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ABSTRACT

We study how monetary policy affects the asymmetric effects of globalization. To this end, we build an open-economy heterogeneous-agent New Keynesian model (HANK), in which households differ in their income, wealth, and real and financial integration with international markets. We use the model to reassess classic questions in international macroeconomics, but from a distributional perspective: What are the international spillovers of policies and shocks, how do alternative exchange-rate regimes compare, and what are the implications for monetary policy of the international price system. Our results indicate the presence of a trade-off between aggregate stabilization and inequality in consumption responses to external shocks. The asymmetric effects of globalization can be smaller for economies with higher international integration.

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1. Introduction

The redistributional effects of globalization have featured prominently in the policy debates in recent decades. An influential view, developed around the idea of "Globalization and Its Discontents" (Stiglitz, 2002, 2017), argues that international integration has asymmetric effects on households, and that traditional policies, when not designed considering this dimension, can amplify the resulting inequalities. Although the traditional argument for discontents in globalization was formulated with regard to emerging economies' crises of the late 1990s, similar views have taken center stage in developed economies over the last decade. Related to this policy discussion, a large body of academic research on the intersection of international trade and labor has been conducted to study the distributional consequences of international integration and trade policies (see, for example, Goldberg and Pavcnik, 2007; Autor, Dorn and Hanson, 2016). However, less is known in international macroeconomics about the extent to which traditional macroeconomic stabilization policies affect the asymmetric effects of globalization.

In this paper, we study the distributional effects of monetary policy in open economies, in the context of households' uneven international integration and exposure to external shocks. To this end, we build a framework that combines traditional elements of open-economy monetary transmission, heterogeneity in households' integration with international financial and real markets, and realistic income and wealth distributons. We then use this framework to reassess three classic questions in international economics that motivated the seminal work of Mundell (1963) and Fleming (1962), but focus on their distributional aspects: What are the international spillovers of policies and shocks, how do alternative exchange-rate regimes compare, and what are the implications for monetary policy of the international price system? Our results indicate the presence of a trade-off between aggregate stabilization and inequality in consumption responses to external shocks.

The model we develop embeds household heterogeneity in a canonical New Keynesian open-economy framework. In particular, we consider a small open economy populated by households that consume three types of goods: Tradable goods produced by home firms,

tradable goods produced by foreign firms, and nontradable goods (see, for example, Obstfeld and Rogoff, 2000).[1] To study the distributional effects of monetary policy in this open-economy framework, we introduce households' heterogeneity along two dimensions. First, households differ in their income and wealth, modeled with uninsurable labor-income shocks as in the literature on monetary policy with households' heterogeneity in closed-economy models. Second, households differ in their international real and financial integration, with some working in tradable sectors and others in nontradable sectors, and some having access to internationally traded securities and some restricted to domestically traded securities. With these ingredients, we aim to construct a laboratory economy that has at play the main mechanisms of the monetary transmission of open-economy models, combined with realistic distributions of wealth and marginal propensities to consume across households and uneven exposures to external shocks. We refer to this as an open-economy heterogeneous-agent New-Keynesian model (HANK in Kaplan, Moll and Violante, 2018).

We begin by inspecting the monetary transmission mechanisms in our open-economy HANK. At the aggregate level, the economy's response to monetary policy shocks is similar to that of the standard open-economy New Keynesian model, with expansionary monetary policy shocks stimulating aggregate consumption and increasing inflation and external demand through currency depreciation. At the micro level, our model shows that in addition to the distributional channels studied in a closed economy, monetary policy can have asymmetric effects on households with different degrees of international integration. First, depending on its effects on currency depreciation, monetary policy can differentially affect households in tradable and nontradable sectors. Second, given that monetary policy has a direct effect on domestic interest rates, it more strongly affects households that are not integrated into international capital markets and borrow and save in domestic securities.

We then use this framework to reassess three classic questions in international economics, which motivated the seminal work by Mundell (1963) and Fleming (1962), but from

[1]The three-good structure of consumption and production has more recently been used, for example, in Gabaix and Maggiori (2015) and Mukhin (2018), among others. It nests two common environments frequently used in open-economy models: A structure with home and foreign tradable goods (e.g., Gali and Monacelli, 2005) and one with tradable and nontradable goods (e.g., Schmitt-Grohé and Uribe, 2011).

a distributional perspective.[2] The first question concerns international spillovers and how external policies and shocks affect different households in the economy. External shocks naturally have a more severe effect on households more exposed to international integration: Changes in external demand for home tradable goods have a larger effect on income and consumption for workers employed in the tradable sector, while changes in foreign monetary policy have larger effects on households integrated with international capital markets. Traditional monetary policy policy rules, which target aggregate stability, are unlikely to mitigate these uneven responses to external shocks, and can even exacerbate them. For instance, contractionary external demand shocks induce currency depreciation that lead the monetary authority to increase interest rates, affecting more strongly the consumption of households that do not have access to international capital markets than those that do have access to international capital markets.

The second question is how alternative exchange-rate regimes compare. As is standard in open-economy New Keynesian models, fixed exchange-rate regimes amplify aggregate responses to shocks (see, for example, Gali and Monacelli, 2005). We show that with household heterogeneity, a trade-off can emerge between aggregate stabilization and inequality in consumption responses to external shocks. For instance, when there is an external monetary expansion, monetary authorities under a fixed exchange-rate regime avoid currency appreciation by cutting interest rates more than a monetary authority that follows a traditional Taylor rule would. This results in an increase in consumption for households not integrated to international capital markets, and less inequality in consumption responses between households integrated and not integrated to international capital markets. Therefore, reducing the inequality in consumption responses that results from shocks linked to international capital markets can only be achieved at the expense of obtaining less inflation stability.

