treats the output innovation as the most “exogenous” disturbance in the domestic block, consistent with recursive SOE orderings that use activity as an anchor (Bjørnland, 2009).

The nominal effective exchange rate (NEER) is ordered second. Exchange rates are high-frequency asset prices that react almost instantaneously to news about the macroeconomic outlook and monetary policy. Allowing the NEER to respond contemporaneously to manufacturing-activity innovations captures this information-processing feature while restricting same-quarter feedback from producer prices and the policy rate to the exchange rate. At the same time, placing the NEER ahead of prices allows a direct contemporaneous pass-through channel from depreciation to domestic prices, a key mechanism in the ERPT literature (McCarthy, 2000; Ito and Sato, 2006). In Swedish manufacturing, imported intermediates and foreign-currency pricing provide a clear route for immediate cost and price pressure after a depreciation, which the ordering is designed to capture.

Manufacturing PPI inflation is ordered third so that it may respond contemporaneously to both real activity and the exchange rate but not to the policy rate within the quarter. Producer prices are set by firms facing information and adjustment frictions; pass-through tends to be faster at the border and in PPI than in CPI. By letting PPI react within the quarter to y_t^M and the NEER, the identification embodies the imported-input and competitiveness channels emphasized in pass-through studies, while still preserving some sluggishness through dynamics (McCarthy, 2000). This placement is also consistent with recursive price blocks used to measure border pass-through before downstream retail margins adjust.

The policy rate trend is ordered last. Conceptually, this allows the policy instrument to react within the quarter to all domestic information—output, the exchange rate, and producer prices—while its effect on those variables materializes with lags, in line with standard monetary transmission (Sims and Zha, 2006). From an identification perspective, the last position minimizes zero-impact restrictions on the policy innovation and is common in open-economy SVARs where the central bank is viewed as an information aggregator at the quarterly frequency (Bjørnland, 2009). I work with a detrended policy rate to abstract from the effective lower bound and low-frequency shifts, keeping the short-run reaction content of the shock.

Two remarks clarify the maintained assumptions. First, the recursive scheme implies that “contemporaneous” means within-quarter; it does not restrict responses at any longer horizons that occur beyond the quarter in the long term. Second, the Cholesky identification is transparent but not unique: different orderings encode different timing views. As Stock and Watson (2001) emphasize, researchers should justify the ordering economically and assess sensitivity. I therefore conduct robustness checks that move the policy rate to the first position after GDP to allow an immediate $i_t \rightarrow e_t$ channel (an ordering used in Sims and Zha, 2006). Across these alternatives, the qualitative patterns of exchange-rate pass-through and the medium-run real responses are robust.

Finally, the global variables enter as strictly exogenous controls that shift foreign demand, global price pressure, and the external interest rate. In a small open economy this block is reasonably taken as unaffected by Sweden’s domestic shocks (Lütkepohl, 2005). Including it parsimoniously reduces omitted-variable bias in the domestic VAR and helps separate imported price pressure from genuine exchange-rate pass-through.

4.3 Lag length selection

The lag order p is chosen from the grid $p \in \{1, \dots, 8\}$ by minimizing the Schwarz–Bayesian information criterion while checking the Akaike Information Criterion (AIC), Hannan–Quinn (HQ), and the Final Prediction Error (FPE). The specifications chosen must satisfy standard residual diagnostics. The chosen p is used in all impulse-response analysis.

4.4 Model Diagnostics

Model adequacy is assessed with residual-based tests for serial correlation and non-normality. Following standard VAR practice (Lütkepohl, 2005; Kilian and Lütkepohl, 2017), I apply the

Ljung–Box portmanteau statistic to each equation’s residuals and the Jarque–Bera statistic to both each equation and the full system.

For serial correlation, let $\hat{u}_{t,j}$ denote the residuals from equation j and $\hat{\rho}_j(k)$ their sample autocorrelation at lag k . For horizons $h \in \{2, 4, 6, 8\}$ I compute the Ljung–Box Q statistic,

$$Q_j(h) = T(T+2) \sum_{k=1}^h \frac{\hat{\rho}_j(k)^2}{T-k},$$

which is approximately χ^2 with $h-p$ degrees of freedom under the null of no residual autocorrelation, where p is the VAR lag order (Ljung and Box, 1978). I report p -values for each horizon and equation. Failure to reject at conventional levels supports the adequacy of the chosen lag length; rejections motivate increasing p , revisiting deterministic terms, or allowing for additional exogenous controls.

For distributional assumptions, I test normality of the residuals using the Jarque–Bera statistic based on skewness and excess kurtosis. For each equation j ,

$$JB_j = \frac{T}{6} \hat{S}_j^2 + \frac{T}{24} (\hat{K}_j - 3)^2,$$

with $\hat{S}_j$ the sample skewness and $\hat{K}_j$ the sample kurtosis of $\hat{u}_{t,j}$. Under the null of normality, $JB_j \sim \chi_{(2)}^2$ (Jarque and Bera, 1987). In addition to equation-wise tests, I report a system-wide normality test obtained by aggregating skewness and kurtosis across equations as in Lütkepohl (2005, Ch. 4). Normal residuals are not required for consistency of the VAR estimates, but they underpin Gaussian-based inference.

All diagnostic results are presented alongside the VAR estimates. Across specifications I evaluate whether (i) Ljung–Box statistics at $h = 2, 4, 6, 8$ fail to reject serial independence for each endogenous variable’s residuals and (ii) Jarque–Bera statistics do not reject normality for individual equations and for the joint system. The combination of these checks provides evidence that the chosen lag length captures the salient dynamics and that inference based on my SVAR is reliable at the quarterly frequency. (Kilian and Lütkepohl, 2017).

4.5 Orthogonalized exchange-rate shock and impulse responses

Short-run exchange rate movements can arise from several sources. First, news about real fundamentals—such as shocks to relative demand or supply—that change the expected growth path of each economy. Second, revisions in expectations about the stance of monetary policy at home and abroad, which affect short-term interest differentials and hence the relative return on financial assets. Third, shocks to risk premia or market sentiment that are not directly tied to current macroeconomic or policy fundamentals, but can generate rapid and sizable swings in the exchange rate; these are often labelled *exogenous exchange-rate shocks*.

The structural shock that I focus on in the VAR is designed to approximate this third component. In the empirical system, the NEER is ordered after manufacturing output and the Swedish policy rate, but before producer prices. Together with the inclusion of foreign activity, foreign producer prices and the US policy rate as exogenous controls, the Cholesky decomposition implies that the *orthogonalized* innovation to the NEER is the part that cannot be explained, on impact, by contemporaneous movements in domestic real activity, domestic monetary policy, or global conditions. At the same time, this shock is allowed to affect Swedish producer prices immediately within the quarter. The resulting orthogonalized NEER innovation is therefore interpreted as a risk-premium-type depreciation shock, rather than as a shock to domestic fundamentals or to the monetary policy rule itself.

Orthogonalized impulse responses (OIRFs) follow from the identified VAR. Because NEER and PPI enter as growth rates, cumulative IRFs trace level effects that are economically meaningful over medium horizons. Shocks are scaled so that the NEER innovation corresponds to a one-percent depreciation on impact. (Kilian and Lütkepohl, 2017, Ch. 12).

5 Theoretical Model

This section develops a small open economy New Keynesian (SOE–NK) model tailored to manufacturing. The environment combines (i) a PPI Phillips curve with an imported–input cost term (cf. Sbordone, 2005; Monacelli, 2005); (ii) intertemporal demand in CPI real rates (as in Clarida et al., 2001; Galí and Monacelli, 2005); (iii) an Armington final–demand aggregator delivering expenditure switching; and (iv) a parsimonious export block under producer–currency pricing (PCP), consistent with incomplete pass–through at the retail margin (e.g., Betts and Devereux, 2000; Campa and Goldberg, 2005; Burstein and Gopinath, 2014).

5.1 Environment and Notation

Time is discrete. Lowercase variables denote (log) deviations from a zero–inflation deterministic steady state. The nominal exchange rate (SEK per foreign currency) in logs is e_t . Let p_t denote the log PPI (producer price index), p_t^C the log CPI, $\pi_t^p \equiv p_t - p_{t-1}$ PPI inflation, and $\pi_t^C \equiv p_t^C - p_{t-1}^C$ CPI inflation. Foreign variables carry an asterisk, e.g., y_t^* and i_t^* . Shocks are mean zero, i.i.d. or AR(1) as specified below.

5.2 Households, CPI, and the Euler/NK–IS

A representative household has period utility

$$U_t = E_t \sum_{s=0}^{\infty} \beta^s \left[\frac{C_{t+s}^{1-\sigma}}{1-\sigma} - \frac{\varphi}{1+\nu} N_{t+s}^{1+\nu} \right], \quad (4)$$

with standard budget constraints, where C_t is a CES aggregator of home and imported *final* goods (Armington). Log–linearizing the intertemporal optimality condition in CPI real rates yields the NK–IS equation (e.g., Clarida et al., 2001; Galí and Monacelli, 2005):

$$\hat{c}_t = E_t \hat{c}_{t+1} - \frac{1}{\sigma} \left(\hat{i}_t - E_t \hat{\pi}_{t+1}^p - \hat{r}_t^n \right), \quad (5)$$

where r_t^n is the natural (efficient) real rate capturing preference/technology wedges.

5.2.1 CPI and Armington aggregator.

Let the Armington aggregator be $C_t = [(1-\omega)^{1/\xi} C_{H,t}^{(\xi-1)/\xi} + \omega^{1/\xi} C_{F,t}^{(\xi-1)/\xi}]^{\xi/(\xi-1)}$, with $\omega \in (0, 1)$ and elasticity $\xi > 1$. Log–linear CPI is a share–weighted average of the home and import final–goods prices:

$$p_t^C = (1-\omega)p_t + \omega p_t^F, \quad p_t^F = e_t + p_t^{*F}, \quad (6)$$

so import prices in SEK move one–for–one with the nominal ER plus foreign–currency import prices p_t^{*F} (law of one price at the border, abstracting from distribution margins; cf. Monacelli, 2005).

Optimal composition implies a home–absorption demand schedule (Armington expenditure switching):

$$d_t \equiv \log C_{H,t} = c_t - \xi_c (p_t - p_t^C), \quad \xi_c \equiv \xi(1-\omega)\omega, \quad (7)$$

i.e., when home prices fall relative to CPI, households tilt absorption toward home varieties (commodities).

