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Exchange rate overshooting: unraveling the puzzles

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Abstract

We solve a canonical, estimated, medium-sized, open-economy New Keynesian model, cast it into a small-scale population vector autoregression, and assess whether best-practice structural identifications detect textbook “overshooting” after a monetary policy hike—i.e., an instant real appreciation that monotonically reverts. Our results include “delayed overshooting,” “exchange rate puzzles,” “forward discount puzzles,” and model-consistent overshooting. Identifications that regularly indicate open-economy anomalies in empirics likewise produce them in our controlled setup. Vice versa, identifications that prompt theory-conform conclusions in actual data do so in our experimental data. We infer that less empirical evidence may contradict canonical international macro theory than previously understood.

Keywords: New open economy macroeconomics, population vector autoregression, invertibility, structural identification, exchange rate, overshooting.

JEL Codes: C32, E32, E52, F41, F42.

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Non-technical summary

This paper examines how an unanticipated tightening of a central bank's policy stance affects the real exchange rate. A vast empirical literature using vector autoregressions (VARs) has produced mixed findings, including appreciations, depreciations, and immediate or delayed exchange rate adjustments after contractionary monetary policy interventions. The present paper demonstrates that this divergence of results likely stems from (i) the assumptions used to make causal interpretations of the estimated economic relationships possible; and from (ii) the informational content of the regression models themselves. In particular, it suggests that more evidence than previously thought may align with canonical economic theory, particularly the open-economy dynamic stochastic general equilibrium (DSGE) framework.

A key prediction of this model class is exchange rate "overshooting:" the combination of uncovered interest rate parity and purchasing power parity causes an immediate real appreciation after an interest rate hike, which then gradually reverts. Deviations from this benchmark have been interpreted as "puzzles," challenging conventional open-economy theory.

Rather than offering another empirical estimate, this paper uses a prototypical open-economy DSGE model as its laboratory. First, this puzzle-free model is summarized via a typical VAR featuring a small set of model-consistent time series. Next, state-of-the-art identification strategies are applied to isolate so-called monetary policy "shocks" and to analyze their international transmission. The key findings are: identification strategies that reveal counterfactual depreciation or delayed exchange rate adjustment in real data do the same in the controlled setup, while identifications that tend to support theory in empirical work identify model-consistent real exchange rate movements in the simulation design.

Finally, the paper addresses a closely related open-economy anomaly: the failure of uncovered interest rate parity after an interest rate surprise. Empirical studies often show domestic investors earning risk-free excess returns after a domestic policy tightening, violating uncovered interest rate parity. The paper shows that even when relying on ideal assumptions for structural identification, minor informational deficiencies in the estimation of broader economic relationships suffice to spuriously reject uncovered interest rate parity, thus highlighting the central role of VAR "invertibility" in empirical work on open-economy phenomena.

Taken together, the findings of the paper suggest that disagreement across the empirical literature on exchange rate overshooting may be smaller than previously thought, and evidence hitherto seen as challenging may actually support canonical open-economy theory.

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1 Introduction

Central banks across the globe have fought the 2021/22 outburst of inflation by vigorously raising key interest rates. In many cases, the speed and scale of monetary tightening have been unparalleled since the early 1980s. Despite some international coordination, policy responses have not always been synchronized. The resulting variation in cross-country interest rate differentials[1] has revived classic questions. How does hawkish policy affect a country's currency? Will it appreciate or depreciate? How quickly will the policy change be priced in? Can carry traders profit?

To shed light on such fundamental open-economy matters, we analyze the international footprint of monetary policy using best-practice empirical strategies under experimental conditions, by leveraging Wolf (2020, 2022). Specifically, we solve the canonical, estimated, medium-sized, open-economy New Keynesian model of Adolfson et al. (2007); fix it as data-generating process (DGP); cast it into a small-scale, population vector autoregression (VAR); and assess structural identification strategies. Since we *observe* the economic forces underlying the theoretical model, we can formally characterize the performance of different exclusion restrictions in identifying monetary policy shocks in the VAR.

The transmission of exogenous monetary policy interventions in our DGP is well-understood. A one-off interest rate hike causes a transitory contraction of economic activity and a gradual decline in the price level. The interplay of uncovered interest rate parity (UIP) and purchasing power parity (PPP) generate Dornbusch (1976)-style "overshooting": the nominal appreciation of the domestic currency—defined as a decline in the price of foreign currency—is stronger in the short than in the long run. The real foreign exchange rate (FX) monotonically returns to equilibrium after initial appreciation.

Using a reduced-form VAR(∞) representation of the DGP in the policy rate, the output gap, CPI inflation, and the real exchange rate, we ask: do established

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[1] For example, in 2022, when the U.S. Federal Reserve, the European Central Bank, and the Bank of England all tightened their policy stance, the spread of the effective Federal Funds Rate temporarily widened 200 basis points (bp) against the Euro Short-term Rate and 150 bp against the Sterling Overnight Index Average. The corresponding interest rate advantage over the Tokyo Overnight Average Rate even increased by 400 bp, reflecting the Yen's persistently low funding cost.

SVAR estimators isolate the DGP-implied treatment effect of monetary policy at the global stage? Our key insight is straightforward. *If* the data is consistent with our workhorse "New Open Economy Macroeconomics" (see Corsetti, 2008) model, *less* econometric evidence than previously understood might contradict this paradigm. The biases that arise from misidentification in our controlled research design, namely, resemble widely documented exchange rate anomalies of empirical work. Vice versa, the exclusion restrictions that perform well in our population analysis are the ones that prompt theory-conform conclusions in the data:

First, inference from sign restrictions on impulse response functions (IRFs) is compatible with exchange rate appreciation, depreciation, immediate or "delayed overshooting." The identifying restriction of divergent inflation and interest rate reactions, while aligned with the DGP, lacks strength for meaningful inference. Adding assumptions about systematic policy behavior eliminates any delayed overshooting or counterfactual depreciation—the "exchange rate puzzle"—from the identified set of FX reactions.[2] Second, traditional Cholesky identification spuriously indicates non-monotonic FX adjustment and prolonged depreciation *above* the long-run exchange rate equilibrium. The contemporaneous zero impact restrictions on impulse response functions that characterize such a recursive scheme distort the results since they are at odds with the DGP. Imposing a neutrality restriction on the long-run ramifications of monetary policy for the real exchange rate reduces the bias of recursive identification by allowing for full simultaneity among financial variables.[3] Third, instrumental variable (IV) identification detects instant FX overshooting effectively.[4]

Throughout, our population inferences are consistent with persistent, yet spurious, excess returns on domestic investments following a policy tightening; known as

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[2] Sign-restricted VARs in Scholl and Uhlig (2008), Kim et al. (2017), or Rüth and Van der Veken (2023) generally document delayed FX reactions. Kim and Roubini (2000), Mojon and Peersman (2003), Castelnuovo et al. (2022), and Groshenny and Javed (2023) show that non-zero restrictions on the central bank's reaction function parameters can result in non-delayed overshooting.

[3] See Eichenbaum and Evans (1995) and the large body of subsequent studies for delayed overshooting; recursive VARs using the Romer and Romer (2004) shocks confirm this puzzle (e.g., Müller et al., 2024). Mojon and Peersman (2003), Bjørnland (2009), or Hnatkovska et al. (2016) find occasional exchange rate puzzles in recursive VARs. Long-run restrictions in otherwise recursive VARs of Bjørnland (2009) and Terrell et al. (2023) tend to eliminate both puzzles in the data.

[4] Refer to Rogers et al. (2018), Miranda-Agrippino and Rey (2020), Rüth (2020), Miranda-Agrippino and Ricco (2021), Cesa-Bianchi and Sokol (2022), Gründler et al. (2023), and Cesa-Bianchi et al. (2024) for instrumental variable identifications that suggest prompt exchange rate appreciation after contractions in monetary policy.

the “forward premium puzzle.” We demonstrate how even minor misspecification of the reduced-form time-series model can mistakenly indicate conditional UIP failure, even when an *ideal* structural estimator is available. Specifically, our benchmark model abstracts from the time-varying inflation target of the DGP's monetary authority. While this lack of information about the policy rule still allows us to tightly identify the DGP-consistent FX reaction to a policy intervention, it severely distorts inference about risk-free profits from international arbitrage. The VAR's informational insufficiency, namely, manifests in biased impulse responses of inflation and the policy rate. Since both moments underlie conditional UIP dynamics, the likelihood of Type I errors in tests for excess currency returns is likely elevated in practice.