The third question concerns how the international price system matters for monetary policy. A standard result in open-economy New Keynesian models is that a high degree of

[2]For instance, the first sentence in Mundell (1963) reads: "The world is still a closed economy, but its regions and countries are becoming increasingly open. (...) The international economic climate has changed in the direction of financial integration and this has important implications for economic policy. My paper concerns the theoretical and practical implications of the increased mobility of capital."

dollar-currency pricing reduces the ability of monetary policy to stimulate exports through the expenditure-switching channel relative to a case in which prices are set in the currency of producers (see, for example, Devereux and Engel, 2003; Mukhin, 2018). We show that in the heterogeneous-agent framework, a corollary of this result is that monetary policy generates more uneven responses across households in the economy because it stimulates more income and consumption of workers in nontradable sectors than of those working in tradable sectors. Therefore, the international price system not only has important implications for the effectiveness of monetary policy but also for its distributional consequences between households integrated and not integrated to international markets.

Finally, our paper studies the role of globalization in terms of the aggregate and distributional effects of monetary policy and external shocks. Economies with lower degrees of real and financial integration naturally experience milder aggregate effects of changes in foreign demand and monetary policy, respectively. However, in economies that have lower degrees of financial integration, external shocks tend to have more uneven responses across households, because external shocks do not induce large dampening forces from prices in the rest of the economy or the monetary authority. From this, we conclude that an important element to consider in the debate regarding the asymmetric effects of globalization is how generalized international integration is.

Related literature Our paper contributes to three strands of the literature. The first is the large body of literature on monetary policy in open economies. The three main questions that guide our work build on the literature that compares policy regimes (see, for example, the early work of Obstfeld and Rogoff, 2000; Clarida, Gali and Gertler, 2001; Gali and Monacelli, 2005); analyzes the international spillovers of policies and shocks (see, for example, Rey, 2015); and examines the role of the international price system in affecting monetary policy (see, for example, Devereux and Engel, 2003; Engel, 2006; Corsetti, Dedola and Leduc, 2010; Mukhin, 2018; Gopinath, Boz, Casas, Díez, Gourinchas and Plagborg-Møller, 2020; Egorov and Mukhin, 2020).[3] We contribute to this literature by analyzing the

[3]Complementing this literature, there is a large body of empirical work on the global financial cycle and international spillovers (see, for example Forbes and Rigobon, 2002; Gourinchas and Rey, 2007; Giovanni,

distributional aspects of these classic questions in international macroeconomics.

Second, a recent and growing body of research studies the role of households' heterogeneity in open-economy models.[4] De Ferra, Mitman and Romei (2020) and Cugat (2019) introduce household heterogeneity in an open-economy New Keynesian model and study its role in the transmission of foreign shocks. Auclert, Rognlie, Souchier and Straub (2020) study monetary transmission in an open-economy HANK, providing general conditions under which households' heterogeneity matters for aggregate transmission, and uncovering the presence of a strong real-income channel that can lead to contractionary devaluations. Zhou (2020) analyzes different channels of the redistribution of monetary policy in an open economy. Guntin, Ottonello and Perez (2020) show how introducing household heterogeneity can inform macro theories of aggregate consumption adjustment and sudden stops. We complement this body of work by showing how monetary policy affects redistribution in a context in which households face heterogeneity in their international real and financial integration, and globalization leads to asymmetric effects among households.

Third, our paper is related to the macroeconomics literature that analyzes consumption inequality (see, for example, Attanasio, Battistin and Ichimura, 2004; Krueger and Perri, 2006; Aguiar and Bils, 2015; Quadrini and Ríos-Rull, 2015, and references therein) and the redistributive effects of macroeconomic policies (see, for example, Doepke and Schneider, 2006; Auclert, 2019; Auclert, Rognlie and Straub, 2018; Kaplan and Violante, 2018, and references therein). Our paper complements this literature by studying the distributional aspects of monetary policy in open economies, which are characterized by inequality stemming from international integration.

Layout The rest of the paper is organized as follows. Section 2 presents the model. Section 3 studies monetary transmission in a parameterized version of the model by analyzing the

Kalemli-Ozcan, Ulu and Baskaya, 2017; Gourinchas, 2018) and on the currency of prices and the international price system (see, for example, Goldberg and Tille, 2008; Gopinath, Itskhoki and Rigobon, 2010; Gopinath, 2015; Corsetti, Crowley, Han and Song, 2019; Burstein and Gopinath, 2014, and references therein)

[4] A related empirical literature has documented the heterogenous impacts of currency depreciation (see, for example, Gopinath and Neiman, 2014; Cravino and Levchenko, 2017; Drenik, Pereira and Perez, 2018; Blanco, Drenik and Zaratiegui, 2020).

aggregate and distributional effects of monetary policy shocks. Section 4 studies the three classic questions in international macroeconomics from a distributional perspective. Section 5 analyzes how the degree of real and financial integration affects the distributional effects of monetary policy and the responses to external shocks. Section 6 concludes.

2. Model

This section describes the open-economy HANK model. The environment is that of a canonical New Keynesian small open-economy model with home tradable goods, foreign tradable goods, and nontradable goods, enriched with household heterogeneity. The small open economy is populated by households, firms, and a government. Firms in the economy produce the home tradable goods and nontradable goods. The rest of the world exchanges tradable goods and financial securities with the small open economy. Households in the small open economy are heterogeneous in two dimensions. First, households face uninsurable labor-income shocks, as is standard in closed-economy HANK models. Second, households are heterogeneous in their access to international financial and real markets: Some work in tradable sectors and others in nontradable sectors; some are able to save and borrow in internationally traded securities and others only in domestically traded securities.