5.3 Firms, Imported Inputs, and the PPI NKPC

5.3.1 Technology and input pricing.

Following the open–economy NK setup in Monacelli (2005, Sec. 2), a continuum of intermediate producers uses Cobb–Douglas technology with an imported intermediate:

$$Y_t = A_t N_t^{1-\alpha_m} M_t^{\alpha_m}, \quad \alpha_m \in (0, 1), \quad (8)$$

where A_t is TFP, N_t is labor, and M_t an imported input. Let W_t be the nominal wage, P_t the producer price index (PPI), S_t the nominal exchange rate (SEK per unit of foreign currency), and P_t^{*M} the foreign-currency price of the imported input. As in Monacelli (2005), I impose the law of one price at the border for the *intermediate* input,

$$P_t^M = S_t P_t^{*M} \Rightarrow p_t^M = e_t + p_t^{*M},$$

so exchange-rate movements load one-for-one onto the home-currency cost of the imported input.

5.3.2 Real marginal cost in PPI units.

Cost minimization under (8) implies unit nominal cost

$$MC_t = \frac{1}{A_t} \frac{W_t^{1-\alpha_m} P_{M,t}^{\alpha_m}}{(1-\alpha_m)^{1-\alpha_m} \alpha_m^{\alpha_m}} \quad (9)$$

and log-linearizing gives the (log) *real marginal cost* in PPI units (see Sbordone, 2005; Galí, 2015, Ch. 3):

$$\widehat{mc}_t = (1-\alpha_m)(w_t - p_t) + \alpha_m(e_t + p_t^{*M} - p_t) - a_t. \quad (10)$$

Thus a depreciation ($e_t \uparrow$) raises real marginal cost in proportion to the imported-input share α_m through the border-price term $e_t + p_t^{*M} - p_t$.

5.3.3 Price setting and Phillips curve.

Prices are sticky à la Calvo: in each period a measure $1-\theta$ of firms can reoptimize, while a share θ keeps last period's price (see Calvo, 1983; Woodford, 2003; Galí, 2015). Aggregation with Dixit–Stiglitz demand yields a *PPI* New Keynesian Phillips curve written in real-marginal-cost form (cf. Sbordone, 2005; Monacelli, 2005):

$$\pi_t^p = \beta E_t \pi_{t+1}^p + \kappa_0 \widehat{mc}_t, \quad \kappa_0 = \frac{(1-\theta)(1-\beta\theta)}{\theta}. \quad (11)$$

Equation (11) keeps the slope at the *Calvo* value κ_0 , because the driving term is real marginal cost itself; the elasticity of substitution affects markups inside $\widehat{mc}_t$ rather than the slope.¹

The first term of (10) is labor's cost share times the *real wage*; the second is the imported-input share times the *border price in SEK* relative to PPI; TFP lowers cost one-for-one. Writing the NKPC in PPI units (rather than CPI) follows Monacelli (2005) and Sbordone (2005) and is crucial for manufacturing: it places exchange-rate movements directly into marginal cost via imported inputs, delivering the empirically observed strong pass-through at the border even when retail prices (CPI) are insulated by distribution margins and local-currency pricing.

5.4 Price indexes and inflation measures

Let p_t denote the (log) producer price index (PPI) and p_t^c the (log) consumer price index (CPI). I define PPI and CPI inflation as

$$\pi_t^p \equiv p_t - p_{t-1}, \quad (12)$$

$$\pi_t^c \equiv p_t^c - p_{t-1}^c. \quad (13)$$

Taking first differences of (6) yields the link between CPI and PPI inflation:

$$\pi_t^c = (1-\omega_c)\pi_t^p + \omega_c(\Delta e_t + \pi_t^{f,*}), \quad \Delta e_t \equiv e_t - e_{t-1}. \quad (14)$$

Thus π_t^c generally differs from π_t^p because exchange-rate movements and foreign-currency price changes of imported finals pass through directly to CPI.

¹If one eliminates $w_t - p_t$ using a simple labor-market closure (e.g., $w_t - p_t = \varphi_y y_t$), the NKPC can be rewritten in an output-gap form with slope $\kappa_y = \kappa_0 \varphi_y$; see Galí (2015). I retain the marginal-cost form because it makes the imported-input pass-through channel explicit, as in Monacelli (2005).

5.5 Exports and the Real Exchange Rate

Under PCP (producer–currency pricing), consistent with larger pass–through at the border than at retail (e.g., Betts and Devereux, 2000; Campa and Goldberg, 2005; Corsetti et al., 2008), foreign demand for domestic exports is

$$x_t = \eta_y y_t^* + \varepsilon_x (e_t - p_t), \quad (15)$$

i.e., a depreciation that lowers the (PPI-deflated) relative price of home goods abroad raises volumes; $\eta_y > 0$ captures foreign activity and $\varepsilon_x > 0$ the real exchange-rate elasticity.

5.6 Monetary Policy

The central bank follows a CPI-based Taylor rule with interest smoothing (e.g., Clarida et al., 2001; Adolfson et al., 2008):

$$i_t = \rho_i i_{t-1} + (1 - \rho_i)(\phi_\pi \pi_t^C + \phi_y y_t) + \varepsilon_t^i, \quad \phi_\pi > 1. \quad (16)$$

Targeting CPI, rather than PPI, captures the conventional stabilization objective in open economies (Monacelli, 2005).

5.7 External Sector and Exchange Rate Dynamics

To allow persistence and low-frequency movements, I write the exchange rate as a stationary component plus a permanent level (useful empirically when price *levels* shift):

$$e_t = \rho_e e_{t-1} + \theta_e (i_t - i_t^*) + \mu_t + \varepsilon_t^{er}, \quad (17)$$

$$\mu_t = \mu_{t-1} + \varepsilon_t^\mu. \quad (18)$$

Foreign activity, interest rates and import prices follow AR(1) processes:

$$\begin{aligned} y_t^* &= \rho_y y_{t-1}^* + \varepsilon_t^{y^*}, & i_t^* &= \rho_{i^*} i_{t-1}^* + \varepsilon_t^{i^*}, \\ p_t^{*M} &= \rho_m p_{t-1}^{*M} + \varepsilon_t^{*M}, & p_t^{*F} &= \rho_f p_{t-1}^{*F} + \varepsilon_t^{*F}, \\ a_t &= \rho_a a_{t-1} + \varepsilon_t^a, & r_t^n &= \rho_r r_{t-1}^n + \varepsilon_t^r. \end{aligned} \quad (19)$$

5.8 Market Clearing and Output

Aggregate (log) output is a mix of home absorption d_t and exports x_t :

$$y_t = (1 - \chi_x) d_t + \chi_x x_t + \varepsilon_t^g, \quad (20)$$

where $\chi_x \in (0, 1)$ is the export share (the remainder is home absorption), and ε_t^g captures small residual demand wedges (inventory, measurement).

5.9 Log–Linear Equilibrium System

Collecting the equilibrium conditions:

$$\text{Euler (CPI real rate): } c_t = E_t c_{t+1} - \frac{1}{\sigma} (i_t - E_t \pi_{t+1}^C - r_t^n), \quad (21)$$

$$\text{CPI and import prices: } p_t^C = (1 - \omega)p_t + \omega(e_t + p_t^{*F}), \quad (22)$$

$$\text{Home absorption (Armington): } d_t = c_t - \xi_c(p_t - p_t^C), \quad (23)$$

$$\text{PPI NKPC (imported-input cost): } \pi_t^p = \beta E_t \pi_{t+1}^p + \kappa \left[(1 - \alpha_m)(w_t - p_t) + \alpha_m(e_t + p_t^{*M} - p_t) - a_t \right], \quad (24)$$

$$\text{PPI identity: } p_t = p_{t-1} + \pi_t^p, \quad (25)$$

$$\text{Exports (PCP): } x_t = \eta_y y_t^* + \varepsilon_x(e_t - p_t), \quad (26)$$

$$\text{Goods market: } y_t = (1 - \chi_x)d_t + \chi_x x_t + \varepsilon_t^g, \quad (27)$$

$$\text{Policy rule (CPI Taylor): } i_t = \rho_i i_{t-1} + (1 - \rho_i)(\phi_\pi \pi_t^C + \phi_y y_t) + \varepsilon_t^i, \quad (28)$$

$$\text{Exchange rate: } e_t = \rho_e e_{t-1} + \theta_e(i_t - i_t^*) + \mu_t + \varepsilon_t^{er}, \quad \mu_t = \mu_{t-1} + \varepsilon_t^\mu, \quad (29)$$

$$\text{Exogenous blocks: } (y_t^*, i_t^*, p_t^{*M}, p_t^{*F}, a_t, r_t^n) \text{ as in (19).}$$

A standard labor market closure implies $w_t - p_t \approx \varphi_y y_t$ so that $\widehat{m}c_t = \phi_y y_t + \alpha_m(e_t + p_t^{*M} - p_t) - a_t$, yielding the reduced–form NKPC used in estimation (cf. Monacelli, 2005).

5.10 Discussion and Mapping to the Literature

Following Monacelli (2005), the NKPC is written in PPI units so that imported–input ER pass–through loads directly into the cost term. CPI enters the Euler equation and the policy rule, consistent with inflation targeting at the consumer level (Galí and Monacelli, 2005).

The Armington block (7) and export demand (15) deliver the core quantity responses to e_t ; this mirrors the PCP/LCP and pass–through gradient documented by Betts and Devereux (2000); Campa and Goldberg (2005); Burstein and Gopinath (2014) and rationalized in models with international price discrimination (Corsetti et al., 2008).

The permanent component μ_t in (18) is a reduced–form device to capture level shifts in relative prices (useful when PPI shows persistent level changes after ER shocks), consistent with evidence on persistent ER innovations (e.g., Bussière et al., 2013).

Open–economy DSGEs for Sweden embed CPI targeting with interest smoothing, imported–input cost pressure, and Armington switching, and reproduce joint dynamics in output, exports, CPI and PPI (Adolfson et al., 2007, 2008).

6 Calibration

All parameters are calibrated at a quarterly frequency to match standard values used in the small open economy New Keynesian literature and to be consistent with Swedish DSGE applications. I keep the Phillips curve in real–marginal–cost form, so the slope is the Calvo slope $\kappa_0 = \frac{(1-\theta)(1-\beta\theta)}{\theta}$ and the cost driver embeds the imported–input channel. The baseline values and robustness ranges follow the sources indicated below.