The latter caveat highlights the central role of VAR (non-)invertibility when addressing fundamental questions of international economics and finance. Thereby, our study complements, and strongly builds on, recent research on invertibility in time-series models by Plagborg-Møller (2019), Wolf (2020, 2022), Plagborg-Møller and Wolf (2021, 2022), and Li et al. (2024).

The structure of the paper is as follows. Section 2 describes the research design, Section 3 presents our findings, Section 4 discusses them, and Section 5 concludes.

2 Identifying FX overshooting under experimental conditions

This section sketches central features of the DGP, presents its reduced-form VAR representation, and outlines identifications to recover the VAR's structural form.

2.1 A structural New Open Economy Macroeconomics model

Our DGP, also denoted as $\mathcal{D}$, is a New Keynesian dynamic stochastic general equilibrium (DSGE) chassis, which combines key elements of the medium-sized closed-economy setup of Christiano et al. (2005) with the small open-economy framework of Kollmann (2001) or Galí and Monacelli (2005). The model is estimated with Bayesian full-information techniques (e.g., Smets and Wouters, 2007) on Eurozone data, offering a quantitatively realistic description of shocks, frictions, and propagation mechanisms in internationally integrated economies. Since we borrow the DGP from Adolfson et al. (2007), a hallmark reference, we refer to their paper for details.

2.2 DSGE-VAR mapping

A first-order, log-linear approximation of $\mathcal{D}$ has a linear state-space representation (see Fernández-Villaverde et al., 2007):

$$\mathbf{s}_t = \widetilde{\mathbf{A}}\mathbf{s}_{t-1} + \widetilde{\mathbf{B}}\boldsymbol{\eta}_t, \tag{1}$$

$$\mathbf{y}_t = \widetilde{\mathbf{C}}\mathbf{s}_{t-1} + \widetilde{\mathbf{D}}\boldsymbol{\eta}_t. \tag{2}$$

$\mathbf{s}_t \in \mathbb{R}^{69}$ represents (unobservable) state variables. For the DGP's structural shocks $\boldsymbol{\eta}_t \in \mathbb{R}^{21}$, we assume $\boldsymbol{\eta}_t \sim \mathcal{N}(\mathbf{0}, \boldsymbol{\Sigma}^{\eta})$, where $\boldsymbol{\Sigma}^{\eta}$ is diagonal. Our observables of interest are the output gap, CPI inflation, the policy rate, and the real exchange rate, given by $\mathbf{y}_t = [\mathrm{y}_t,\ \pi_t,\ \mathrm{i}_t,\ \mathrm{fx}_t]'$. The elements in $\widetilde{\mathbf{A}}_{69\times69}$, $\widetilde{\mathbf{B}}_{69\times21}$, $\widetilde{\mathbf{C}}_{4\times69}$, and $\widetilde{\mathbf{D}}_{4\times21}$ are functions of posterior mode estimates of structural parameters and contain micro-founded cross-equation restrictions.

We represent $\mathbf{y}_t$ through a reduced-form VAR(∞):

$$\mathbf{y}_t' = \mathbf{x}_t'\boldsymbol{\Phi} + \mathbf{u}_t', \text{ with } \mathbf{x}_t' = [\mathbf{y}_{t-1}', \ldots,\ \mathbf{y}_{t-\infty}']. \tag{3}$$

$\mathbf{u}_t = \mathbf{y}_t - \mathbb{E}\{\mathbf{y}_t|\mathbf{x}_t\}$ are reduced-form forecast errors given information at $t-1$, with $\mathbf{u}_t \sim \mathcal{N}(\mathbf{0}, \boldsymbol{\Sigma}^{u})$, and $\boldsymbol{\Phi} = f(\widetilde{\mathbf{A}}, \widetilde{\mathbf{B}}, \widetilde{\mathbf{C}}, \widetilde{\mathbf{D}})$. We treat information in (3) as observable, but *not* the underlying transformations by $f(\cdot)$; that is, knowing (3) is insufficient to identify the structural monetary policy shock $\eta_t^{m} \in \boldsymbol{\eta}_t$.

2.3 SVAR analysis

A structural version of (3) reads:

$$\mathbf{y}_t'\mathbf{A}_0 = \sum_{l=1}^{\infty}\mathbf{y}_{t-l}'\mathbf{A}_l + \boldsymbol{\varepsilon}_t' = \mathbf{x}_t'\mathbf{A}_+ + \boldsymbol{\varepsilon}_t', \text{ with } \mathbf{A}_+' = [\mathbf{A}_1', \ldots,\ \mathbf{A}_\infty'], \tag{4}$$

where $\boldsymbol{\Sigma}^{u} = (\mathbf{A}_0\mathbf{A}_0')^{-1}$ and $\boldsymbol{\Phi} = \mathbf{A}_+\mathbf{A}_0^{-1}$. $\boldsymbol{\varepsilon}_t = \mathbf{A}_0'\mathbf{u}_t$ are SVAR shocks. We seek to partially identify the monetary policy shock $\varepsilon_t^{m} \in \boldsymbol{\varepsilon}_t$; leaving the remaining three SVAR shocks in the system $\boldsymbol{\varepsilon}_t^{-m}$ unidentified. $\mathbf{A}_0^{-1}$ contains the contemporaneous impact of ε_t^{m} on variables in $\mathbf{y}_t$, while $\mathbf{A}_0$ contains the systematic, contemporaneous reaction of monetary policy to these observables.

The challenge of identification. To recover the VAR's structural form in (4), we need to sort out cause and effect in our experimental data by imposing exact or qualitative exclusion restrictions on $\mathbf{A}_0$, $\mathbf{A}_0^{-1}$, or both. This step is the critical hurdle in empirics: traders in the Forex market meticulously monitor central banks, seeking to predict policy directions. Central bankers, in turn, can track high-frequency exchange rate movements right up to the moment they make decisions. Addressing such simultaneity of events in different ways can notably affect our conclusions about the international treatment effect of monetary policy.

Best-practice identifications. We transition from (3) to (4) by adopting widely studied open-economy SVAR estimators that we take off the shelf from the empirical literature (see footnotes 2 to 4 for references). In particular, we identify $\varepsilon_t^{\mathrm{m}}$ using alternative sets of exclusion restrictions:

$\mathcal{R}.i$ **Sign restrictions on IRFs.** Following a contractionary monetary policy shock, $\varepsilon_t^{\mathrm{m}} > 0$, we assume a non-negative interest rate response and a non-positive inflation response for the first post-shock year; that is, for $k = 0, \ldots, 3$, we impose: $\frac{\partial \mathrm{i}_{t+k}}{\partial \varepsilon_t^{\mathrm{m}}} \geq 0$ and $\frac{\partial \pi_{t+k}}{\partial \varepsilon_t^{\mathrm{m}}} \leq 0$.

$\mathcal{R}.ii$ **Sign restrictions on IRFs and the policy rule.** Complementing the set of restrictions in $\mathcal{R}.i$, we add two types of identifying information:

- $\mathcal{R}.ii.i$ Non-negative restrictions on the systematic, contemporaneous reaction coefficients of monetary policy to the output gap and inflation, $\frac{\partial \mathrm{i}_t}{\partial \mathrm{y}_t}, \frac{\partial \mathrm{i}_t}{\partial \pi_t} \geq 0$.
- $\mathcal{R}.ii.ii$ A monetary policy motive of leaning against real depreciation through interest rate tightening, $\frac{\partial \mathrm{i}_t}{\partial \mathrm{fx}_t} \geq 0$.

$\mathcal{R}.iii$ **Recursive identification.** Assuming a Wold causal ordering as in $\mathbf{y}_t$, we Cholesky-factorize $\mathbf{\Sigma}^{\mathrm{u}}$ to impose:

- $\mathcal{R}.iii.i$ Zero contemporaneous policy impacts on the output gap and inflation, $\frac{\partial \mathrm{y}_t}{\partial \varepsilon_t^{\mathrm{m}}}, \frac{\partial \pi_t}{\partial \varepsilon_t^{\mathrm{m}}} = 0$.
- $\mathcal{R}.iii.ii$ A zero contemporaneous policy reaction to real depreciation, $\frac{\partial \mathrm{i}_t}{\partial \mathrm{fx}_t} = 0$.

$\mathcal{R}.iv$ **Imposing long-run neutrality.** We retain the conditions in $\mathcal{R}.iii.i$, but replace

$\mathcal{R}$*.iii.ii* against a long-run zero restriction for the impact of monetary policy on FX, $\frac{\partial\left(\sum_{h'=0}^{\infty}\Delta \mathrm{fx}_{t+h'}\right)}{\partial \varepsilon_t^{\mathrm{m}}} = 0$.