2.1. Households

Households have preferences over consumption described by the lifetime utility function

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t, l_t), \tag{1}$$

where c_t and l_t denote consumption and hours worked in period t; $u : \mathbb{R}^2_+ \to \mathbb{R}$ is a continuous and differentiable function, increasing in the first argument and decreasing in the second argument; $\beta \in (0, 1)$ denotes the subjective discount factor; and $\mathbb{E}_t$ denotes the expectation conditional on the information set available at time t. The consumption good is a composite of tradable and nontradable goods, with a constant-elasticity-of-substitution (CES) aggre-

gation technology $c_t = \mathcal{C}_{\text{TN}}(c_{\text{T}t}, c_{\text{N}t}) = \left[\omega_{\text{T}}^{\frac{1}{\eta_{TN}}} (c_{\text{T}t})^{1-\frac{1}{\eta_{\text{TN}}}} + (1-\omega_{\text{T}})^{\frac{1}{\eta_{TN}}} (c_{\text{N}t})^{1-\frac{1}{\eta_{\text{TN}}}}\right]^{\frac{\eta_{\text{TN}}}{\eta_{\text{TN}}-1}}$, where $c_{\text{T}t}$ and $c_{\text{N}t}$ denote tradable and nontradable consumption and $\eta_{\text{TN}} > 0$ is the elasticity of substitution between tradable and nontradable goods. The tradable good is, in turn, a composite of home and foreign tradable goods with a CES aggregation technology $c_{\text{T}t} = \mathcal{C}_{\text{HF}}(c_{\text{H}t}, c_{\text{F}t}) = \left[\omega_{\text{H}}^{\frac{1}{\eta_{HF}}} (c_{\text{H}t})^{1-\frac{1}{\eta_{\text{HF}}}} + (1-\omega_{\text{H}})^{\frac{1}{\eta_{HF}}} (c_{\text{F}t})^{1-\frac{1}{\eta_{\text{HF}}}}\right]^{\frac{\eta_{\text{HF}}}{\eta_{\text{HF}}-1}}$, where $c_{\text{H}t}$ and $c_{\text{F}t}$ denote home tradable and foreign tradable goods and $\eta_{\text{HF}} > 0$ is the elasticity of substitution between home tradable and foreign tradable goods.

We set up the household's problem recursively. The idiosyncratic state vector of a household includes its idiosyncratic income shock, z, its asset holdings, b, and its integration with international financial and real markets, $\mathbf{o} \equiv [o_R, o_F]$, with o_R denoting a dummy variable that takes the value of one if the household receives its income from the tradable sector and zero if it receives it from the nontradable sector and o_F denoting a dummy variable that takes the value of one if the household is integrated to financial international markets and and zero if the household only has access to domestic markets. Households' recursive problem is given by

$$V_t(z,b,\mathbf{o}) = \max_{c_{\text{H}},c_{\text{F}},c_{\text{N}},l,b'} u(c,l) + \beta \mathbb{E}_t \left[(1-\xi) V_{t+1}(z',b',\mathbf{o}') + \xi \hat{V}_{t+1}(z',b',\mathbf{o}')\right] \tag{2}$$

$$\text{s.t. } c = \mathcal{C}_{\text{TN}}(c_{\text{T}}, c_{\text{N}}), c_{\text{T}} = \mathcal{C}_{\text{HF}}(c_{\text{H}}, c_{\text{F}}), \tag{3}$$

$$q_t(o_F,b')b' = b + z(1-\tau_t)W_t(\mathbf{o})l + T_t + \bar{\gamma}(z,b,\mathbf{o})\gamma_t - P_{\text{H}t}c_{\text{H}} - P_{\text{F}t}c_{\text{F}} - P_{\text{N}t}c_{\text{N}} \tag{4}$$

$$b' \geq \underline{b}$$

$$\mathbf{o}' = \Gamma_t(z,b,\mathbf{o}),$$

where $P_{\text{H}t}$, $P_{\text{F}t}$, and $P_{\text{N}t}$ are the prices of home tradable goods, foreign tradable goods, and nontradable goods denominated in local currency; $W_t(\mathbf{o})$ is the nominal wage per unit of effective labor in the sector in which the household is employed; τ_t is a labor-income tax; T_t is a lump-sum transfer from the government; $\bar{\gamma}(z,b,\mathbf{o})$ and γ_t are transfers from firms to households, which potentially depend on the households' idiosyncratic states; $q_t(o_F,b')$ is the price of the zero-coupon bond which, as further detailed below, depends on whether the

household is integrated with international capital markets and on whether households are borrowing or saving; $\Gamma_t(z, b, \mathbf{o})$ denotes the law of motion of the household's financial and real integration, which can potentially depend on the aggregate and individual households' states; $\underline{b}$ is a fixed debt limit; ξ is the households' death rate; and $\hat{V}_t(z, b, \mathbf{o})$ is the value of a household that receives the realization of a shock indicating that it dies and retires from the economy in the following period, given by $\hat{V}_t(z, b, \mathbf{o}) = \max_{c_{\mathrm{H}}, c_{\mathrm{F}}, c_{\mathrm{N}}, l} u(c, l)$ s.t. $P_{\mathrm{H}t}c_{\mathrm{H}} + P_{\mathrm{F}t}c_{\mathrm{F}} + P_{\mathrm{N}t}c_{\mathrm{N}} = \bar{\gamma}(z, b, \mathbf{o})\gamma_t + b + z(1 - \tau_t)W_t(\mathbf{o})l_t$. Each period, a new mass of households, ξ, is born with no assets, so the total mass of households is always fixed at one.

2.2. Firms

The economy has access to technologies to produce two types of goods: home tradable goods (H) and nontradable goods (N). Two types of firms occupy each sector, described next. All firms are owned by domestic households.

Final-good Producers A continuum of representative final-good producers occupies each sector and transform intermediate goods $\tilde{y}_{jst}$, where $j \in [0, 1]$ and $s \in \{\mathrm{H}, \mathrm{N}\}$, into final goods with production technology

$$Y_{st} = \left(\int_0^1 \tilde{y}_{jst}^{\frac{\epsilon_s - 1}{\epsilon_s}} dj \right)^{\frac{\epsilon_s}{\epsilon_s - 1}}.$$

Final-good producers in each sector choose intermediate inputs $(\tilde{y}_{jst})_{j \in [0,1]}$ to maximize their static profits, leading in equilibrium to a demand function faced by intermediate-good producers in each sector, $\mathcal{Y}_{jst}(p_{jst}) = \left(\frac{p_{jst}}{P_{st}} \right)^{-\epsilon_s} Y_{st}$ and the price aggregator $P_{st} = \left(\int_0^1 p_{jst}^{1-\epsilon_s} \right)^{\frac{1}{1-\epsilon_s}}$.