Time preference and intertemporal substitution. I set $\beta = 0.99$ (annual real rate $\approx 4\%$) and $\sigma = 1$ (unit elasticity), both standard in NK models (Galí, 2015, Ch. 2–3). Robustness explores $\sigma \in [0.5, 2]$.

Price rigidity and NKPC slope. Quarterly Calvo stickiness $\theta = 0.75$ implies an average price duration of 4 quarters. With $\beta = 0.99$, the PPI-NKPC slope is

$$\kappa_0 = \frac{(1-\theta)(1-\beta\theta)}{\theta} \approx 0.085.$$

This is in line with closed- and open-economy NK estimates using marginal-cost drivers (Sbordone, 2005; Monacelli, 2005) and with Swedish DSGE calibrations (Adolfson et al., 2007, 2008). As a steady-state markup reference I use $\varepsilon = 6$ (gross markup = 20%), which affects levels but not the slope in the marginal-cost formulation.

Imported-input cost share. The imported-intermediate share in manufacturing is set to $\alpha_m = 0.30$ (baseline), consistent with IO-based evidence on foreign content in production and the strength of input pass-through (Auer et al., 2019; Halpern et al., 2015). I consider $\alpha_m \in [0.2, 0.5]$ in sensitivity.

Armington final-demand block. The CPI is an Armington composite with import share $\omega_c = 0.30$ at steady state; the home-import substitution elasticity is $\xi = 1.5$. Macro trade elasticity evidence suggests aggregate elasticities around 1–2 when heterogeneity is accounted for, while micro elasticities can be larger (Broda and Weinstein, 2006; Imbs and Mejean, 2015; Feenstra et al., 2018). I explore $\xi \in [1, 3]$ and $\omega_c \in [0.2, 0.4]$.

Exports. Export demand (PCP) is $x_t = \eta_y y_t^* + \varepsilon_x(e_t - p_t)$. I set $\eta_y = 0.5$ to reflect sizable foreign-activity spillovers into Swedish exports and $\varepsilon_x = 0.4$ at medium horizons, consistent with G-7 trade elasticity surveys and VAR-based evidence (Hooper et al., 2000; Bussière et al., 2013). Robustness covers $\varepsilon_x \in [0.2, 0.8]$.

Monetary policy (CPI rule). The policy rule features interest-rate smoothing and CPI inflation targeting:

$$i_t = \rho_i i_{t-1} + (1 - \rho_i)(\phi_\pi \pi_t^c + \phi_y y_t) + \varepsilon_t^i.$$

I use $\rho_i = 0.7$, $\phi_\pi = 2.0$, $\phi_y = 0.1$, consistent with open-economy policy rules in Clarida et al. (2001); Galí and Monacelli (2005) and with Swedish DSGE estimates (Adolfson et al., 2007, 2008). Sensitivity: $\rho_i \in [0.5, 0.9]$, $\phi_\pi \in [1.5, 2.5]$.

Exogenous processes. Foreign activity, rates, and import prices follow AR(1) processes with moderate persistence; technology and the “natural rate” are more persistent. The nominal exchange rate has a stationary component reacting to the interest-rate differential and a permanent component (random walk) to capture level shifts in relative prices, which empirically help match durable PPI level responses.

$$\begin{aligned} y_t^* &= \rho_y y_{t-1}^* + \varepsilon_t^{y^*}, & \rho_y &= 0.2; & i_t^* &= \rho_i^* i_{t-1}^* + \varepsilon_t^{i^*}, & \rho_i^* &= 0.9; \\ p_t^{*M} &= \rho_m p_{t-1}^{*M} + \varepsilon_t^m, & \rho_m &= 0.7; & p_t^{*F} &= \rho_f p_{t-1}^{*F} + \varepsilon_t^f, & \rho_f &= 0.6; \\ a_t &= \rho_a a_{t-1} + \varepsilon_t^a, & \rho_a &= 0.85; & r_t^n &= \rho_r r_{t-1}^n + \varepsilon_t^r, & \rho_r &= 0.8; \\ e_t &= \rho_e e_{t-1} + \theta_e (i_t - i_t^*) + \mu_t + \varepsilon_t^{er}, & \rho_e &= 0.7, \theta_e = 0.2; \\ \mu_t &= \mu_{t-1} + \varepsilon_t^\mu. \end{aligned}$$

The coefficient of exogenous AR(1) process is matched by running a AR(1) model on the series of exogenous variables after transformation in empirical part. These ranges are in line with SOE-VAR and DSGE-VAR evidence for advanced SOEs and with the role of persistent/permanent ER components in matching price-level dynamics (Bussière et al., 2013; Adolfson et al., 2007).

Shock volatilities. Unless otherwise stated in the empirical section, I use illustrative standard deviations (quarterly): $\sigma(\varepsilon^\mu) = 0.010$. These are chosen to reproduce standard unconditional variability in SOE simulations and align the ER innovation with a $\sim 1\%$ depreciation on impact.

Three choices align the model tightly with the empirical evidence in manufacturing: (i) the NKPC is written in *PPI* units with the imported-input term $\alpha_m(e_t + p_t^{*M} - p_t)$, which delivers strong border pass-through (Monacelli, 2005); (ii) the IS and policy rule use *CPI* inflation, consistent with household intertemporal prices and inflation targeting (Galí and Monacelli, 2005); (iii) the ER includes a permanent component, which helps reconcile durable PPI level shifts with more transient quantity responses (Bussière et al., 2013). Robustness exercises vary $(\xi, \omega_c, \alpha_m, \varepsilon_x, \rho_i, \phi_\pi)$ over the ranges noted above; results are reported in the appendix.

Table 1: Baseline calibration (quarterly).

Block	Symbol	Value	Source / rationale
Time preference	β	0.99	Quarterly discounting; standard SOE calibration (e.g., Galí & Monacelli 2005).
Intertemporal elasticity	σ	1.00	Unit EIS as in Galí & Monacelli (2005).
Calvo stickiness	θ	0.75	Avg. price duration $\approx 4q$; Sbordone (2005); Monacelli (2005).
NKPC slope	$\kappa_0 = \frac{(1-\theta)(1-\beta\theta)}{\theta}$	0.85	Implied by β, θ (textbook mapping).
Imported-input share	α_m	0.30	Imported input content in manufacturing / I–O evidence; Auer et al. (2019); Halpern et al. (2015).
Armington import weight	ω_c	0.30	Import share in CPI tradables; Monacelli (2005).
Armington elasticity	ξ	1.50	Midpoint of macro/micro estimates (Broda & Weinstein, 2006; Imbs & Mejean, 2015; Feenstra et al., 2018).
Export ER elasticity	ε_x	0.40	Medium-run trade elasticities (Hooper et al., 2000; Bussière et al., 2013).
Foreign demand elasticity	η_y	0.50	Sensitivity of exports to foreign activity in Swedish SOE DSGE/SVAR (Adolfson et al., 2007; Bjørnland, 2009).
Policy smoothing	ρ_i	0.70	Interest-rate inertia in SOE rules (Clarida et al., 2001; Adolfson et al., 2007).
Policy π weight (CPI)	ϕ_π	2.00	Taylor-type rule; Clarida et al. (2001).
Policy y weight	ϕ_y	0.10	Small output stabilization; Adolfson et al. (2007).
ER AR(1)	ρ_e	0.70	Persistence of risk-premium/ER innovations in Swedish SOE models and SVARs (c.f. Adolfson et al., 2007; Bjørnland, 2009).
ER differential coeff.	θ_e	0.20	Calibrated so a 100 bp $i_t - i_t^*$ moves the ER by $\approx 1\text{--}2\%$ on impact; consistent with policy-shock and event-study evidence (Eichenbaum & Evans, 1995; Rogers et al., 2014).

Notes: This table summarizes the concepts and values of parameter in the theoretical model. κ_0 follows from β, θ . Signs are defined for e_t as a depreciation; for an appreciation, flip the sign of θ_e .

7 Results

7.1 Empirical SVAR results

The empirical model is the four-variable SVAR described in Section 4, with endogenous variables real GDP in manufacturing, the nominal effective exchange rate (NEER), the manufacturing producer price index (PPI), and the Swedish policy rate. Europe-wide real GDP, Euro area PPI, US PPI and the trend component of the US effective federal funds rate enter as exogenous controls. All variables are transformed as in Section 3 so that the VAR is estimated in stationary form.

7.1.1 Lag order selection

The first step is to determine the appropriate lag length for the VAR. Table 2 reports the values of the Akaike Information Criterion (AIC), Hannan–Quinn criterion (HQ), Schwarz criterion (SC/BIC) and Final Prediction Error (FPE) for lag orders $n = 1, \dots, 8$. For quarterly macro data the literature typically recommends relatively parsimonious lag structures to preserve degrees of freedom and avoid overfitting, while still capturing the main business-cycle dynamics (Enders, 2014; Ivanov and Kilian, 2005).

Table 2: VAR Lag Order Selection

	AIC(n)	HQ(n)	SC(n)	FPE(n)
Selected lag n^*	8	3	1	8

Notes: The table reports the lag order n that minimizes each criterion for the estimated VAR. AIC = Akaike Information Criterion; HQ = Hannan–Quinn; SC = Schwarz (Bayesian) Criterion; FPE = Final Prediction Error.

In my sample of $T = 115$ quarterly observations, the HQ and SC criteria favour three and one lags respectively, whereas the AIC and FPE both point to eight lags. Given the relatively small sample and the focus on dynamic responses to exchange rate shocks and the model with short lags having a serial correlation problem, I follow the information criteria geared towards impulse-response analysis and choose *eight* lags as the baseline specification.² This lag length is sufficiently rich to absorb residual serial correlation (see below) and to span a five-year horizon in the impulse-response analysis.

7.1.2 Residual diagnostics

To assess the adequacy of the VAR specification I conduct standard residual diagnostics. Table 3 presents Ljung–Box portmanteau tests for autocorrelation at lags 2, 4, 6, and 8 for each endogenous variable. In all cases the p -values are comfortably above 5%, indicating that the null of no residual autocorrelation up to the indicated lag cannot be rejected. Hence the eight-lag VAR appears to capture the dynamic structure of the data well.