$\mathcal{R}.v$ **Instrumental variable identification.** We use the DGP shock η_t^{m} as an *external* instrument to identify $\varepsilon_t^{\mathrm{m}}$ in an SVAR-IV strategy.[5]

3 Population results

This section contains our findings. We first discuss properties of our reduced-form model environment. Then, we outline results on the identification of FX overshooting under qualitative and exact exclusion restrictions, before analyzing implications of monetary policy shocks for uncovered interest rate parity.

3.1 Properties of the reduced-form VAR

Does our experimental design allow typical SVAR estimators, at least in principle, to successfully isolate the monetary policy shock? Ex ante, prospects appear promising. First, we seize an unbiased reduced-form VAR(∞). Second, we rule out any uncertainty surrounding its parameters. Third, a projection of the DGP's structural monetary policy shock η_t^{m} on present and past realizations in $\mathbf{y}_t$ yields $R^2 = 0.9772$. The VAR is near-invertible; that is, the four observables in $\mathbf{y}_t$ carry rich information for *partial* identification of monetary policy.[6] At the same time, the four-dimensional time-series model cannot identify all 21 DGP shocks $\boldsymbol{\eta}_t$, rendering the full structure inevitably non-invertible (see Sims and Zha, 2006).

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[5] Notably, using a noise-contaminated version of η_t^{m} as proxy would not alter our inference. We exclusively characterize population limits of the SVAR-IV estimator, where instrument weakness becomes irrelevant. For (small-sample) Monte Carlo simulations on SVAR (mis)identification, see Paustian (2007), Carlstrom et al. (2009), Castelnuovo (2012), Istrefi and Vonnak (2015), Herwartz et al. (2022), or recently Li et al. (2024).

[6] This result echoes closed-economy findings in Wolf (2020). Unless stated otherwise, we follow his lead for implementation details—such as truncating lags of VAR(∞) and VMA(∞) representations at horizons 250 and 350; or abstracting from money as a VAR observable. We build on code of his paper and Plagborg-Møller and Wolf (2022), while our replication of Adolfson et al. (2007) relies on the *Macroeconomic Model Data Base* (Wieland et al., 2012) and *Dynare 5.3*.

3.2 Qualitative exclusion restrictions and FX overshooting

Sign restrictions on IRFs. Since $\mathcal{R}.i$ involves only *qualitative* restrictions on nonlinear transformations of the structural parameters $\left(\mathbf{A}_0, \mathbf{A}'_+\right)$, there is no unique structural VAR model. Instead, the *identified set* of FX reactions is non-singleton (and in each case that we consider non-empty). Specifically, for any structural model that conforms to $\mathcal{R}.i$, there exists an orthogonal rotation matrix $\mathbf{Q}$, arbitrarily similar to $\mathbf{I}$, which ensures that not only $\left(\mathbf{A}_0, \mathbf{A}'_+\right)$, but also $\left(\mathbf{A}_0\mathbf{Q}, \mathbf{A}'_+\mathbf{Q}\right)$ conforms to $\mathcal{R}.i$.

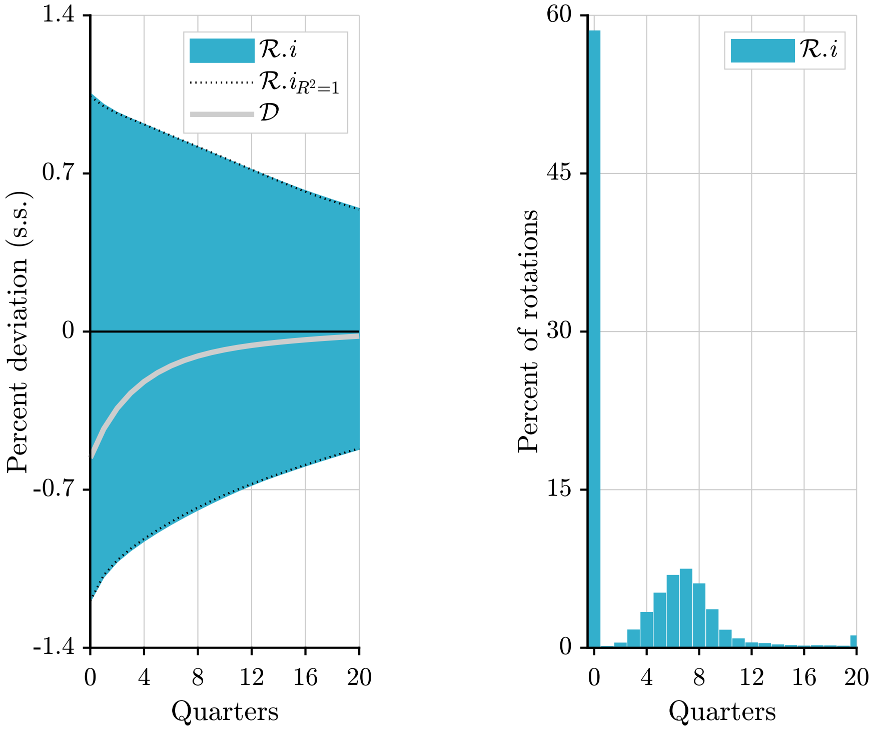
Following Rubio-Ramírez et al. (2010), we compute such rotation matrices $\mathbf{Q}$ until we find $n = 20{,}000$ successful candidate draws that satisfy $\mathcal{R}.i$. Each draw yields an equally likely or plausible structural model. Hereafter, we refer to structural VAR "rotations," "draws," or "models" interchangeably.

Figure 1, Panel a shows the contour $\mathcal{C}^i_h$ of the identified set of FX impulse response functions under $\mathcal{R}.i$, $\mathcal{S}^i_h$, to a one standard deviation monetary policy contraction. In particular, for forecast horizon $h = 0, \ldots, 20$, the light turquoise surface delimits the most extreme FX reactions to monetary policy shocks among all 20,000 structural VAR models considered.

What can we learn about the dynamic effects of unexpected interventions by monetary policy on the real exchange rate? On impact, population inference is compatible with appreciation or depreciation by more than one percent, respectively. Over time, $\mathcal{C}^i_h$ monotonically narrows. Five years after the shock, the real exchange rate may still deviate by -40 bp or $+40$ bp from steady state.

Does the sign restrictions estimator predict immediate or delayed overshooting? Panel b presents the percentage of members in the identified set of FX responses that reach their maximum deviation from steady state at horizon h (Scholl and Uhlig, 2008) and suggests: both. For less than 60 percent of rotations, we observe instant FX overshooting; the remaining rotations are compatible with delayed overshooting. Overall, comparison with $\mathcal{D}$—the gray line in Panel a traces $\frac{\partial \mathrm{fx}_{t+h}}{\partial \eta^{\mathrm{m}}_t}$—reveals major identification uncertainty. What underlies this uncertainty?

Figure 1: FX overshooting under sign restrictions on IRFs



(a) Real depreciation (b) Timing of peak reaction

Notes: The light turquoise area in Panel a shows the identified set of FX responses to a one standard deviation monetary policy shock, derived from sign restrictions on IRFs (see $\mathcal{R}.i$). The observables underlying the VAR are $\mathbf{y}_t = [\mathrm{y}_t,\ \pi_t,\ \mathrm{i}_t,\ \mathrm{fx}_t]'$. The dotted black lines depict the identified set when we apply $\mathcal{R}.i$ to the invertible VAR (3a), which uses $\dot{\mathbf{y}}_t = [\mathrm{y}_t,\ \pi_t,\ \bar{\pi}_t,\ \mathrm{i}_t,\ \mathrm{fx}_t]'$. The gray line illustrates the FX reaction in the DGP ($\mathcal{D}$). The vertical axis measures percent deviation from steady state (s.s.), and the horizontal axis represents the forecast horizons $h = 0, \dots, 20$ in quarters. In Panel b, we present a histogram displaying the distribution across h of IRF peaks or troughs as a percentage of all 20,000 SVARs. Models featuring responses that peak at $h \geq 20$ are summed into the $h = 20$ bar.