Intermediate-good Producers A continuum of intermediate-good producers indexed by $j \in [0, 1]$ use capital and labor to produce intermediate goods with the technology $y_{jst} = n_{jst}^{1-\alpha_s}$ for $s \in \{\mathrm{H}, \mathrm{N}\}$. The markets for intermediate goods and labor are competitive. The marginal cost of producing each unit of intermediate good is $mc_{st} = \frac{w_{st} N_{st}}{(1-\alpha_s) Y_{st}}$, where mc_{st} and $w_{st} \equiv \frac{W_{st}}{P_{st}}$ denote the marginal cost and wage in sector s, and N_{st} and Y_{st} refer to aggregate labor and output in sector s. Each intermediate-good producer sets its price facing an adjustment cost *à la* Rotemberg (1982), $\Theta_{st}\left(\frac{p_{st}}{p_{st-1}} \right) = \frac{\theta_s}{2} \left(\frac{p_{st}}{p_{st-1}} - 1 \right)^2 Y_{st} P_{st}$. The

problem of each intermediate-good producer is then given by

$$\max_{p_{st}} \tilde{\Pi}_s(p_{st}) - \Theta_{st}\left(\frac{p_{st}}{p_{st-1}}\right) + \sum_{l=1}^{\infty} \mathbb{E}_t \left[\left(\prod_{k=1}^{l} \frac{1}{1+r_{t+k}} \right) \left[\tilde{\Pi}_s(p_{s,t+l}) - \Theta_{st}\left(\frac{p_{s,t+l}}{p_{s,t+l-1}}\right) \right] \right],$$

where $r_t = i_t - \pi_{t+1}$ is the real interest rate and $\tilde{\Pi}_{st}(p_t) \equiv \left(\frac{p_{st}}{P_{st}} - mc_{st}\right)\left(\frac{p_{st}}{P_{st}}\right)^{-\epsilon_s} Y_{st}$. From the solution to this problem, we can derive the New Keynesian Phillips Curve for each sector $s \in \{\mathrm{H}, \mathrm{N}\}$:

$$\pi_{st}(1+\pi_{st}) = \frac{\epsilon_s}{\theta_s}\left(mc_{st} - \frac{\epsilon_s - 1}{\epsilon_s}\right) + \mathbb{E}_t\left[\frac{1}{1+r_{t+1}} \frac{Y_{s,t+1}}{Y_{st}} (1+\pi_{s,t+1}) \cdot \pi_{s,t+1}\right], \tag{5}$$

where $\pi_{st} \equiv \frac{P_{st}}{P_{s,t-1}} - 1$.

2.3. Government

The government determines monetary and fiscal policies in the small open economy. For monetary policy, we assume that the government follows a simple Taylor Rule,

$$i_t = i_{ss} + \phi(\pi_t - \bar{\pi}) + v_t, \tag{6}$$

where v_t is an exogenous monetary policy shock that follows the autoregressive process $v_t = \rho_v v_{t-1} + \epsilon_t^m$; $\pi_t \equiv \frac{P_t}{P_{t-1}} - 1$ is the inflation of the ideal price index; and i_{ss} and $\bar{\pi}$ are linked to steady-state nominal rates and levels of inflation. This interest rate determines the price of the zero-coupon bond at which unintegrated households invest, which is given by

$$q_t(\mathrm{dom}, b') = \frac{1}{1 + i_t + \mathbb{1}_{b'<0}\kappa}, \tag{7}$$

where $\kappa > 0$ is a borrowing premium.

In Section 4.2, we compare the dynamics under a fixed-exchange-rate regime instead of a Taylor rule. On the fiscal side, government raise labor tax and issues domestic debt to

finance their spending and transfer:

$$\frac{B_{t+1}}{1+i_t} - B_t + \tau_t \left(N_{Ht} W_{Ht} + N_{Nt} W_{Nt}\right) = T_t + G_t. \tag{8}$$

We assume that the government maintains a constant level of spending, transfer, and debt, i.e. $G_t = G_{ss}$, $T_t = T_{ss}$, and $B_t = B_{ss}$, where T_{ss}, G_{ss}, and B_{ss} are parameters that govern the steady-state level of spending, transfer, and government debt.

2.4. The Rest of the World

The rest of the world trades financial securities and tradable goods with the small open economy. From the perspective of the small open economy, the rest of the world provides an international interest rate for trading securities in foreign currency, a foreign demand of the home tradable good, and a foreign supply of the foreign tradable good.

For financial securities, the small open economy faces a perfectly elastic demand, with a nominal interest rate in foreign currency, i_t^*, following an exogenous autoregressive process $i_t^* = (1-\rho_{i^*}) i_{ss}^* + \rho_{i^*} i_{t-1}^* + \epsilon_t^{i^*}$, where i_{ss}^* is the steady-state rate and $0 < \rho_{i^*} < 1$. The shock, $\epsilon_t^{i^*}$, can be interpreted as a foreign monetary-policy shock, which we consider in Section 4.1 in analyzing international spillovers. This interest rate determines the price of the zero-coupon bond at which financially integrated households invest, which is given by

$$q_t(\text{ext}, b') = \frac{1}{1 + i_t^* + \mathbb{E}_t \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} + \mathbb{1}_{b'<0}\kappa}, \tag{9}$$

where $\mathcal{E}_t$ denotes the nominal exchange rate of domestic currency per unit of foreign currency.

On the tradable goods side, we assume a completely elastic supply of the foreign good at a fixed price in foreign currency, which we denote as P_{Ft}^*, and a downward-sloping foreign demand of the home tradable good, which is given by

$$C_{\text{H}t}^* = \left(\frac{P_{Ht}^*}{P_{Ft}^*}\right)^{-\eta_{HF}} Y_{\text{F}t}^*, \tag{10}$$

where P_{Ht}^* is the price of the home tradable good expressed in foreign currency and $Y_{\text{F}t}^*$

is a foreign demand shifter that follows an exogenous autoregressive process $\log Y^*_{\mathrm{F}t} = \rho_{Y^*_{\mathrm{F}}} \log Y^*_{\mathrm{F}t-1} + \epsilon^{Y^*_{\mathrm{F}}}_t$.

These conditions can be micro-founded from the problem of a representative foreign household that is risk neutral, has CES preferences over H and F tradable goods, and is infinitely large relative to the small open economy, but the share of home tradable good consumption in its consumption basket is infinitely small.[5]

2.5. Equilibrium

We define the competitive equilibrium as follows.