²For $T < 120$, Ivanov and Kilian (2005) recommend using AIC or FPE when the primary interest lies in impulse responses.

Table 3: Ljung–Box Residual Autocorrelation Tests at Multiple Lags

Lags	Ljung–Box							
	2		4		6		8	
	χ^2	p	χ^2	p	χ^2	p	χ^2	p
GDP_Manufacturing	2.5425	0.2805	3.9187	0.4171	6.3486	0.3853	9.4553	0.3054
NEER	0.0224	0.9889	2.0355	0.7292	3.3944	0.7580	3.6964	0.8834
PPI_Manufacturing	0.1571	0.9245	0.1594	0.9970	0.7102	0.9943	2.2208	0.9735
Policy_Rate	0.0629	0.9690	0.1016	0.9988	1.1327	0.9801	5.1680	0.7395

Notes: Entries are Ljung–Box χ^2 statistics with p -values for the null of no residual autocorrelation up to the indicated lag (df equals the lag). Higher p -values indicate failure to reject the null.

Normality of the residuals is examined using Jarque–Bera tests. Panel A of Table 4 reports univariate tests for each equation, while Panel B reports a multivariate normality test for the VAR system as a whole. For manufacturing GDP, NEER and PPI, the univariate p -values exceed 5%, suggesting that the residuals are approximately normal. The policy rate equation exhibits some departure from normality (univariate $p \approx 0.04$), driven by skewness and kurtosis in periods of large rate moves. However, the multivariate Jarque–Bera statistics for the system (overall, skewness, and kurtosis components) all fail to reject normality at conventional levels. Given that non-normality in interest rate equations is common in macro VARs and that the whole system still accept the null hypothesis confirming the normality, the model is accepted and used for later structural VAR estimation.

Table 4: Normality Tests on VAR Residuals

Panel A: Univariate (Jarque–Bera)	df	χ^2	p
GDP_Manufacturing	2	0.0421	0.9792
NEER	2	0.1861	0.9112
PPI_Manufacturing	2	1.3134	0.5185
Policy_Rate	2	6.5033	0.0387
Panel B: Multivariate (VAR residuals)			
JB (overall)	8	4.1189	0.8462
Skewness only	4	1.3308	0.8561
Kurtosis only	4	2.7881	0.5939

Notes: Panel A reports Jarque–Bera tests for each series’ residuals (df = 2). Panel B reports multivariate normality tests on the VAR residuals: the overall JB test and its skewness/kurtosis components. The null hypothesis is normality; small p -values reject the null.

Overall, the residual diagnostics suggest that the SVAR with eight lags provides a reasonably well-behaved approximation to the joint dynamics of manufacturing output, the exchange rate, producer prices and the policy rate.

7.1.3 Impulse responses to a depreciation shock

This subsection presents the responses of manufacturing prices and output to an orthogonalized innovation in the NEER. The exchange rate shock is normalized to a one-standard-deviation depreciation of the krona, which corresponds to roughly a one-percent quarterly weakening of the nominal effective rate. All responses are reported in percentage points relative to the pre-shock baseline.

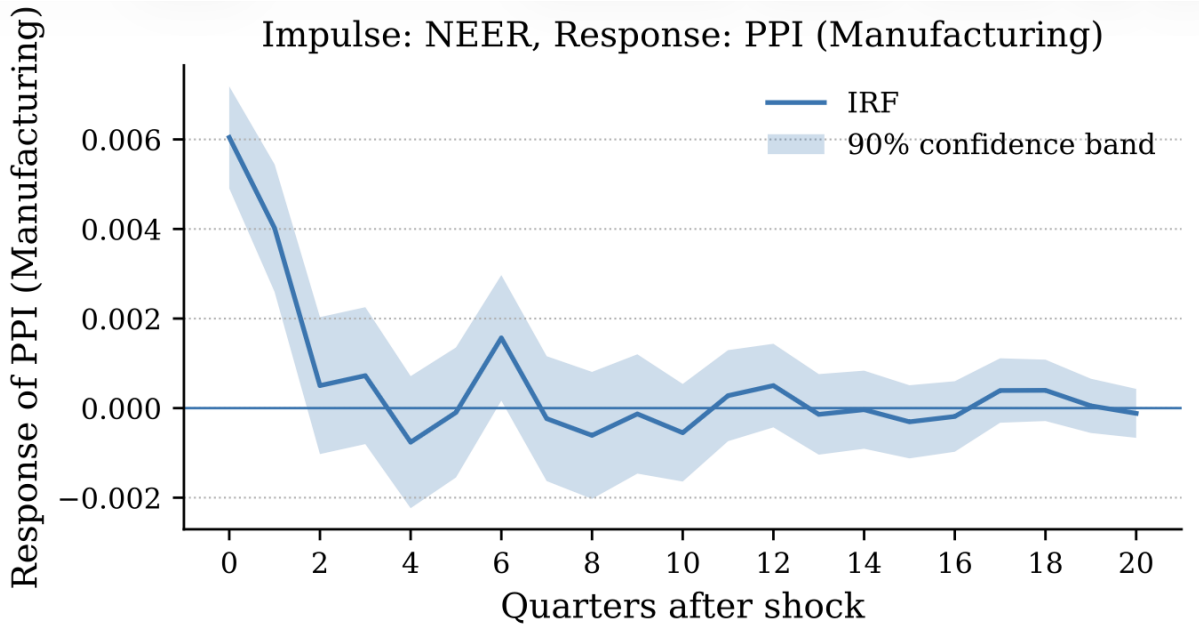


Figure 2: Impulse response functions to PPI

Note. This figure displays how a 1% depreciation in the exchange rate (NEER) impacts producer prices (PPI) up to 20 quarters after the shock in the SVAR model using all data after transformation. The solid line reports the estimated orthogonalized impulse response, and the shaded band depicts the 90 percent confidence interval.

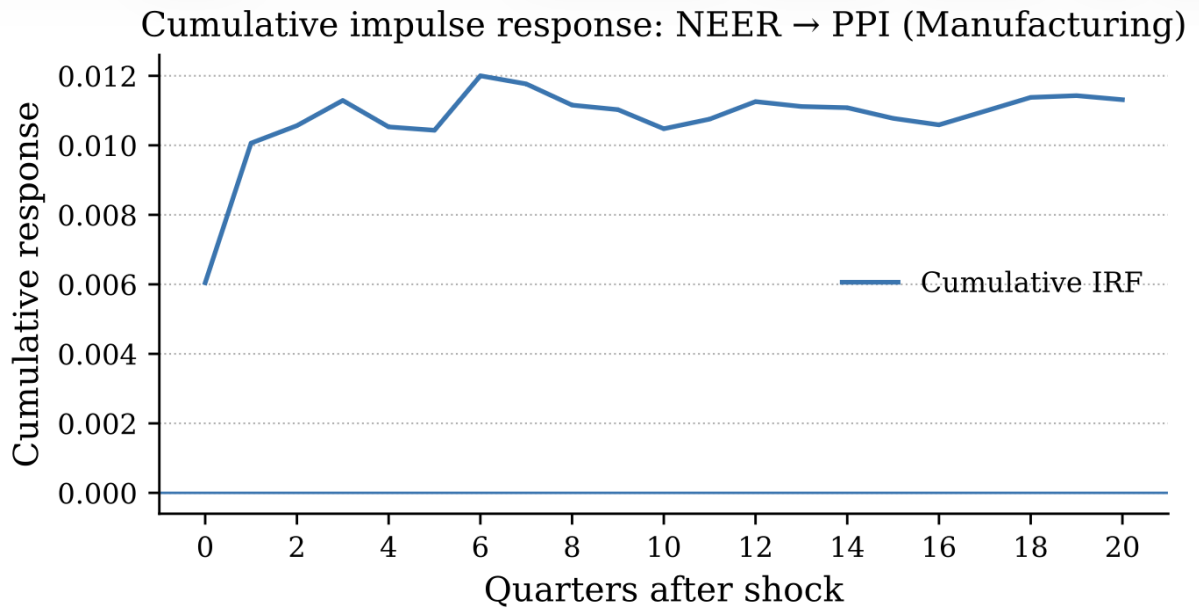


Figure 3: Cumulative impulse response to PPI

Note. This figure reports the cumulative response of manufacturing producer prices (PPI) to a 1 percent depreciation of the nominal effective exchange rate (NEER) over 20 quarters in the SVAR model using all data after transformation. The cumulative impulse response at each horizon is obtained by summing the point estimates of the quarterly impulse responses in the previous IRF figure. The vertical axis therefore measures the total percentage-point change in GDP relative to the pre-shock level.

Figure 2 shows the orthogonalized impulse response of the manufacturing PPI to a NEER shock with 90% confidence bands. On impact, manufacturing prices rise modestly as imported input costs increase, but the point estimate is small and not statistically different from zero at short horizons. The subsequent quarters exhibit a gradual pass-through: the response becomes

more clearly positive after several quarters, before slowly reverting towards zero. The lack of large, precisely estimated short-run effects is consistent with the presence of nominal rigidities and staggered pricing in the manufacturing sector.

To gauge the economically relevant level effect, Figure 3 plots the corresponding cumulative orthogonalized response over a five-year horizon. Because PPI manufacturing is modelled in log differences, the cumulative response approximates the effect on the log price level. Following a one-percent depreciation, the cumulative PPI response rises steadily and stabilizes around 1–1.2 percent after about five years. The effects remains entirely above zero beyond the medium run. The magnitude and persistence of the estimated ERPT are broadly in line with the international evidence: Campa and Goldberg (2005) and Bussière et al. (2013) document substantial pass-through into import and producer prices in advanced small open economies, while retail/CPI responses are typically more muted. Recent regime-dependent estimates for ERPT in advanced economies also find positive and persistent pass-through to import and producer prices, though often below unity (e.g. Ito and Sato, 2006).