Characterizing misidentification. Following Wolf (2020), we pinpoint how $\varepsilon_t^{\mathrm{m}}$ relates to $\boldsymbol{\eta}_t$. Consider $\varepsilon_t^{\mathrm{m}} = \eta_t^{\mathrm{m}}$ as a reference point. Under such *perfect* identification, the SVAR estimator assigns a weight ω of 1 to η_t^{m}, $\omega^{\mathrm{m}} = 1$, and weighs each non-monetary policy shock $\boldsymbol{\eta}_t^{-\mathrm{m}}$ with 0, $\boldsymbol{\omega}^{-\mathrm{m}} = \mathbf{0}$, where $\boldsymbol{\omega} \in \mathbb{R}^{21}$. Any deviation from $\boldsymbol{\omega} = \mathrm{e}_{\mathrm{m}}$, where e_{m} is a standard basis vector, represents SVAR *misidentification*.

The light-colored bars in Figure 2 illustrate $min(\omega^j)$ and $max(\omega^j)$ for each structural shock j, $\eta_t^j \in \boldsymbol{\eta}_t$, across all 20,000 SVAR rotations. We sort the shocks in descending order by $range(\omega^j)$. Focus first on the light-colored yellow bar showing the range of shock weights assigned to the DGP's monetary policy shock η_t^{m}. While some rotation ensures $\omega^{\mathrm{m}} \approx 1$, another indicates strong misidentification, $\omega^{\mathrm{m}} < 0$. The case of perfect identification is *not* covered since the VAR's non-invertibility bounds $\omega^{\mathrm{m}} \leq \sqrt{\mathrm{R}^2} = 0.9885$ from above (see Wolf, 2020, Proposition 1).

We approximate the importance of non-invertibility for misidentification under $\mathcal{R}.i$ in an auxiliary VAR (referred to as 3a). Relative to (3), we add the time-varying inflation target of the DGP's central bank, $\bar{\pi}_t$, to the vector of VAR observables, such that $\dot{\mathbf{y}}_t = [\mathrm{y}_t, \pi_t, \bar{\pi}_t, \mathrm{i}_t, \mathrm{fx}_t]'$. Since only y_t, π_t, $\bar{\pi}_t$, and η_t^{m} enter the DGP-implied Taylor rule in period t, $\dot{\mathbf{y}}_t$ provides sufficient information for invertibility of (3a), raising the R^2 from Section 3.1 to exactly 1; that is, perfect information on systematic policy renders perfect identification of unsystematic policy shocks feasible. However, identifying $\varepsilon_t^{\mathrm{m}}$ via $\mathcal{R}.i$ yields inference on FX overshooting that is very similar whether we use $\dot{\mathbf{y}}_t$ or $\mathbf{y}_t$ (see the dotted black lines in Figure 1, Panel a, referred to as $\mathcal{R}.i_{R^2=1}$). Hence, the lack of (perfect) invertibility of (3) is not the major source of misidentification under $\mathcal{R}.i$.

Misidentification predominantly stems from the "masquerading" shock complication. In particular, linear combinations of structural shocks in $\boldsymbol{\eta}_t$ fulfill $\mathcal{R}.i$ and are misidentified as monetary policy shocks in the SVAR analysis, which implies: $\varepsilon_t^{\mathrm{m}} = \sum_{j \in \mathcal{J}} \omega^j \eta_t^j$, with $\sum_{j \in \mathcal{J}} [\omega^j \neq 0] > 1$ and $\mathcal{J} = \{\mathrm{m}, \ldots\}$.[7] This deficiency applies to *each* member of $\mathcal{S}_h^i$ since $\omega^j \neq 0 \,\forall\, j$, and across all n rotations. Figure 2 underscores the relevance of structural demand shocks (light green) for this type of misidentification; in particular, when compared to the DGP's structural cross-border (light blue) or supply shocks (light gray).

Sign restrictions on the policy rule. Can complementary identifying information about the systematic conduct of monetary policy alleviate the documented SVAR misidentification? The intensely colored bars in Figure 2 show they indeed can. Under $\mathcal{R}.ii$, the minimum weight assigned to η_t^{m} exceeds 0.6. For each masquerading shock, we observe a reduction in the maximum range of shock weights across rotations of at least 34 percent, relative to $\mathcal{R}.i$; for 13 masquerading shocks the reduction exceeds 50 percent.

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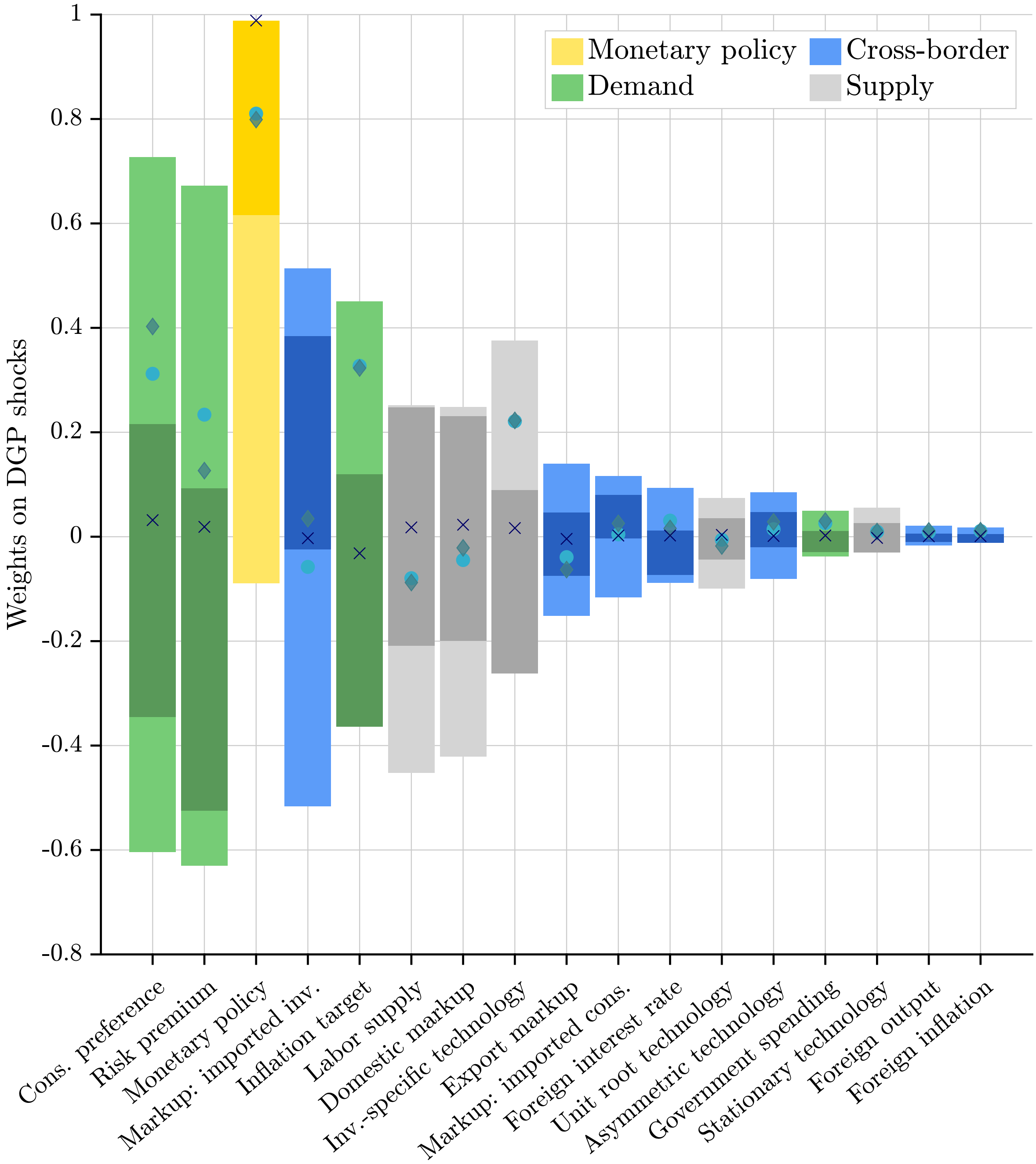
[7] Among structural shocks in $\boldsymbol{\eta}_t^{-\mathrm{m}}$, the investment-specific technology shock η_t^{it} stands out since it is the only stochastic disturbance in the DGP that fulfills $\mathcal{R}.i$ on its own; i.e., absent any linear combination with other shocks the SVAR estimator may interpret it as a monetary policy shock candidate. However, $\mathcal{C}_h^i$ is virtually unchanged when we abstract from η_t^{it} in $\mathcal{D}$. Hence, in practice, η_t^{it} appears to play no special role for our inference.