***Definition* 1.** *Given exogenous processes* $\{v_t, Y^*_{\mathrm{F}t}, i^*_t\}$ *and government policies* $\{i_t,\ \tau_t, T_t\}$, *an equilibrium is a stochastic sequence of households' value functions* $\{V_t(z,b,\mathbf{o})\}$ *and policy functions* $\{c_{\mathrm{H},t}(z,b,\mathbf{o}),\ c_{\mathrm{F},t}(z,b,\mathbf{o}),\ c_{\mathrm{N},t}(z,b,\mathbf{o}),\ l_t(z,b,\mathbf{o}),\ b'_t(z,b,\mathbf{o})\}$; *firms' choices* $\{\tilde{y}_{st},\ y_{st},\ n_{st},\ p_{st}\}$; *aggregate quantities* $\{Y_t,\ Y_{\mathrm{N},t},\ Y_{\mathrm{H},t},\ C_t,\ C_{\mathrm{H},t},\ C_{\mathrm{F},t},\ C_{\mathrm{N},t},\ N_t, N_{\mathrm{H},t},\ N_{\mathrm{N},t}\}$; *prices* $\{W_{\mathrm{H},t},\ W_{\mathrm{N},t}\ P_{\mathrm{H}t},\ P_{\mathrm{F}t},\ P_{\mathrm{N}t}, \mathcal{E}_t\}$; *bond prices* $\{q_t(o_F, b')\}$; *and a distribution of households* $\mu_t(z,b,\mathbf{o})$ *such that*

1. *Household optimization: Value function* $V_t(z,b,\mathbf{o})$ *solves households' problem* (2) *with the associated policy functions* $\{c_{\mathrm{H},t}(z,b,\mathbf{o}),\ c_{\mathrm{F},t}(z,b,\mathbf{o}),\ c_{\mathrm{N},t}(z,b,\mathbf{o}),\ l_t(z,b,\mathbf{o}),\ \text{and}\ b'_t(z,b,\mathbf{o})\}$ *taking as given the equilibrium prices, interest rates, policies, and the transfers.*

2. *Firm optimization: Individual firms' choices satisfy their problems given the equilibrium prices, interest rates, policies, and transfers.*

3. *Bond prices satisfy* (7) *and* (9).

4. *Prices of foreign tradable goods satisfy the law of one price:* $P_{\mathrm{F}t} = P^*_{\mathrm{F}}\mathcal{E}_t$.

[5] Under this structure, the foreign supply of the foreign good is infinitely large relative to the small open economy, which gives rise to a completely elastic supply of that good. On the other hand, the foreign demand of the home tradable good is finite from the perspective of the small open economy, by making the share of the home tradable good infinitesimally small. In fact, in this case the demand shifter is equal to $Y^*_{\mathrm{F}t} \equiv \lim_{\omega^*_{\mathrm{H}}\to 0, C^*_{\mathrm{F}t}\to\infty} \left(\frac{\omega^*_{\mathrm{H}}}{1-\omega^*_{\mathrm{H}}}\right)^{\frac{1}{\eta}} C^*_{\mathrm{F}t} > 0$ and finite.

5. *The sequence of aggregate quantities and distributions satisfy aggregate consistency conditions.*

6. *All markets clear.*

3. Distributional Effects of Monetary Policy in Open Economies

3.1. Parameterization

We calibrate our model to Canada, which is a prototypical small open economy that has been extensively analyzed in the literature. Our calibration strategy targets key macro moments of the economy and micro moments related to household heterogeneity. One period is a quarter. We first discuss the calibration of the model's steady state, which has five different blocks of parameters that are reported in Table 1.

Panel 1 of Table 1 reports the first block of parameters that are related to households' preferences. We assume the following functional form for the period utility:

$$u(c,l) = \frac{c^{1-\nu_c}}{1-\nu_c} - \psi \frac{l^{1+\nu_L}}{1+\nu_L},$$

and set the intertemporal elasticity of substitution $1/\nu_c$ and the Frisch elasticity of labor supply ν_L to one, which are standard values in the literature. We calibrate the disutility of labor supply ψ to target a steady-state level of hours of 0.5, and the discount factor to target a steady-state domestic annual interest rate of 4%. We calibrate the share of tradable goods in the consumption basket $\omega_{\mathrm{T}} = 0.5$ to match the share of tradable goods output in the Canadian economy. Similarly, we calibrate the share of home goods in the tradable consumption basket $\omega_{\mathrm{H}} = 0.6$ to match the ratio of exports to output. We calibrate the elasticity of substitution between home and foreign tradable goods and tradable and nontradable goods to $\eta_{\mathrm{TN}} = \eta_{\mathrm{HF}} = 3$ to match the peak response of the exchange rate to a monetary shock. We provide more details on this and other conditional responses as part of

the calibration targets later in this section.

Panel 2 of Table 1 reports the parameters that govern the idiosyncratic risks faced by households. The idiosyncratic income shock process is constructed as a mixture of two independent Markov processes: $z = z_1 + z_2$, where z_1 and z_2 are, respectively, the persistent and temporary components f households' idiosyncratic income process. The idiosyncratic income shock process is calibrated to target the moments of log-earning dynamics summarized in Table 2.[6] We model the evolution of households' financial and real integration type as two independent Markov processes with two states. The two states in the financial integration are integrated and non-integrated, and the transition-probability matrix is calibrated to a transition probability from non-integrated to non-integrated of λ_0^F and a transition probability from integrated to integrated of λ_1^F, so that the fraction of integrated households in the ergodic distribution is $\frac{\lambda_1^F}{\lambda_0^F+\lambda_1^F}$. We set $\lambda_1^F = 0.9$ and calibrate $\lambda_0^F = 0.98$ to match a share of financially integrated households of 15%. In the data, we identify financially integrated households as households that have external assets in their asset portfolio or savings denominated in U.S. dollars.[7] The two states in the real integration correspond to working in the tradable and non-tradable sectors, and the transition-probability matrix is calibrated to a transition probability of maintaining employment in the non-tradable sector of λ_0^R and a transition probability of maintaining the employment in the tradable sector of λ_1^R, so that the fraction of integrated households in the ergodic distribution is $\frac{\lambda_1^R}{\lambda_0^R+\lambda_1^R}$. We set $\lambda_1^R = 0.9$ and calibrate $\lambda_0^R = 0.94$ to target the share of households working in the non-tradable sector which corresponds to the share of households working in the tradable sector in Canada of 35%.[8] In Section 5 we analyze the macroeconomic consequences of varying the degree of financial and real integration in the economy.