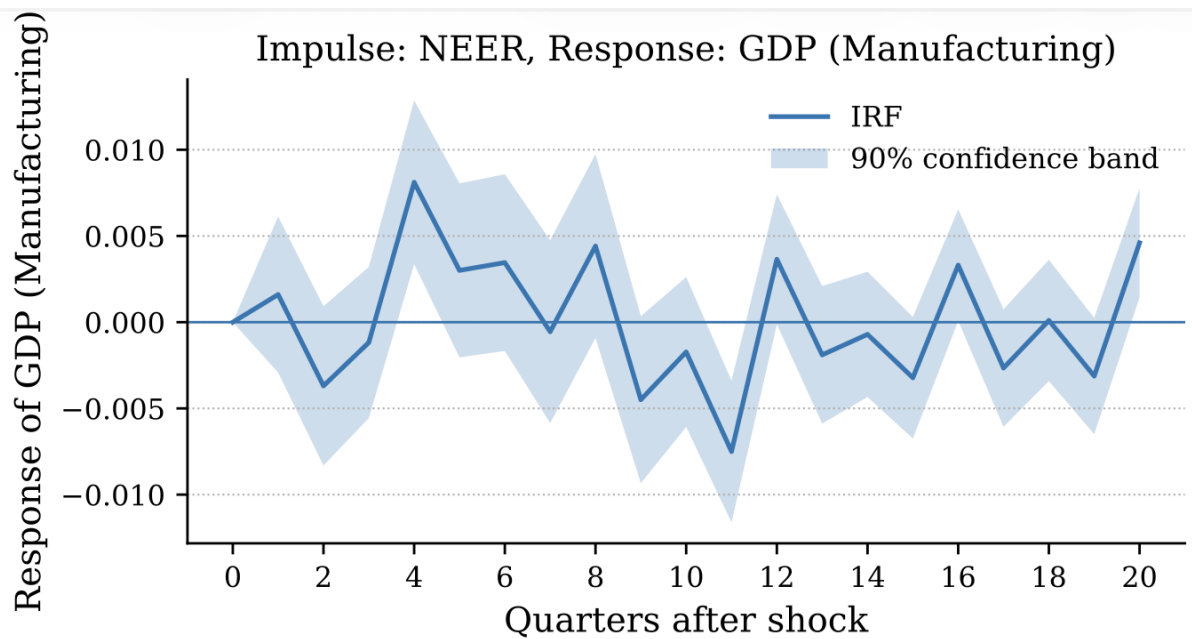


Figure 4: Impulse response functions to GDP

Note. This figure display a how a 1% depreciation in the exchange rate (NEER) impacts production (GDP manufacturing) up to 20 quarters after the shock in the SVAR model using all data after transformation. The solid line reports the estimated orthogonalized impulse response, and the shaded band depicts the 90 percent confidence interval.

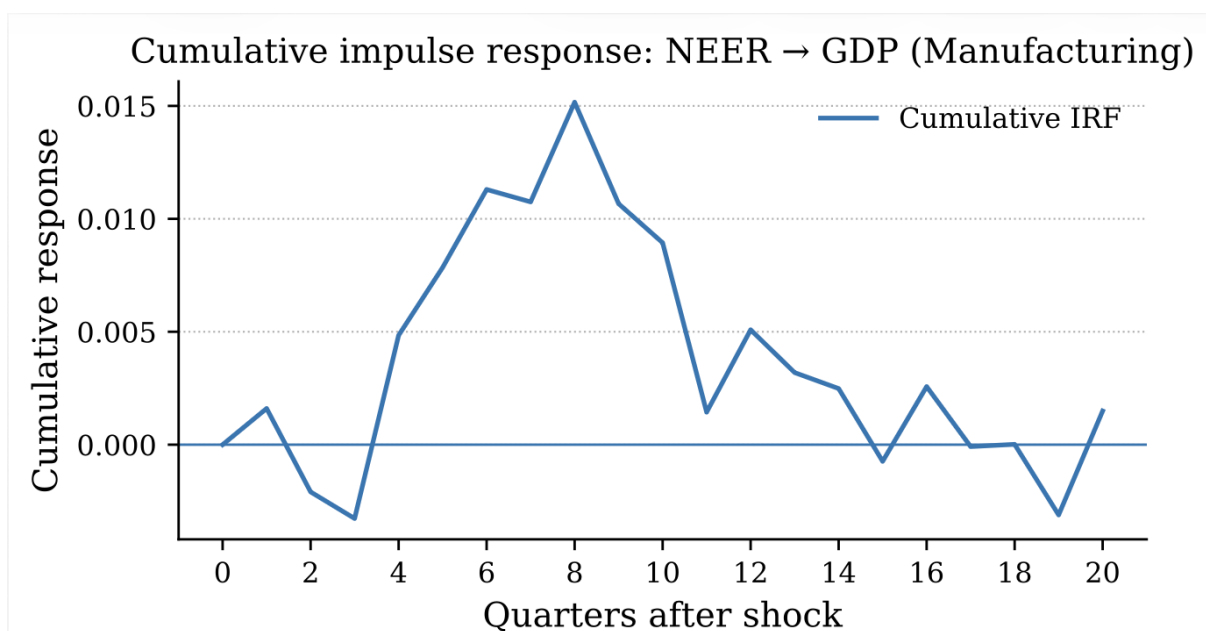


Figure 5: Cumulative impulse response to GDP

Note. This figure reports the cumulative response of production (GDP manufacturing) to a 1 percent depreciation of the nominal effective exchange rate (NEER) over 20 quarters in the SVAR model using all data after transformation. The cumulative impulse response at each horizon is obtained by summing the point estimates of the quarterly impulse responses in the previous IRF figure. The vertical axis therefore measures the total percentage-point change in PPI relative to the pre-shock level.

Turning to output of manufacturing, figure 4 reports the orthogonalized response of real manufacturing GDP to a NEER shock. The point estimate displays a hump-shaped profile: output increases gradually after the depreciation, peaks after around two to three years, and then slowly declines back towards zero. Confidence bands are fairly wide at very short horizons but tighten around the peak, suggesting that the medium-run expansion in manufacturing activity is reasonably well identified. This behaviour is consistent with an expenditure-switching channel where a weaker krona improves the competitiveness of Swedish manufactures in foreign markets, thereby raising production with a delay.

The cumulative response in Figure 5 confirms that the depreciation has a persistent positive effect on the level of manufacturing output. The cumulative gain stabilizes around 0.5–0.7 percent relative to baseline after five years. While the magnitude is smaller than the corresponding PPI response, the qualitative pattern mirrors the classic hump-shaped output responses found in structural VAR studies of exchange-rate shocks: a weaker currency boosts external demand for manufactured exports, leading to a persistent but ultimately transitory expansion in the tradables sector (Eichenbaum and Evans, 1995; Kim and Roubini, 2000; Bjørnland, 2009). The timing and hump-shape are also similar to those found in DSGE-VAR studies for Sweden (Adolfson et al., 2007, 2008), where output in the traded sector increases for several years following an exchange-rate shock before returning to its steady state.

Taken together, the SVAR results suggest that an unanticipated depreciation of the krona leads to (i) a gradual but persistent increase in border producer prices in manufacturing, and (ii) a medium-run expansion in manufacturing output with a hump-shaped profile. These findings provide empirical targets for the theoretical model: any structural interpretation should generate both cost-push pass-through into PPI and expenditure-switching effects on sectoral activity, with dynamics operating at business-cycle frequencies.

7.2 Theoretical SOE–NK model results

I now turn to the small open economy New Keynesian model developed in Section 5, calibrated to Swedish data and the international evidence summarized in Section 2. The model features imported intermediates in manufacturing, a PPI-based NKPC with real marginal costs in producer-price units, an Euler equation for CPI consumption, Armington demand for home versus imported final goods, and a monetary policy rule that responds to CPI inflation and the output gap. Exchange rate dynamics combine a stationary AR(1) component with a permanent level component.

7.2.1 Impulse responses to a permanent depreciation

Figure 6 displays the model-implied responses to an orthogonalized innovation in the permanent exchange rate component, $\varepsilon_{\mu,t}$, calibrated to generate approximately a one-percent step depreciation in the nominal exchange rate e_t . The shock raises the home-currency cost of imported inputs and imported final goods and simultaneously improves the relative price of Swedish exports in foreign markets.

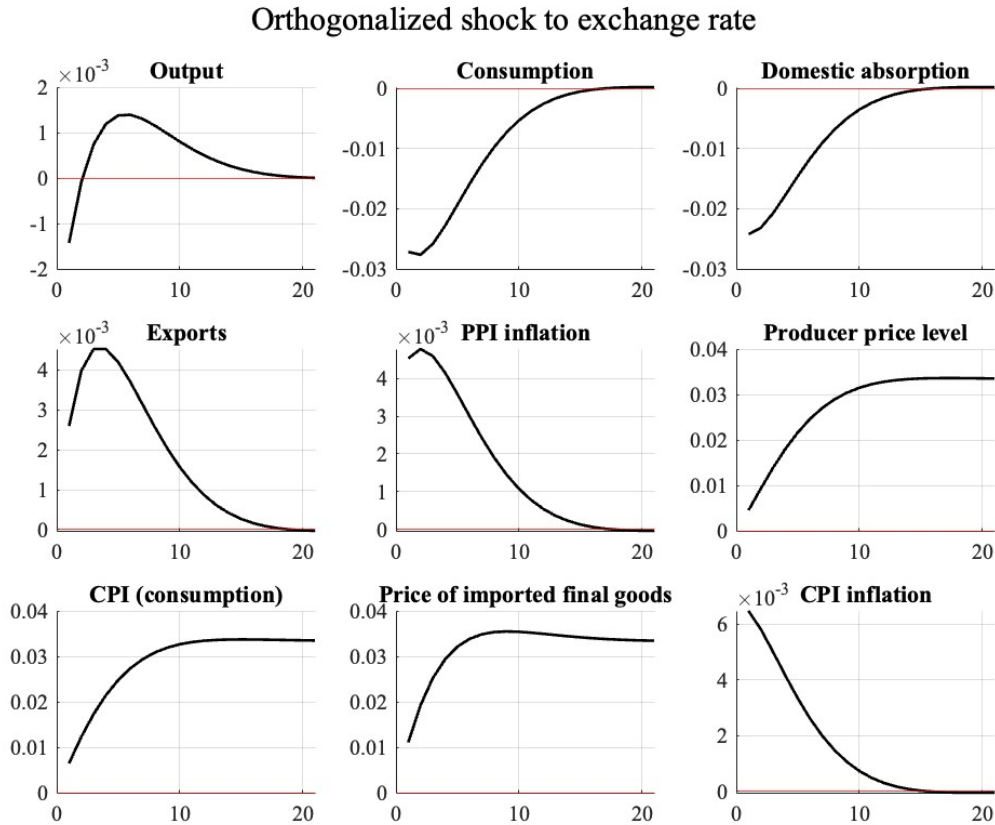


Figure 6: Impulse response to a exchange rate depreciation shock

Notes: The figure shows model-implied impulse responses to a 1% depreciation with simulated data. A higher e_t denotes a depreciation of the domestic currency. All variables are reported as deviations from the non-stochastic steady state. Output, consumption, domestic absorption and exports are in log deviations (approximately percentage changes), while price and inflation variables are in percentage points. The horizon on the x -axis is measured in quarters.