Figure 2: Characterizing misidentification of open-economy SVAR estimators



Notes: Across all 20,000 SVAR rotations, the bars in the Figure present the maximum and minimum shock weights ω^j, which structural estimators $\mathcal{R}.i$ and $\mathcal{R}.ii$ assign to DGP shock η_t^j when identifying the monetary policy shock $\varepsilon_t^{\mathrm{m}}$ in the baseline VAR, using $\mathbf{y}_t = [\mathrm{y}_t,\ \pi_t,\ \mathrm{i}_t,\ \mathrm{fx}_t]'$. Light-colored bars refer to $\mathcal{R}.i$ and the more intensely colored bars to $\mathcal{R}.ii$. The vertical axis measures the shock weights ω^j, and the labels on the horizontal axis represent shock $j \in \mathcal{J}$ from $\mathcal{D}$. Domestic shocks are categorized as either demand or supply based on the short-run conditional correlation they induce between domestic inflation and the output gap. Shock weights of identification strategies using exact exclusion restrictions are shown as light turquoise nodes ($\mathcal{R}.iii$), dark turquoise diamonds ($\mathcal{R}.iv$), and blue crosses ($\mathcal{R}.v$). Four shocks $j \in \mathcal{J}$ with the smallest absolute weights are excluded from the presentation since together their (ranges of) shock weights are less than 0.01.

How does this reduced misidentification update our population inference about FX overshooting? Members in the identified set of FX responses under $\mathcal{R}.ii$, $\mathcal{S}_h^{ii}$, become more uniform: $\mathcal{C}_h^{ii}$ narrows by more than half, compared to $\mathcal{C}_h^{i}$ (see the dark turquoise surface in Figure 3, Panel a). No rotation spuriously indicates instant depreciation. Each FX response reaches its maximum appreciation on impact. Hence, the addition of systematic policy restrictions resolves the delayed overshooting *and* exchange rate puzzles present in the purely IRF-restricted SVARs from Figure 1.

Why do exclusion restrictions involving the central bank's policy rule identify FX overshooting so tightly? Exclusively restricting the Taylor rule's reaction coefficients to fluctuations in y_t and π_t as in $\mathcal{R}.ii.i$ mitigates some output puzzle. Yet, $\mathcal{C}_h^{ii.i}$ still aligns closely with $\mathcal{C}_h^{i}$, preserving both the delayed overshooting and the exchange rate puzzles (not reported). Thus, it is the direct constraint on the monetary policy reaction coefficient to exchange rate fluctuations in $\mathcal{R}.ii.ii$ that revises our inference about exchange rate overshooting.

Notably, in the DGP's Taylor rule, the contemporaneous reaction of monetary policy to FX is actually *zero* (see the gray vertical line with nodes in Panel b of Figure 3). However, simply eliminating rotations from $\mathcal{R}.i$ that imply FX *destabilization* due to a softening policy stance in the face of real depreciation—compare the light and dark turquoise bars in Panel b—is sufficient to tighten $\mathcal{C}_h^{ii}$ more closely around $\frac{\partial fx_{t+h}}{\partial \eta_t^m}$.[8]

Let us take stock. "Agnostic" restrictions in $\mathcal{R}.i$ give rise to spurious FX puzzles, which we can largely eliminate by adding assumptions about systematic policy conduct in $\mathcal{R}.ii$. Nonetheless, identifying information across both estimators is of qualitative nature. The resulting model uncertainty limits our ability to draw strong conclusions about structural relations in the experimental data; in particular, about the sign, size, and timing of FX overshooting.

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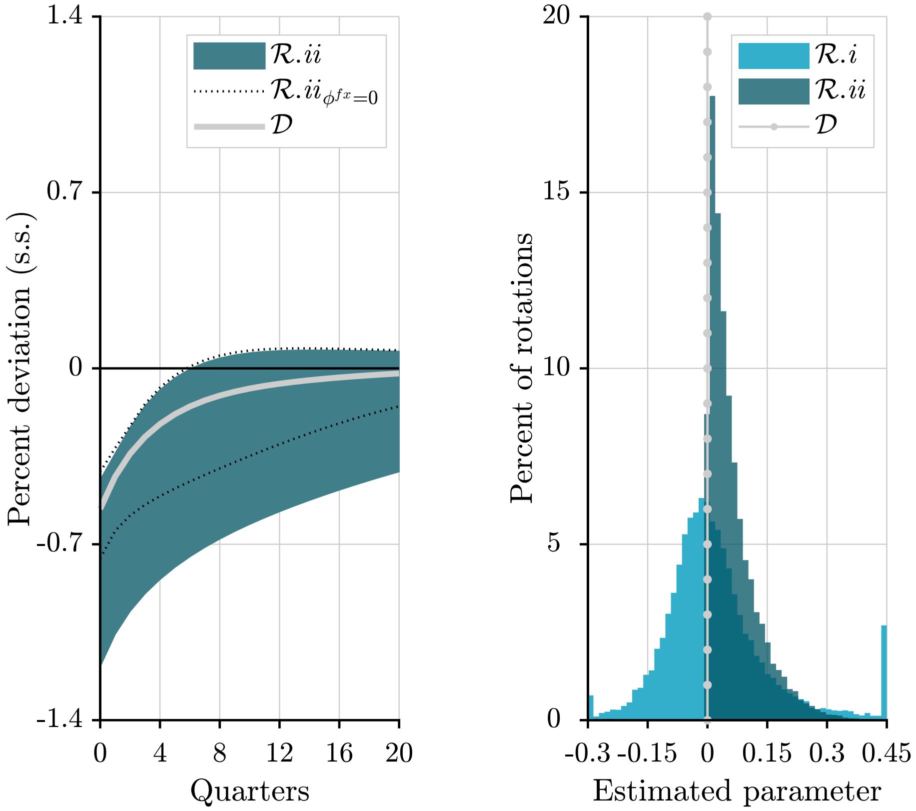
[8] As an alternative to $\mathcal{R}.ii.ii$, we follow Uhlig's (2017) principle "If you know it, impose it!" and enforce that $\phi^{fx} = \frac{\partial i_t}{\partial fx_t} = 0$; note, $\mathcal{R}.ii.ii$ posits $\frac{\partial i_t}{\partial fx_t} \geq 0$, not $\frac{\partial i_t}{\partial fx_t} > 0$. Such a DGP-consistent yet rather "dogmatic" restriction sharpens identification of FX overshooting even further (dotted lines in Panel a of Figure 3, referred to as $\mathcal{R}.ii_{\phi^{fx}=0}$). Notably, imposing the somewhat less-dogmatic restriction of $|\phi^{fx}| \leq 0.05$ already suffices to narrow down the identified set to a similar extent as under $\mathcal{R}.ii_{\phi^{fx}=0}$ (not reported).

Figure 3: FX overshooting under sign restrictions on IRFs and the policy rule



(a) Real depreciation

(b) Distribution of ϕ^{fx}

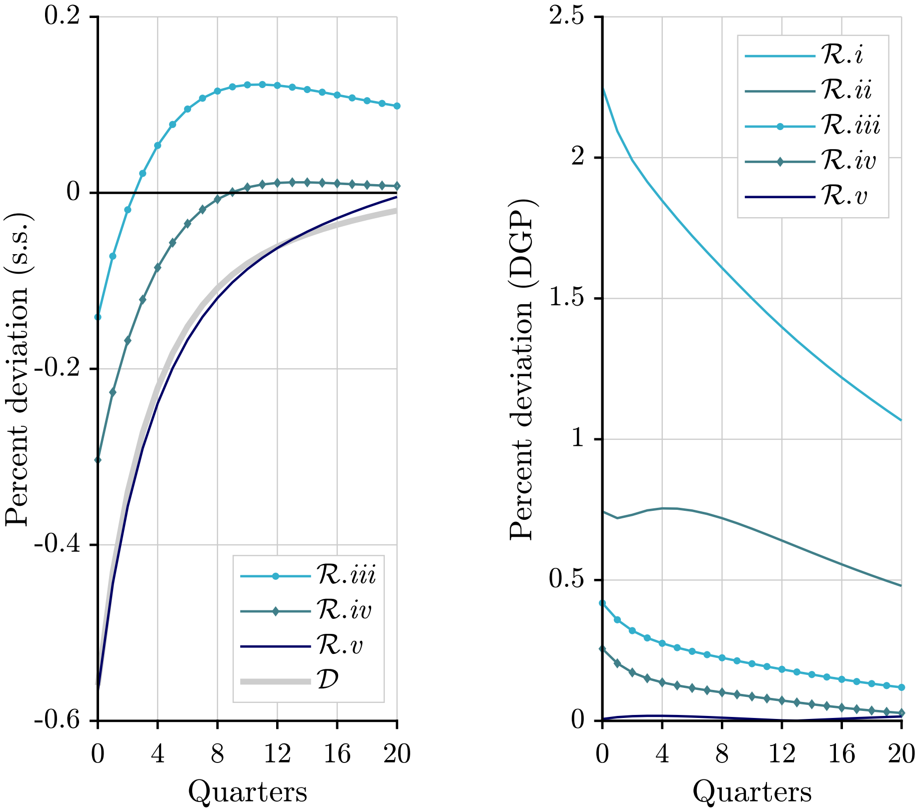
Notes: The dark turquoise area in Panel a shows the identified set of FX responses to a one standard deviation monetary policy shock, derived from sign restrictions on both, IRFs *and* policy rule coefficients (see $\mathcal{R}.ii$). The dotted black lines depict the identified set for a variant of this estimator in which we impose $\phi^{\text{fx}} = \frac{\partial \text{i}_t}{\partial \text{fx}_t} = 0$ instead of $\frac{\partial \text{i}_t}{\partial \text{fx}_t} \geq 0$ (referred to as $\mathcal{R}.ii_{\phi^{\text{fx}}=0}$). The gray line illustrates the FX reaction in the DGP ($\mathcal{D}$). The vertical axis measures percent deviation from steady state (s.s.), and the horizontal axis represents the forecast horizons $h = 0, \ldots, 20$ in quarters. Panel b presents the distributions of the central bank's systematic reaction coefficient to the real exchange rate, ϕ^{fx}, under $\mathcal{R}.i$ (light turquoise bars) and $\mathcal{R}.ii$ (dark turquoise bars), respectively, and across all $20,000$ rotations. We group reaction coefficients with $\phi^{\text{fx}} < -0.30$ and $\phi^{\text{fx}} > 0.45$ into the edge bars. The observables underlying each VAR in this Figure are $\mathbf{y}_t = [\text{y}_t,\ \pi_t,\ \text{i}_t,\ \text{fx}_t]'$.