[6]Both z_1 and z_2 are approximated as discrete Markov processes with equal-distance state space after Rouwenhorst (1995). Under this approximation, each process will be uniquely determined by three moments: the process's first-order autocorrelation ρ_i, and the unconditional distribution's standard deviation σ_i, and the skewness $skew_i$, for $i = 1, 2$.

[7]We estimate this share using data for 2008-2015 from the Canadian Financial Monitor Survey.

[8]We measure the fraction of households working in tradable sectors based on the average fraction of total employment working in tradable sectors in Canada between 1979 and 2019. The tradable sectors include: Forestry, fishing, mining, quarrying, oil and gas; Manufacturing; Agriculture; Information, culture and recreation; Wholesale trade; Professional, Scientific, and technical services; and Finance and insurance.

Table 1: Calibration

	Parameter	Value
Panel 1. Household preferences		
ξ	Exit rate	1/45/4
$1/\nu_c$	Elasticity of intertemporal substitution	1
$1/\nu_l$	Frisch elasticity of labor supply	1
ψ	Disutility of labor	3.5107
β	Discount factor	0.9909
η_{TN}	Elasticity of substitution between tradable and nontradable goods	3
η_{HF}	Elasticity of substitution between home and foreign goods	3
ω_T	Fraction of tradable goods in consumption basket	0.5
ω_H	Fraction of home goods in tradable goods consumption basket	0.6
Panel 2. Idiosyncratic risk		
λ_0^F	Transition probability of keeping being non-integrated HH, financial integration	0.98
λ_1^F	Transition probability of keeping being integrated HH, financial integration	0.90
λ_0^R	Transition probability of keeping being non-integrated HH, real integration	0.95
λ_1^R	Transition probability of keeping being integrated HH, real integration	0.90
ρ_1	Persistent component of idiosyncratic income, first-order autocorrelation	0.75
σ_1	—, unconditional standard deviation	0.78
$skew_1$	—, unconditional skewness	−4.07
ρ_2	Transitory component of idiosyncratic income, first-order autocorrelation	0.25
σ_2	—, unconditional standard deviation	0.31
$skew_2$	—, unconditional skewness	−2.05
Panel 3. Asset markets and financial frictions		
i_{ss}^*	Steady-state international interest rate	0.04/4
$\underline{b}$	Borrowing constraint, relative to quarterly average labor income in steady state	−1
κ	Premium in borrowing interest rate	0.06/4
Panel 4. Government		
τ	Income tax rate	0.20
T_{ss}	Total transfer, relative to quarterly average labor income in steady state	0.12
B_{ss}	Total government debt, relative to annual GDP in steady state	0.78
$\bar{\pi}$	Steady-state inflation rate	0.02/4
ϕ_π	Taylor rule, coefficient of inflation	1.10
ϕ_i	—, coefficient of lagged nominal interest rate	0.90
Panel 5. New Keynesian		
ϵ_{N}	Nontradable goods demand elasticity	10
θ_{N}	Nontradable goods price adjustment cost	100
ϵ_{T}	Tradable goods demand elasticity	10
θ_{T}	Tradable goods price adjustment cost	100

Table 2: Targeted moments for idiosyncratic income shock processes

Moment	Model	Data
1-year change in log annual earnings		
Variance	0.47	0.49
Skewness	−0.27	−0.81
Kurtosis	15.56	15.55
5-year change in log annual earnings		
Variance	0.71	0.69
Skewness	−0.29	−0.71
Kurtosis	13.33	10.33

Notes: Data moments from Bowlus, Gouin-Bonenfant, Liu, Lochner and Park (2020).

Panel 3 of Table 1 summarizes the financial frictions households face. The steady-state foreign annual interest rate is also calibrated at 4%, so that there are no steady-state differences in the financial returns of integrated and nonintegrated households. The borrowing constraint is set to the average quarterly labor income, and the annualized premium in the borrowing interest rate is set to 6%, which is consistent with Kaplan *et al.* (2018). Panel 4 reports the parameters related to the government's fiscal and monetary policies. The income tax rate is set at 20%, calibrated to match the average ratio of tax payments to total earnings, obtained from the Canadian Survey of Financial Security. The lump-sum transfer is set to 12% of the aggregate labor income, which is consistent with the ratio of government transfers to total earnings. The level of government debt is set to match the average ratio between government debt and annual GDP in Canada. We set the steady-state level of annual inflation to be 2%, the aautocorrelation of the Taylor rule to 0.9, and the coefficient of inflation to 1.1. In Panel 5, we report the calibrated parameter for the demand elasticities and price adjustment costs, which we set to $\epsilon_{\mathrm{N}} = \epsilon_{\mathrm{T}} = 10$ and $\theta_{\mathrm{N}} = \theta_{\mathrm{T}} = 100$, respectively.

The economy is subject to three sources of aggregate fluctuations: shocks to the domestic and foreign monetary policy rates and shocks to foreign demand of the home tradable good. For the policy rates, we calibrate the persistence of shock processes at 0.3 and the standard deviation of the shock at 25 bp. For the foreign demand shock, we set the persistence to 0.7

and its standard deviation to 0.02.

We solve the model with the method proposed by Reiter (2009), which consists of two steps. First, we solve the steady state with no aggregate shocks. The steady state characterizes the distribution of households and the heterogeneity in their consumption and saving when the aggregate quantities and prices are fixed at their steady-state levels. Then we solve the first-order perturbation around the steady state. The solved dynamics characterize the responses of different households' consumption and saving policies, the distribution of households, and the aggregate quantities and prices following the different types of aggregate shocks.