On the price side, PPI inflation π_t^p jumps up on impact as firms gradually adjust prices in response to higher marginal costs. Because the NKPC is forward-looking and driven by real marginal cost, PPI inflation then decays back towards zero while the price level p_t exhibits

a persistent increase, levelling off at roughly four percent above baseline after five years. A permanent depreciation pushes up marginal costs through imported inputs and, under Calvo pricing, leads to gradual but long-lasting increases in producer prices (cf. Sbordone, 2005; Monacelli, 2005). CPI inflation and the prices of imported final goods (p_t^f) and consumption (p_t^c) also rise, but the shapes of each plot is slightly different, reflecting the weighting of home and imported goods in the consumption basket.

Real marginal cost increases primarily through the imported-input term, consistent with the calibration of the import share in manufacturing. Exports x_t surge following the depreciation due to improved price competitiveness, but as foreign demand and prices adjust, export volumes gradually revert towards steady state. Total manufacturing output y_t rises with a hump-shaped pattern, peaking after a few years before slowly returning towards baseline. Domestic absorption d_t initially contracts, as higher real interest rates (due to the monetary response to higher inflation) and the deterioration in the terms of trade weigh on consumption; absorption then recovers as inflation and the policy rate normalize. These dynamics echo the empirical VAR evidence: the model delivers both a persistent increase in producer prices and a medium-run expansion in manufacturing output after a depreciation.

7.2.2 Comparison with SVAR evidence

The model helps interpret the SVAR responses in terms of structural channels. First, the persistent increase in the manufacturing PPI in both the VAR and the model reflects imported-input cost pass-through in a sector with sticky producer prices. The calibrated share of imported intermediates and the slope of the NKPC are chosen so that a one-percent permanent depreciation generates a roughly one-percent long-run increase in the PPI level, matching the magnitude of the cumulative VAR response.

Second, the hump-shaped response of manufacturing output is driven by the interaction of expenditure switching and monetary policy. In the model, a weaker krona boosts exports and thus manufacturing production, but the central bank reacts to higher CPI inflation by raising the policy rate, which dampens domestic demand and eventually brings output back towards potential. This mechanism mirrors the VAR evidence, where output rises for several years but does not explode, and the policy rate responds with a delayed tightening.

Third, the model clarifies the role of a highly persistent or permanent exchange rate component. A purely transitory ER shock would generate only short-lived price and output responses, at odds with the data. Allowing for a permanent shift in the exchange rate level aligns the theoretical PPI and output dynamics with the empirical cumulative impulse responses, supporting an interpretation in which exchange rate innovations embody a persistent risk-premium component rather than pure monetary noise.

Overall, the SOE–NK model with imported inputs, forward-looking pricing, Armington demand and CPI-based policy reproduces the key empirical findings from the Swedish manufacturing SVAR: sizeable and persistent pass-through into producer prices and a medium-run expansion in manufacturing activity following a depreciation. The next subsection explores the sensitivity of these conclusions to alternative calibrations and identification schemes.

7.3 Robustness analysis

This subsection examines how sensitive the main findings are to (i) the structural ordering in the SVAR, (ii) a clear structural break on the global financial crisis in SVAR and (iii) the calibration of key parameters in the small–open–economy New Keynesian model. Overall, the qualitative conclusions are robust: a depreciation shock generates a persistent rise in producer prices for manufacturing and a hump-shaped, but relatively modest, response of manufacturing output, both in the empirical model and in the calibrated SOE–NK framework.

7.3.1 Alternative SVAR ordering

The baseline specification orders the nominal effective exchange rate first, followed by manufacturing GDP, PPI for manufacturing, and the policy rate. This ordering is consistent with the view that exchange rate innovations are relatively high-frequency and can contemporaneously affect real activity and prices, while output and policy react with a short delay. To assess whether the main results depend on this timing assumption, I re-estimate the VAR with a more conservative “slow-variable-first” ordering in which manufacturing GDP and PPI are placed before the exchange rate and policy rate. The alternative system is therefore ordered as

$$\mathbf{Y}_t = [\Delta GDP, \text{POLICY RATE}, \Delta NEER, \Delta PPI]',$$

while keeping the exogenous controls for foreign GDP, foreign PPI and the US policy rate unchanged and maintaining the same lag length.

Appendix section A: reports the corresponding orthogonalized and cumulative impulse responses. For PPI in manufacturing, the instantaneous effect of a one-standard-deviation depreciation becomes slightly more front-loaded and less precisely estimated in the first few quarters: the conventional IRF oscillates around zero with a short-run dip, and the confidence band includes zero at most horizons. However, when cumulated over time, the response of PPI is clearly positive and stabilizes at a level of roughly 1 percent after six to eight quarters. This is very close to the medium-run pass-through estimated under the baseline ordering. Hence, the key conclusion that a depreciation leads to a persistent increase in producer prices for manufacturing is not driven by the particular recursive ordering.

For manufacturing GDP, the alternative ordering yields somewhat noisier short-run responses, reflecting the fact that the exchange rate is now restricted not to affect output contemporaneously. The pointwise IRF shows small fluctuations around zero in the first few quarters, with wide confidence bands. The cumulative response nevertheless exhibits a hump-shaped pattern, peaking after roughly eight quarters and then gradually returning towards zero. The peak cumulative effect is similar in magnitude to the baseline specification, although the precision is lower. Taken together, the alternative ordering confirms that the output effects of exchange rate shocks are modest and less tightly estimated than the price effects, but it does not overturn the finding of a positive medium-run response of manufacturing activity.

7.3.2 Structural break and parameter stability

A natural concern for a sample spanning almost three decades is that the relationship between exchange rate and manufacturing industry may have changed around major events, such as the global financial crisis. If the reduced-form VAR coefficients are unstable, the estimated impulse responses would average over different regimes and could be hard to interpret structurally. To assess the stability of the VAR, I therefore perform Chow tests for a single structural break around the crisis period (2008Q3) for it has huge impact on the global economy and is around the midpoint of the window of observations, following standard time-series practice (e.g. Enders, 2014; Stock and Watson, 2001).

The Chow test is implemented equation-by-equation for the reduced-form VAR. For each endogenous variable $y_t \in \{\text{GDP}, \text{NEER}, \text{PPI}, \text{Policy_Rate}\}$, I re-estimate its linear regression on eight lags of all endogenous variables on the full sample and separately on the pre- and post-crisis subsamples. Let SSR_{full} denote the sum of squared residuals from the full-sample regression, and SSR_1 and SSR_2 the corresponding sums for the two subsamples, with n_1 and n_2 observations, respectively. Denoting by k the number of regressors in the equation (including the constant), the Chow F -statistic is

$$F_{\text{Chow}} = \frac{(\text{SSR}_{\text{full}} - (\text{SSR}_1 + \text{SSR}_2))/k}{(\text{SSR}_1 + \text{SSR}_2)/(n_1 + n_2 - 2k)},$$

which under the null of coefficient stability is distributed as $F(k, n_1 + n_2 - 2k)$.

Table 5 reports the resulting F -statistics and p -values. For manufacturing GDP, the Chow statistic is $F = 0.79$ with a p -value of 0.76. For the NEER equation, $F = 1.52$ with a p -value of 0.11. The PPI and policy-rate equations yield $F = 1.09$ ($p = 0.41$) and $F = 1.18$ ($p = 0.32$), respectively. In all cases the p -values are above conventional significance levels, so the null hypothesis could not be rejected that coefficients are stable across the pre- and post-crisis subsamples. NEER displays the lowest p -value, but even there the evidence is above the decisive 10% level.

Overall, these results suggest that there is no strong statistical evidence for a discrete structural break in the reduced-form dynamics at the chosen date. Given the relatively small sample and the fairly parameter-rich VAR (eight lags), the Chow tests have limited power, so the findings should be interpreted as ‘no clear break detected’ rather than proof of exact stability. Nevertheless, the absence of significant instabilities provides some reassurance that the baseline VAR can be estimated on the full sample and that the reported impulse responses are not simply driven by a drastic regime shift around the global financial crisis.

Table 5: Chow tests for a structural break in the VAR equations

Dependent variable	Chow F	p -value
$GDP_{Manufacturing}$	0.789	0.759
NEER	1.517	0.114
$PPI_{Manufacturing}$	1.085	0.408
$Policy_{Rate}$	1.178	0.318

Notes: This table reports Chow F -statistics and p -values from separate stability tests on each reduced-form VAR equation. The null hypothesis is that the regression coefficients are stable across the pre- and post-break subsamples. All p -values are above conventional significance levels, so we do not reject coefficient stability for any equation.

7.3.3 Alternative SOE–NK calibration

On the theoretical side, I also explore how the theoretical impulse responses react to a relatively substantially different calibration of the SOE–NK model. The robustness specification increases the import share of intermediate inputs to $\alpha_m = 0.40$ and the Armington elasticity to $\xi_c = 2.0$, thereby strengthening both the cost channel and the expenditure-switching channel. The weight of imported final goods in the CPI is raised to $\omega_c = 0.40$, while the export demand elasticities are adjusted to $\eta_y = 0.70$ and $\varepsilon_x = 0.40$. The monetary policy rule features more interest-rate smoothing, with $\rho_i = 0.75$, and the same Taylor-type response to CPI inflation and a small weight on the output gap. All other parameters are kept at their baseline values.