3.3 Exact exclusion restrictions and FX overshooting

In this section, we set aside uncertainty or doubts about identification by recovering each SVAR through $|\mathbf{y}_t| - 1 = 3$ *exact* exclusion restrictions. As a consequence, the identified sets of FX responses per identification collapse to a singleton member; that is, to exactly one IRF. Such a tighter identifying corset, though, is by no means inherently superior or inferior to the looser ones employed in Section 3.2. What matters is the quality of identifying information, which we can observe in our controlled setup.

Recursive identification. The light turquoise line with nodes in Figure 4, Panel a illustrates the FX response under identification $\mathcal{R}.iii$. On impact, this recursive estimator understates FX overshooting compared to $\mathcal{D}$ (gray line) by more than two thirds. From the second post-shock quarter onward, the SVAR response spuriously predicts depreciation, beyond equilibrium. After two years, the real exchange rate starts to stabilize back toward steady state; that is, the FX adjustment is non-monotonic, unlike the one in $\mathcal{D}$. Misalignment stems from $\mathcal{R}.iii.i$, which imposes a transmission lag of monetary policy, absent in $\mathcal{D}$. The light turquoise nodes in Figure 2 display which weights the recursive estimator assigns to the respective DGP shocks.

Figure 4: FX overshooting under exact exclusion restrictions and model comparison



(a) Real depreciation (b) Deviation from DGP

Notes: Panel a shows FX responses to a one standard deviation monetary policy shock. The light turquoise line with nodes refers to identification $\mathcal{R}.iii$, the dark turquoise line with diamonds refers to $\mathcal{R}.iv$, and the blue line refers to $\mathcal{R}.v$. The gray line illustrates the FX reaction in the DGP ($\mathcal{D}$). The vertical axis measures percent deviation from steady state (s.s.), and the horizontal axis represents the forecast horizons $h = 0, \ldots, 20$ in quarters. In Panel b, we present absolute differences between the exchange rate IRFs under identifications $\mathcal{R}.i$ to $\mathcal{R}.v$ and the DGP-implied exchange rate IRF, respectively. The observables underlying each VAR in this Figure are $\mathbf{y}_t = [\mathrm{y}_t,\ \pi_t,\ \mathrm{i}_t,\ \mathrm{fx}_t]'$.

Imposing long-run neutrality. Although $\mathcal{R}.iii.ii$ is DGP-consistent, we still consider an alternative, mimicking empirical practice. The dark turquoise line with diamonds in Figure 4, Panel a shows the FX reaction to a monetary policy shock in a block-recursive VAR, which we recover through $\mathcal{R}.iv$; that is, by assuming conditional mean-reversion of FX in the long run. The impact appreciation exceeds 50 percent of $\frac{\partial \mathrm{fx}_t}{\partial \eta_t^{\mathrm{m}}}$. The SVAR-implied exchange rate IRF does not cross the zero line, i.e., the long-run equilibrium, for more than two years. Subsequent depreciation above equilibrium is modest compared to the initial appreciation. Overall, among both DGP-consistent assumptions, the restriction of conditional FX mean reversion outperforms the short-run reaction function constraint in $\mathcal{R}.iii.ii$; at least when it comes to the structural identification of exchange rate overshooting.

Instrumental variable identification. Can we do even better? The FX reaction (blue line) in Figure 4, Panel a clearly indicates: yes. Equipped with ideal information for structural identification—using η_t^{m} as an external instrument—the SVAR-IV estimator $\mathcal{R}.v$ detects FX overshooting more accurately than its competitors. For the first three years after the shock, SVAR- and DGP-generated exchange rate adjustments are essentially the same. Thereafter, both IRFs start to diverge modestly.

Model comparison. As a final summary statistic, we report the deviations of the real exchange rate response among our open-economy SVAR estimators from the one implied by the DGP. In particular, for each identification and forecast horizon, we calculate the absolute distance between $\frac{\partial \mathrm{fx}_{t+h}}{\partial \eta_t^{\mathrm{m}}}$ and $\frac{\partial \mathrm{fx}_{t+h}}{\partial \varepsilon_t^{\mathrm{m}}}$.

Panel b of Figure 4 presents the results of this exercise. Generally, exactly identified SVARs follow the DGP-implied IRF more closely compared to set-identified models. Moreover, differences between IRFs in the SVAR and the DGP tend to decline with longer impulse response horizons; that is, misidentification across estimators is particularly pronounced in the very short run, which is the critical time horizon for tests of exchange rate overshooting.

3.4 Implications for uncovered interest rate parity

Unconditional UIP in the DGP. Uncovered interest rate parity is a central feature of the DGP that we study. A linear approximation accommodating (un)systematic UIP deviations, so-called excess returns Ψ_t, reads in real terms:

$$\begin{aligned}\Psi_t &= (\mathrm{i}_t - \mathbb{E}_t\{\pi_{t+1}\}) - (\mathrm{i}_t^* - \mathbb{E}_t\{\pi_{t+1}^*\}) - \mathbb{E}_t\{\Delta \mathrm{fx}_{t+1}\} \quad (5a)\\ &= -\Lambda \cdot \mathrm{nfa}_t + \eta_t^{\mathrm{uip}}. \quad (5b)\end{aligned}$$

Textbook UIP asserts that positive expected real interest rate differentials between domestic and foreign (denoted by *) bond holdings need to be offset by expected changes in real depreciation (see 5a); any expected excess returns should be immediately arbitraged away by international investors, ensuring $\Psi_t = 0$.

However, our DGP introduces two departures that result in UIP premia, $\Psi_t \neq 0$ (see 5b). First, a stochastic risk-premium shock η_t^{uip} exogenously disturbs investors' preferences for domestic relative to foreign bonds. Second, fluctuations in the net foreign asset position nfa_t generate endogenous deviations from UIP. Specifically, domestic investors encounter systematically higher interest rates as indebtedness abroad increases, where $\Lambda > 0$ scales the debt elasticity of interest rates. Incorporating such debt feedback is a common modeling device to "close" New Open Economy Macroeconomics models (see Kollmann, 2002; Schmitt-Grohé and Uribe, 2003).