Since our focus is on the macro and micro responses to different aggregate shocks and the role of monetary policy in affecting its transmission, we use the aggregate responses of key variables to a monetary policy shock as a subset of our targeted moments. We focus on the peak responses of aggregate consumption, the bilateral exchange rate between the Canadian dollar (CAD) and the U.S. dollar (USD), and the CPI. As documented by Champagne and Sekkel (2018), following an 1% decrease in the innovation to monetary policy shock, consumption increases by 0.6% to 1.4%; the CAD depreciates vis a vis USD by 0.4% to 1.2%; and the CPI increases by 0.05% to 0.55%. The IRF of aggregate consumption is mainly used to discipline the persistence of monetary policy shock; the IRF of the exchange rate is mainly disciplined by the elasticity between home and foreign tradable goods, η_{HF}; and the IRF of the CPI is mostly disciplined by the Taylor rule coefficient of inflation.

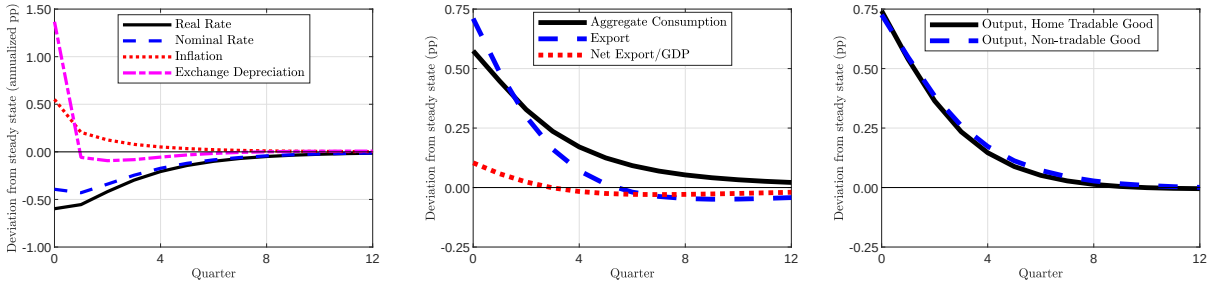
3.2. Aggregate and Distributional Effects of Monetary Policy Shocks

Figure 1 shows the aggregate response to an expansionary monetary policy shock: a negative innovation to the Taylor rule $\epsilon_t^m = -0.0025$; more detailed responses are depicted in Appendix Figure A.1. Due to price rigidities, the nominal decline in rates translates to a decline in real rates, which increases consumption. Currency depreciates, generating an increase in external demand and higher exports. Firms respond to increased external and domestic demand by increasing both their output and prices. The increase in firms' output leads to higher wages, leading to additional increases in domestic consumption. Overall,

the aggregate effects of monetary shocks are aligned with those of the representative-agent open-economy New Keynesian model. This result is consistent with the findings of Auclert *et al.* (2020), who provide general conditions under which households heterogeneity does not lead to an aggregate response significantly different from that of the representative-agent open-economy New Keynesian model.

Figure 1: Aggregate Effects of Monetary Policy Shocks

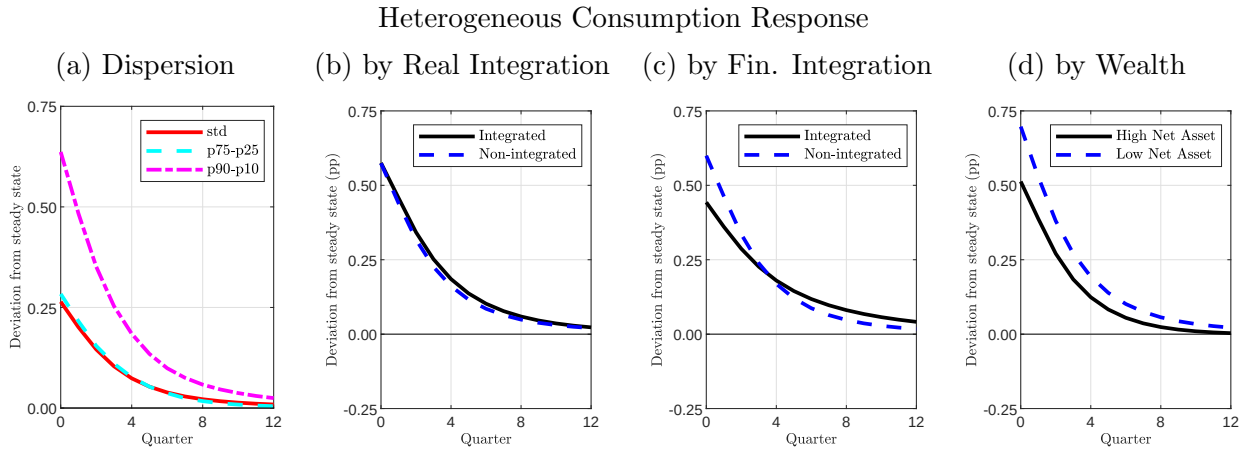
(a) Interest Rates and Inflation (b) Aggregate Demand (c) Aggregate Supply



Notes: This figure shows aggregate impulse responses to a 25 bp expansionary monetary policy shock (i.e., an innovation to the Taylor rule $\epsilon_t^m = -0.0025$). Panel (a) shows the response of nominal and real interest rates, the inflation rate of the ideal price index, and the rate of nominal currency depreciation. Panel (b) shows the response of aggregate consumption, exports, and the trade balance to GDP ratio. Panel (c) shows the output of the home tradable good and the non-tradable good.

Figure 2 illustrates the distributional effects of changes in monetary policy for different households in the economy. Panel (a) shows that changes in monetary policy have uneven effects on households, as measured by the standard deviation of consumption responses, the difference between the 75th percentile and the 25th percentile, and the difference between the 90th percentile and the 10th percentile, all scaled by the average peak effect of aggregate consumption. All these measures increase in response to the shock. Panels (b)-(d) decompose these heterogeneous responses for different types of households in the economy. Panel (b) shows similar responses for households working in the tradable and non-tradable sectors. Panel (c) shows that monetary policy has a larger effect on households that are not integrated to international capital markets and are directly affected by changes in domestic rates. Finally, Panel (d) shows that monetary policy has larger effects on consumption for households with low asset holdings, which tend to have higher marginal propensities to consume.