The resulting model-based impulse responses to an exchange rate depreciation are displayed in Appendix Figure 11. Relative to the baseline calibration, the higher import intensity and stronger trade elasticities amplify the real marginal cost channel and the expenditure-switching mechanism. Output in the manufacturing-intensive sector now displays a somewhat larger and more pronounced hump, peaking after around six to eight quarters before gradually returning to its steady state. Exports respond more strongly on impact and decay more slowly, reflecting the higher sensitivity of foreign demand and the larger imported-input share. PPI inflation becomes more negative in the short run as marginal costs adjust, but the producer price level rises by roughly the same order of magnitude as in the baseline model, reaching a new, permanently higher plateau. CPI inflation and the CPI level also display slightly stronger and more persistent increases, consistent with the higher weight of imported final goods.

Despite these quantitative differences, the qualitative message of the theoretical analysis is unchanged. In both calibrations, an exogenous depreciation leads to (i) a persistent increase

in producer prices for manufacturing driven by imported-input costs, (ii) a hump-shaped but ultimately transitory rise in output and exports, and (iii) a gradual increase in CPI and domestic absorption. The fact that these patterns are robust to sizeable changes in import intensity, trade elasticities and policy inertia supports the interpretation that the empirical SVAR responses capture a combination of cost-push and expenditure-switching channels that are well approximated by the SOE-NK framework.

Overall, the robustness checks—both in the reduced-form VAR and in the structural model—indicate that the main conclusions of the thesis do not hinge on a particular identification scheme or a narrow set of parameter values. The evidence consistently points to sizable and persistent pass-through of exchange rate movements into manufacturing producer prices, accompanied by more moderate and less precisely estimated effects on manufacturing activity.

8 Conclusion

This thesis has examined how exchange-rate movements affect prices and real activity in the Swedish manufacturing sector, combining an empirical SVAR analysis with a small open economy New Keynesian (SOE-NK) model. The motivation stems from the central role of manufacturing in Sweden’s GDP and exports, and from the long-standing debate about how strongly the exchange rate transmits into domestic inflation and competitiveness under inflation targeting. By focusing on producer prices and sectoral output, rather than aggregate CPI alone, the thesis sheds light on the border between international price setting and domestic production.

On the empirical side, I estimate a quarterly SVAR for 1995–2023 that includes the manufacturing GDP, the nominal effective exchange rate, manufacturing PPI and the policy rate, while controlling for foreign demand, foreign prices and the US policy rate. After documenting that an eight-lag specification yields well-behaved residuals, structural shocks are identified using a recursive (Cholesky) scheme consistent with small-open-economy reasoning. A depreciation shock to the NEER generates a clear pattern in the orthogonalized impulse responses. Manufacturing producer prices rise on impact and remain above baseline for several years; the cumulative response over a five-year horizon is around one percent, pointing to incomplete but economically meaningful pass-through into PPI. Manufacturing output displays a hump-shaped expansion, peaking after roughly two years before gradually returning to trend. These dynamics are broadly in line with international evidence for advanced small open economies: exchange-rate movements produce persistent level effects in traded-goods prices and medium-run, but ultimately transitory, gains in tradables activity.

On the theoretical side, the thesis develops and calibrates a tractable SOE-NK model that places imported-input costs and producer prices at centre stage. Firms use an imported intermediate input in production; the associated marginal-cost term enters a PPI-based New Keynesian Phillips curve. Final demand is modelled with an Armington aggregator, so that a depreciation generates expenditure switching toward home goods, and monetary policy follows a CPI-based Taylor rule with interest-rate smoothing. The exchange rate itself contains a highly persistent component, capturing the empirical persistence of NEER shocks. When hit by a permanent depreciation shock, the model reproduces the main empirical regularities: a hump-shaped expansion of output and exports, and a persistent increase in producer prices through the imported-input cost channel. The mapping from calibration targets to impulse responses clarifies which structural parameters—import intensity, trade elasticities, the NKPC slope and the policy rule—are key for matching the Swedish evidence.

In conclusions, the empirical and model-based results imply that the exchange-rate channel in Swedish manufacturing operates through both competitiveness and costs. A weaker krona raises external demand and stimulates manufacturing output, but it also increases the domestic-currency cost of imported intermediates, feeding into producer prices and, ultimately, CPI. For monetary policy this underscores a familiar trade-off: aggressive exchange-rate depreciations can support

the traded sector in the short and medium run, but at the cost of higher producer prices and potential inflationary pressure. From an industrial perspective, the results highlight the exposure of Swedish manufacturing to exchange-rate movements via global value chains and imported inputs, not only via export demand.

Naturally, the analysis has limitations. The VAR is linear and estimated on a relatively short sample, which precludes a detailed treatment of regime changes in monetary policy or inflation environments. The identification relies on a recursive ordering and treats foreign variables as strictly exogenous. The structural model abstracts from capital accumulation, heterogeneous firms, explicit currency-of-invoicing choices and financial frictions; these simplifications help transparency but restrict the range of mechanisms that can be analysed. The calibration, while anchored in the literature, is not formally estimated to match the Swedish data in a perfect and full-information sense.

These limitations suggest several avenues for future research. On the empirical side, it would be valuable to explore local-projection methods. Linking the aggregate VAR to micro firm-level data (evidence) on prices, imports, and invoicing currencies could also disentangle the roles of dominant-currency pricing and input linkages more precisely. On the theoretical side, estimating a richer open-economy DSGE model for Sweden, with explicit production networks and a micro-founded currency choice for trade, would allow a tighter quantitative evaluation of policy trade-offs. Despite these open questions, the evidence assembled in this thesis supports a coherent narrative: in a small, highly open manufacturing economy such as Sweden, exchange-rate shocks have non-negligible and persistent effects on producer prices and traded-sector activity, and simple SOE-NK frameworks with imported inputs and expenditure switching provide a useful lens through which to interpret these dynamics.

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Appendix

A: Estimations with Alternative Structural Order

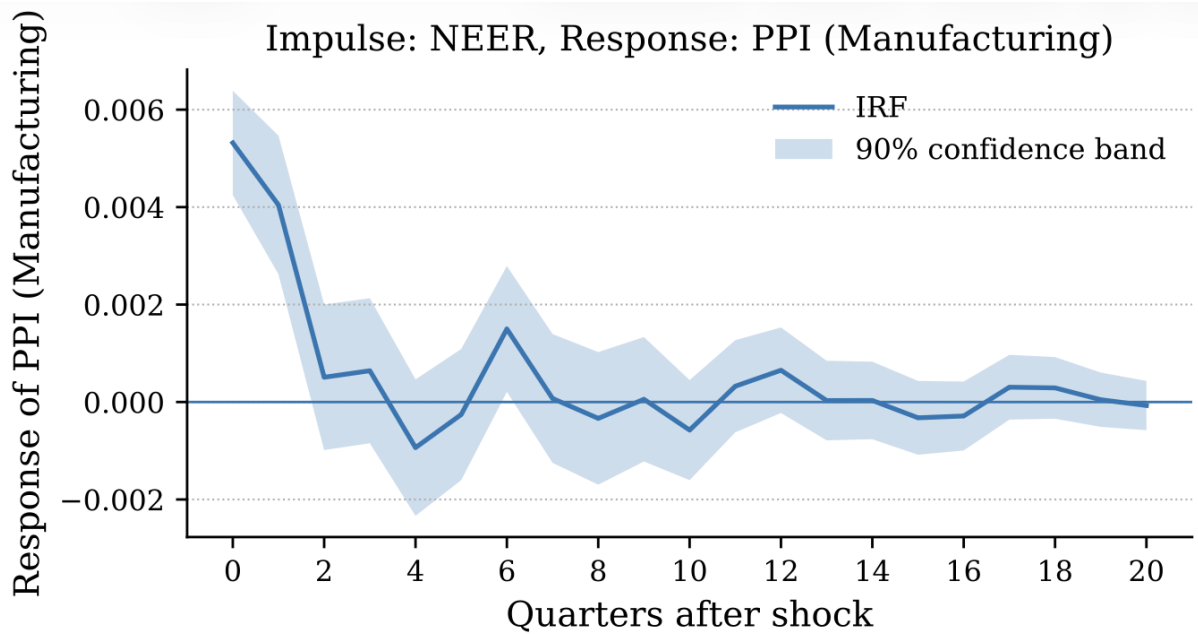


Figure 7: Impulse response functions to PPI

Note. This figure displays how a 1% depreciation in the exchange rate (NEER) impacts producer prices (PPI) up to 20 quarters after the shock using alternative structural order in the SVAR model using all data after transformation. The solid line reports the estimated orthogonalized impulse response, and the shaded band depicts the 90 percent confidence interval.

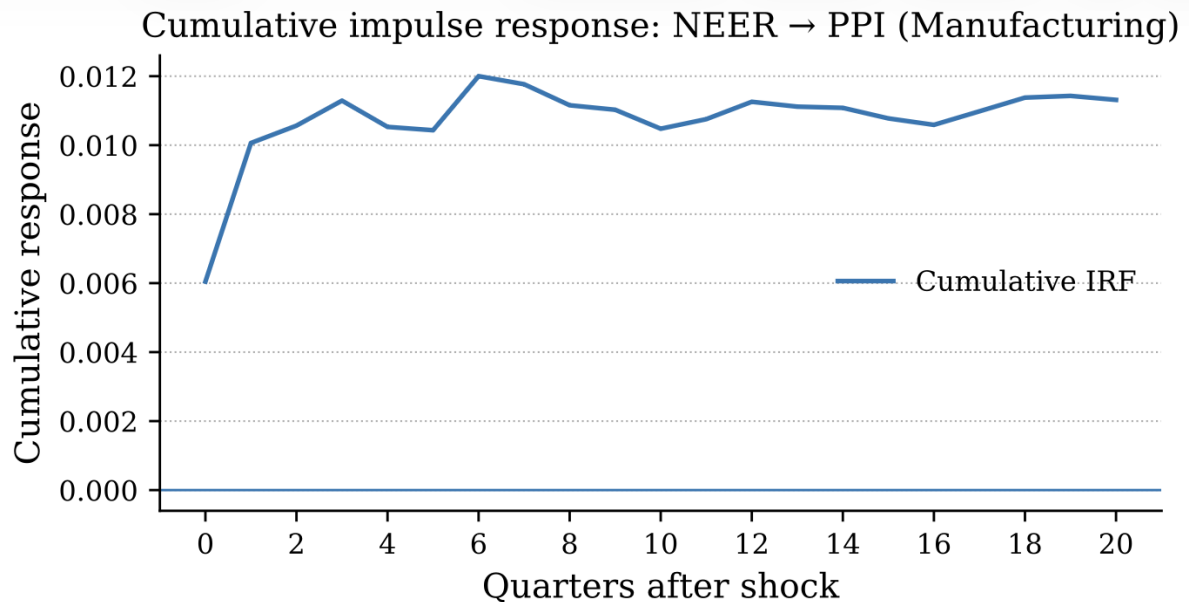


Figure 8: Cumulative impulse response to PPI

Note. This figure reports the cumulative response of producer prices (PPI) to a 1 percent depreciation of the nominal effective exchange rate (NEER) over 20 quarters using alternative structural order in the SVAR model using all data after transformation. The cumulative impulse response at each horizon is obtained by summing the point estimates of the quarterly impulse responses in the previous IRF figure. The vertical axis therefore measures the total percentage-point change in PPI relative to the pre-shock level.