Conditional UIP in the DGP. Conditional on a structural monetary policy shock, the dynamic behavior of excess returns in $\mathcal{D}$ over $h = 0, \dots, 20$ is:

$$\begin{aligned}\frac{\partial \Psi_{t+h}}{\partial \eta_t^{\mathrm{m}}} &= \frac{\partial \mathrm{i}_{t+h} - \partial \pi_{t+h+1}}{\partial \eta_t^{\mathrm{m}}} - \underbrace{\frac{\partial \mathrm{i}_{t+h}^* - \partial \pi_{t+h+1}^*}{\partial \eta_t^{\mathrm{m}}}}_{=0.\ (i)} - \frac{\partial \mathrm{fx}_{t+h+1} - \partial \mathrm{fx}_{t+h}}{\partial \eta_t^{\mathrm{m}}} \quad (6a)\\ &= -\Lambda \cdot \frac{\partial \mathrm{nfa}_{t+h}}{\partial \eta_t^{\mathrm{m}}} + \underbrace{\frac{\partial \eta_{t+h}^{\mathrm{uip}}}{\partial \eta_t^{\mathrm{m}}}}_{=0.\ (ii)}. \quad (6b)\end{aligned}$$

Systematic excess returns are inversely proportional to the IRF of the net foreign asset position (see 6b). Equivalently, we can derive conditional UIP premia by subtracting the IRFs of the expected inflation rate and the expected change of real depreciation from the policy rate IRF (see 6a).[9]

Conditional UIP across SVAR estimators. Which role do our best-practice SVAR estimators assign to monetary policy shocks in driving UIP premia? While equality (i) from (6a) holds for the DGP's structural monetary policy shock, it does not need to hold for its SVAR counterparts. Therefore, we augment the vector of VAR observables to capture developments in the interest rate and the expected inflation rate abroad: $\ddot{\mathbf{y}}_t = [\mathrm{y}_t,\ \pi_t,\ \pi_t^*,\ \mathrm{i}_t^*,\ \mathrm{i}_t,\ \mathrm{fx}_t]'$. Based on the resulting six-dimensional VAR (referred to as 3b), we can pin down excess returns following identified monetary policy shocks along the lines of (6a).

Panel a of Figure 5 compares accumulated, non-annualized quarter-on-quarter UIP premia from $\mathcal{D}$ (in gray) with those derived from set-identified SVARs using restrictions $\mathcal{R}.i$ and $\mathcal{R}.ii$. Relative to the DGP, the contours of both identified sets indicate sizable UIP premia. Specifically, pure IRF restrictions are consistent with cumulative excess returns of up to 0.8 percent after five years (light turquoise area); adding policy rule restrictions lowers maximum UIP premia below 0.4 percent (dark turquoise area).

Exact exclusion restrictions shown in Panel b of Figure 5 consistently result in biased excess returns favoring domestic investments. Long-run restrictions under $\mathcal{R}.iv$ (dark turquoise line with diamonds) modestly reduce spurious UIP premia, compared to the fully recursive SVAR in $\mathcal{R}.iii$ (light turquoise line with nodes). The SVAR-IV estimator $\mathcal{R}.v$ (in blue) yields results closest to the excess returns from $\mathcal{D}$.

Spurious UIP premia under ideal exclusion restrictions. Lastly, we further zoom in on this most successful—but at the same time most artificial—scenario, identification $\mathcal{R}.v$. Since the instrumental variable estimator employs ideal identifying information in our application, any discrepancy between IRFs in $\mathcal{D}$ and the SVAR model must arise from non-invertibility of (3b): indeed, the R^2 from the Sims and Zha (2006) regression in Section 3.1 increases by only 6×10^{-6} when we add i_t^* and π_t^* to (3); that is, the six-dimensional VAR in (3b) remains near-invertible.

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[9] Equality (i) in (6a) follows from the standard assumption that domestic shocks in the DGP's *small* open economy do not affect economic developments in the rest of the world. Equality (ii) results from the *conditional* analysis of excess returns in (6b), holding non-monetary policy shocks constant.

We break down the spurious excess returns under $\mathcal{R}.v$, i.e., $\widetilde{\Psi}^{v}_{t+h} = \frac{\partial \Psi_{t+h}}{\partial \varepsilon^{m}_{t}} - \frac{\partial \Psi_{t+h}}{\partial \eta^{m}_{t}}$, into the contributions of misidentified impulse responses of individual variables following the monetary policy shock:

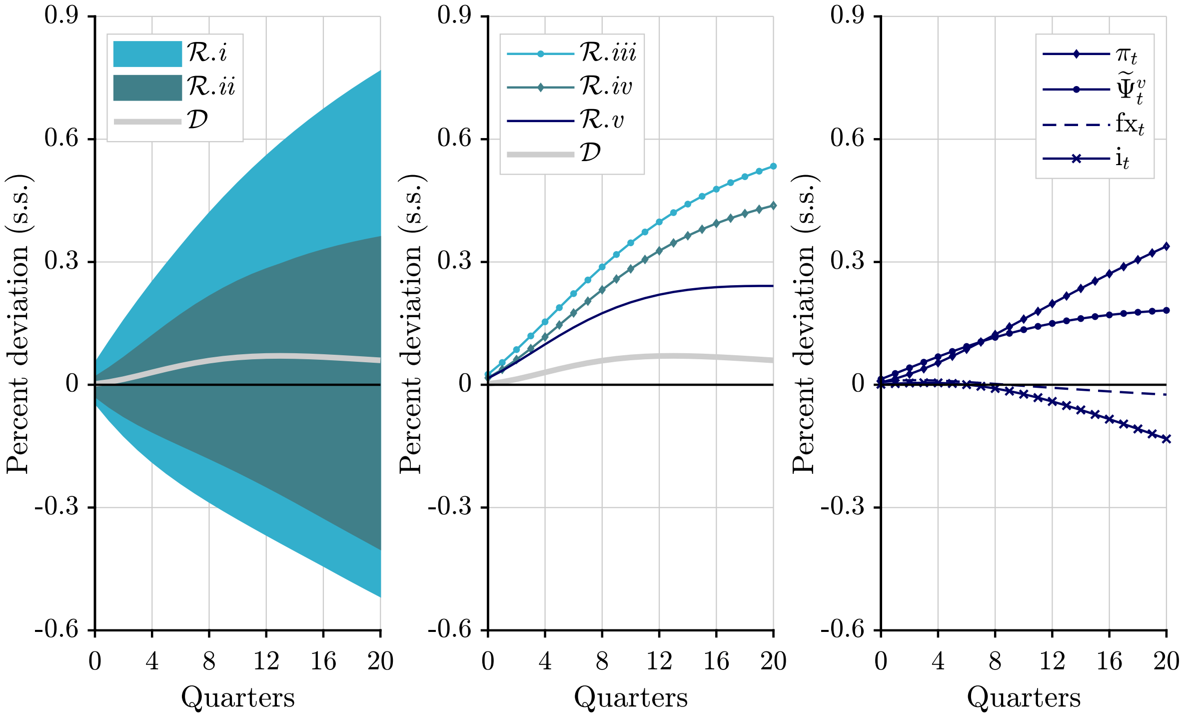
$$\underbrace{\frac{\partial \Psi_{t+h}}{\partial \varepsilon^{m}_{t}} - \frac{\partial \Psi_{t+h}}{\partial \eta^{m}_{t}}}_{\substack{\text{Misidentification of}\\ \text{excess returns}}} = \underbrace{\left(\frac{\partial \mathrm{i}_{t+h}}{\partial \varepsilon^{m}_{t}} - \frac{\partial \mathrm{i}_{t+h}}{\partial \eta^{m}_{t}}\right)}_{\substack{\text{Contribution of}\\ \text{policy rate}}} - \underbrace{\left(\frac{\partial \pi_{t+h+1}}{\partial \varepsilon^{m}_{t}} - \frac{\partial \pi_{t+h+1}}{\partial \eta^{m}_{t}}\right)}_{\substack{\text{Contribution of}\\ \text{expected inflation}}} - \underbrace{\left(\frac{\partial \mathrm{i}^{*}_{t+h}}{\partial \varepsilon^{m}_{t}} - \frac{\partial \pi^{*}_{t+h+1}}{\partial \varepsilon^{m}_{t}}\right)}_{\substack{\text{Contribution of}\\ \text{expected real rate abroad}}}$$
$$- \underbrace{\left(\frac{\partial \mathrm{fx}_{t+h+1} - \partial \mathrm{fx}_{t+h}}{\partial \varepsilon^{m}_{t}} - \frac{\partial \mathrm{fx}_{t+h+1} - \partial \mathrm{fx}_{t+h}}{\partial \eta^{m}_{t}}\right)}_{\substack{\text{Contribution of}\\ \text{expected change in real depreciation}}}. \tag{7}$$

Figure 5, Panel c plots the misidentified excess returns under $\mathcal{R}.v$ (blue line with nodes) and decomposes them into their underlying drivers; i.e., the terms on the right-hand side of (7). The dashed line reveals that the instrumental variable estimator only slightly distorts the IRF of the real exchange rate (see also Figure 4, Panel a). Yet, it exaggerates the persistence of policy-induced disinflation, cumulating to spurious UIP premia of 35 bp after five years (line with diamonds). In addition, the policy rate in the SVAR overshoots into negative terrain after 10 quarters, while the policy rate in $\mathcal{D}$ sluggishly returns to steady state, from above. This distortion amounts to a cumulative 15 bp discrepancy across both IRFs after five years, introducing negative UIP premia (line with crosses). In combination, the biased reactions of individual observables generate spurious excess returns of nearly 20 bp (line with nodes), dwarfing the systematic interest rate premia of six bp in $\mathcal{D}$.

4 Discussion

Central implications. We believe that the above characterization of complications in the structural estimation of FX overshooting and conditional UIP premia revises our understanding of central banks' footprint in exchange rate variation. We argue that empirical evidence hitherto interpreted as contradicting conventional international macro theory could actually support it. Specifically, disagreements within the empirical literature and regular rejections of standard theory might reflect SVAR misidentification and complications arising from non-invertibility rather than inherent differences in the international propagation mechanism of monetary policy across space and time.

Figure 5: Monetary policy shocks and uncovered interest rate parity



(a) Set identification (b) Exact identification (c) Spurious returns in $\mathcal{R}.v$

Notes: The light and dark turquoise areas in Panel a show the identified sets of cumulated excess returns to a one standard deviation monetary policy shock, under $\mathcal{R}.i$ and $\mathcal{R}.ii$, respectively. The gray line illustrates the corresponding moment from the DGP ($\mathcal{D}$). The vertical axis measures percent deviation from steady state (s.s.), and the horizontal axis represents the forecast horizons $h = 0, \ldots, 20$ in quarters. In Panel b, we present the corresponding results under exact exclusion restrictions. Panel c zooms in on the drivers of SVAR-misidentification under $\mathcal{R}.v$. We omit the contribution of the foreign real rate in Panel c since, in absolute terms, it is less than 0.0002 at its maximum. The observables underlying each VAR in this Figure are $\ddot{\mathbf{y}}_t = [\mathrm{y}_t,\ \pi_t,\ \pi_t^*,\ \mathrm{i}_t^*,\ \mathrm{i}_t,\ \mathrm{fx}_t]'$.

Amid a burgeoning collection of empirical estimates on the international ramifications of monetary policy, we base this conclusion on three central observations. First, those structural identification strategies that are notorious for producing exchange rate anomalies in the data also induce open-economy anomalies in our experimental setting. Second, refinements of these exclusion restrictions that are known to alleviate FX puzzles empirically, as well as competing identifications that likewise tend to produce theory-conform conclusions in the data, do not suggest major FX puzzles in our population analysis. Third, since we rely on the "puzzle-free" Adolfson et al. (2007) model to generate a reduced-form VAR system and are able to reproduce empirical FX anomalies *and their solutions* within this experimental setup, we infer that discrepancies between "real-world" data and such a canonical international macro model may be smaller than previously thought; at least when it comes to international, macro-financial fluctuations triggered by monetary policy.

Reproducing empirical puzzles and their solutions. Specifically, our population inferences are compatible with "persistent deviations from uncovered interest parity in favor of [domestic] investments" (see Eichenbaum and Evans, 1995, whose domestic economy is the U.S.). This forward premium puzzle is particularly pronounced in our population applications of IRF-restricted and fully recursive VARs, which further produce delayed overshooting and exchange rate puzzles, resembling empirical evidence (e.g., Faust and Rogers, 2003). In turn, qualitative exclusion restrictions on systematic monetary policy conduct (see Castelnuovo et al., 2022; Groshenny and Javed, 2023) or instrumental variable strategies (see Rogers et al., 2018; Rüth, 2020; Miranda-Agrippino and Ricco, 2021; Cesa-Bianchi and Sokol, 2022) yield results that align with conventional international macro theory. Similarly, sticking to the premise that is "so profoundly rooted in the literature" (Itskhoki, 2021) of real exchange rate stationarity—in our case: assuming *conditional* mean-reversion—tends to align SVAR conclusions with canonical theory (see Bjørnland, 2009; Terrell et al., 2023).

Lessons for empirical work. Two insights may be of particular relevance for empirical research. First, deriving reliable and precise conclusions about the international ramifications of monetary policy shocks may prove challenging without *direct identifying information about open-economy moments* that characterize (un)systematic monetary policy. We illustrate this lesson via our set-identified models: restrictions on domestic variables' IRFs alone produce several FX puzzles. Notably, even with complementary assumptions about systematic policy, the delayed overshooting puzzle persists if these assumptions exclusively involve home-country observables (see also Rüth and Van der Veken, 2023). Only the inclusion of open-economy restrictions "bites strongly," effectively resolving the delayed overshooting puzzle (see also Castelnuovo et al., 2022).

Second, non-invertibility of monetary policy shocks can meaningfully distort inference about their role in exchange rate variation. Our portrayal of misidentification across SVAR estimators may even understate such complications relative to empirical work, as we restrict attention to already *near*-invertible VARs. Nevertheless, our plain-vanilla approach—using *perfect* identifying restrictions in $\mathcal{R}.v$—concisely illustrates how slight departure from perfect invertibility can distort conditional tests of UIP: calculating excess returns involves statistical moments from several observables. Even if we accurately approximate the FX response itself, misidentification of other IRFs could still lead us to erroneously reject UIP. In our application, relying on an ideal instrumental variable in a VAR that is near-invertible in the monetary policy shock, we overstate excess returns by a factor of three. This overstatement primarily arises from the misidentification of the impulse response functions of CPI inflation and the policy rate, whereas the FX reaction itself is identified tightly.

Within our experimental design, we can pin down the biased IRFs under $\mathcal{R}.v$ as immediate symptoms of non-invertibility. In particular, our reduced-form model lacks information about the central bank's time-varying inflation target. While this particular source of informational insufficiency is somewhat artificial, it serves as an illustrative shortcut for more realistic challenges in empirical research. For example, similar invertibility issues could arise from measurement error in inflation data or from selecting VAR observables to proxy for price pressure that do not perfectly align with policymakers' objectives. In this vein, monetary policy VARs rely on a variety of different specifications, such as modeling (i) PCE-, CPI-, or GDP-deflator-based data, (ii) core versus headline inflation, or (iii) price series as log-levels or as growth rates. Our results highlight that such seemingly innocuous specification choices may turn out crucial for conditional tests of uncovered interest rate parity.

Disclaimer. Ultimately, we highlight three caveats for interpreting our population findings. First, we do not challenge the view that unconditional exchange rate movements are notoriously hard to reconcile with standard models.[10] Our results exclusively speak to FX fluctuations following monetary policy shocks; we do not

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[10] A notable exception is Itskhoki and Mukhin (2021), who propose a conventional theoretical framework to simultaneously rationalize major exchange rate puzzles, broadly defined as "exchange rate disconnect." Central features of their fully structural model are financial market disturbances and home bias in consumption.

provide new insights into exchange rate determination more generally.

Second, our conclusions are contingent upon the DGP outlined in Adolfson et al. (2007). While we uncover *qualitative* mechanisms and common sources of misidentification within this representative DGP, we do not aim to assess the quantitative importance of SVAR misidentification across the empirical literature.

Third, by abstracting away small-sample complications that empirical work is plagued with, our juxtaposition of structural estimators takes place in a controlled and thus artificial environment. Consequently, we do not favor particular exclusion restrictions as the preferred choice for empirical applications. Instead, we acknowledge that structural SVAR estimators can perform differently in various contexts.

5 Conclusion

As of August 2024, financial markets have seen recent policy easing by major central banks. For instance, the Bank of Canada lowered its target rate on June 5, becoming the first G7 central bank to do so since the latest inflationary episode. The European Central Bank followed the next day, marking its first rate cut in nearly five years. By contrast, the Federal Reserve still maintains its highest target range for the Federal funds rate in over 20 years, with futures markets factoring in a (sizable) rate cut not earlier than September. Following the "hiking" and "holding" cycles, such a non-synchronized "dialing down cycle" induces renewed divergence between funding costs for major currencies. Reinforcing this observation, the European Central Bank's president Lagarde asserts "we are data dependent, we are not Fed dependent" (ECB, 2024). For international investors and policymakers alike, a critical question is how exchange rates will adjust as the tide of the latest monetary policy cycle continues to turn. Our findings suggest that quantitatively realistic descendants of the canonical Mundell-Fleming-Dornbusch framework remain a solid foundation for analyzing monetary policy-induced exchange rate variation.

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