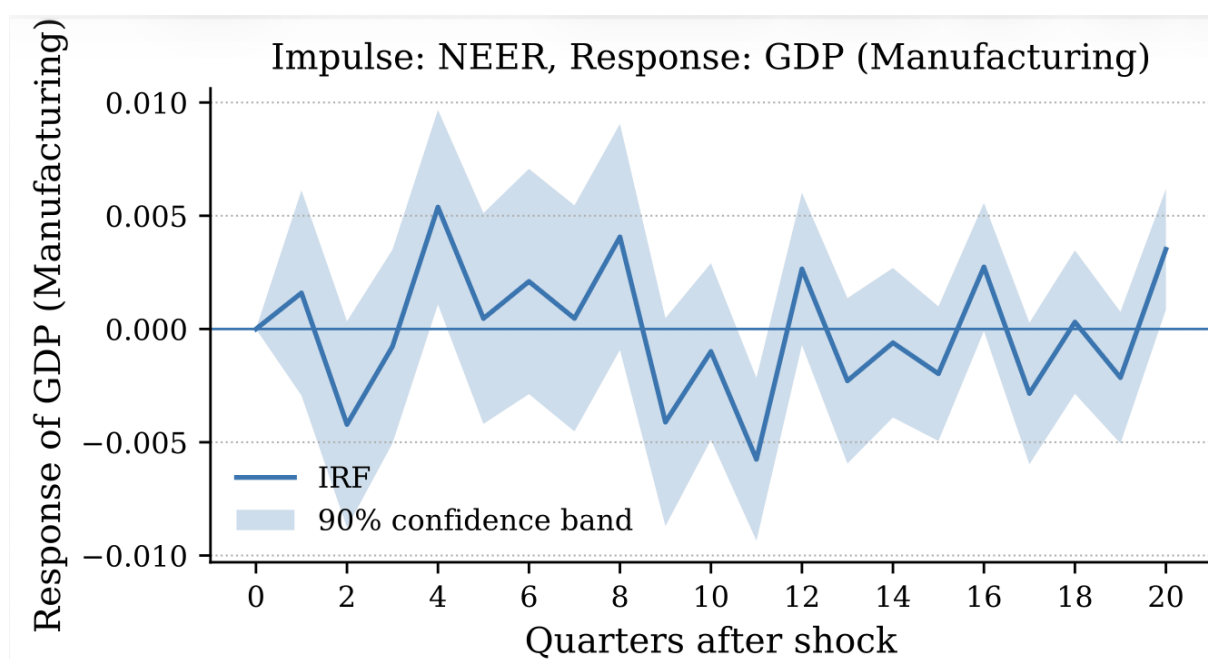


Figure 9: Impulse response functions to GDP

Note. This figure display a how a 1% depreciation in the exchange rate (NEER) impacts producer production (GDP manufacturing) up to 20 quarters after the shock using alternative structural order in the SVAR model using all data after transformation. The solid line reports the estimated orthogonalized impulse response, and the shaded band depicts the 90 percent confidence interval.

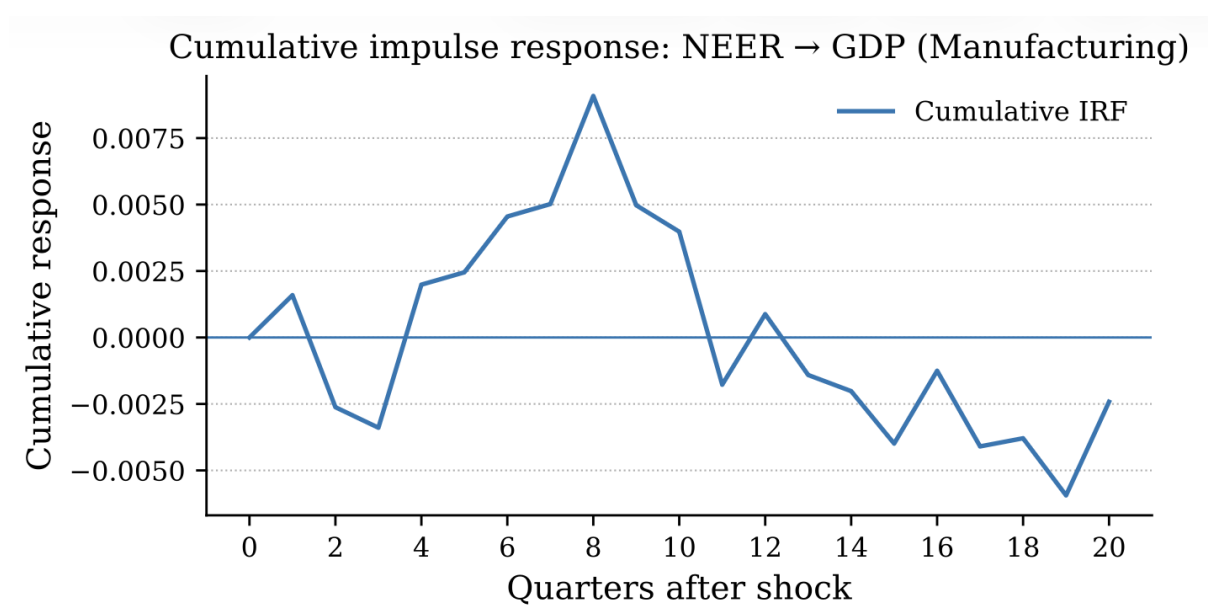


Figure 10: Cumulative impulse response to GDP

Note. This figure reports the cumulative response of production(GDP manufacturing) to a 1 percent depreciation of the nominal effective exchange rate (NEER) over 20 quarters using alternative structural order in the SVAR model using all data after transformation. The cumulative impulse response at each horizon is obtained by summing the point estimates of the quarterly impulse responses in the previous IRF figure. The vertical axis therefore measures the total percentage-point change in GDP relative to the pre-shock level.

B: Simulations with Alternative Calibrations

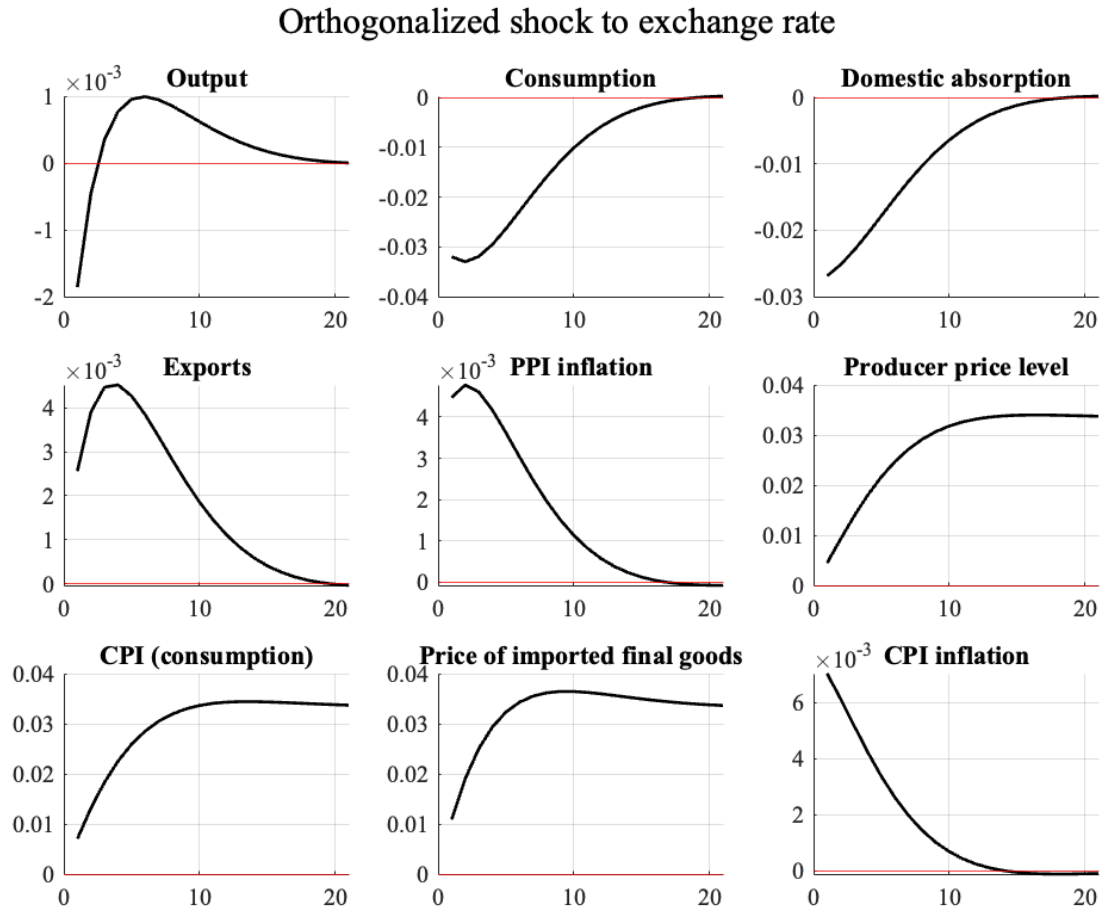


Figure 11: Impulse response to a exchange rate depreciation shock

Notes: The figure shows model-implied impulse responses to a 1% depreciation using alternative calibrations with simulated data. A higher e_t denotes a depreciation of the domestic currency. All variables are reported as deviations from the non-stochastic steady state. Output, consumption, domestic absorption and exports are in log deviations (approximately percentage changes), while price and inflation variables are in percentage points. The horizon on the x -axis is measured in quarters.