Figure 2: Distributional Effects of Monetary Policy Shocks



Notes: This figure shows the distributional effects of a 25 bp expansionary monetary policy shock (i.e., an innovation to the Taylor rule $\epsilon_t^m = -0.0025$). The Panel (a) shows the standard deviation of consumption responses across households and the difference between percentiles 75 and 25 and 90 and 10 of consumption responses, all scaled by the initial response of aggregate consumption. The Panel (b) shows the consumption responses of households employed in the home tradable sector (*integrated*) and those employed in the non-tradable sector (*not integrated*). Panel (c) shows the consumption responses of households that have access to international capital markets (*integrated*) and those that have access to domestically traded financial securities (*not integrated*). The Panel (d) shows consumption responses of households with high and low levels of assets, defined as those with assets above and below the mean asset position in the economy.

4. Classic Questions in International Macroeconomics from a Distributional Perspective

This section uses our open-economy HANK model to reassess three classic questions in international macroeconomics from a distributional perspective: Section 4.1 analyzes the international spillovers of external shocks and policies, Section 4.2 studies the implications of different exchange-rate regimes, and Section 4.3 the implications of the international price system.

4.1. International spillovers

We study the aggregate and distributional effects of two sources of macroeconomic exposure that result from real and financial international integration: Changes in external demand and foreign monetary policy.

External demand The top panels in Figure 3 show the aggregate responses of a positive shock to external demand of home tradable good, with more details provided in Appendix Figure A.2. Firms in the home tradable sector respond to higher external demand by increasing their output and prices. On the one hand, the increase in output leads to higher wages and consumption for workers employed in the tradable sector, which in turn leads to higher output and wages in the non-tradable sector. On the other hand, the relative price of home and foreign tradable goods adjust through a currency appreciation and leads to an expenditure switching of domestic household toward foreign tradable.[9] Currency appreciation pushes down inflation, leading the monetary authority to cut its policy rate, which further amplifies the increase in domestic demand. In spite of currency appreciation, the initial external demand shock implies that the economy increases its exports and its trade balance.

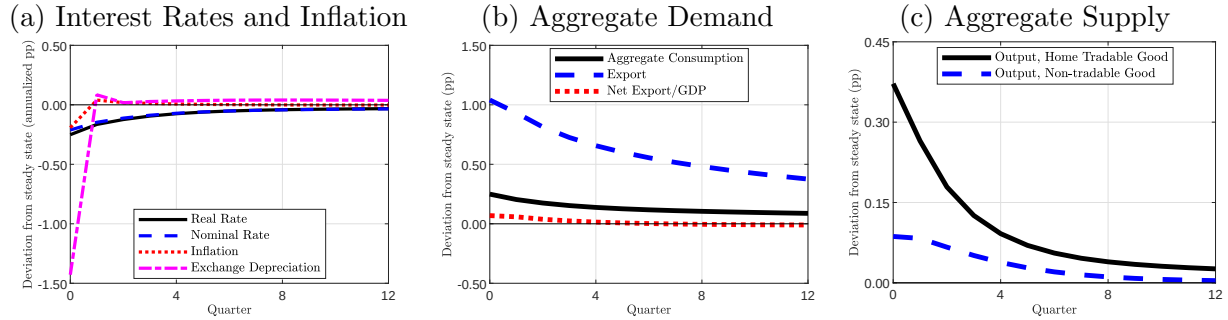
The top panels in Figure 4 show the distributional effects of the external demand shock. Panel (a) shows that the external demand shock leads to uneven responses in consumption across households, as measured by the standard deviation of consumption responses, the difference between the 75th percentile and the 25th percentile, and the difference between the 90th percentile and the 10th percentile, which all increase in response to the shock. As shown in Panel (b), external demand shocks naturally have a larger effect on households working in the tradable sector. In addition, Panel (c) shows that the decline in domestic interest rates in response to the external demand shock induces a larger consumption response for households not integrated to international capital markets than for those integrated to international capital markets. Panel (d) shows that external demand shocks have larger effect on the consumption of households with low asset holdings, which tend to have higher marginal propensities to consume.

Foreign monetary policy The bottom panels in Figure 3 show the aggregate responses to a foreign monetary policy expansion, with more details provided in Appendix Figure A.3.

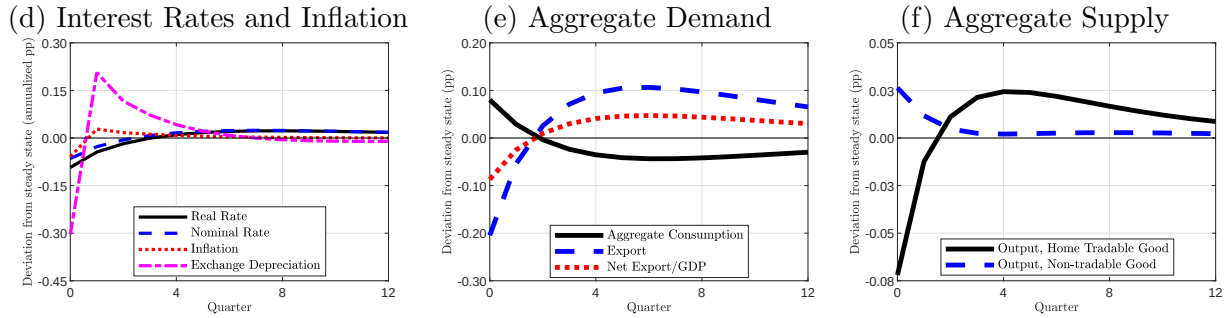
[9]The effects of an external demand shock on output and the real exchange rate in our model are qualitatively consistent with the effects of terms of trade shocks documented in the literature (see, for example Mendoza, 1995; Schmitt-Grohé and Uribe, 2018).

Figure 3: Aggregate Effects of External Shocks

Response to an Expansionary Foreign Demand Shock



Response to an Expansionary Foreign Monetary Policy Shock

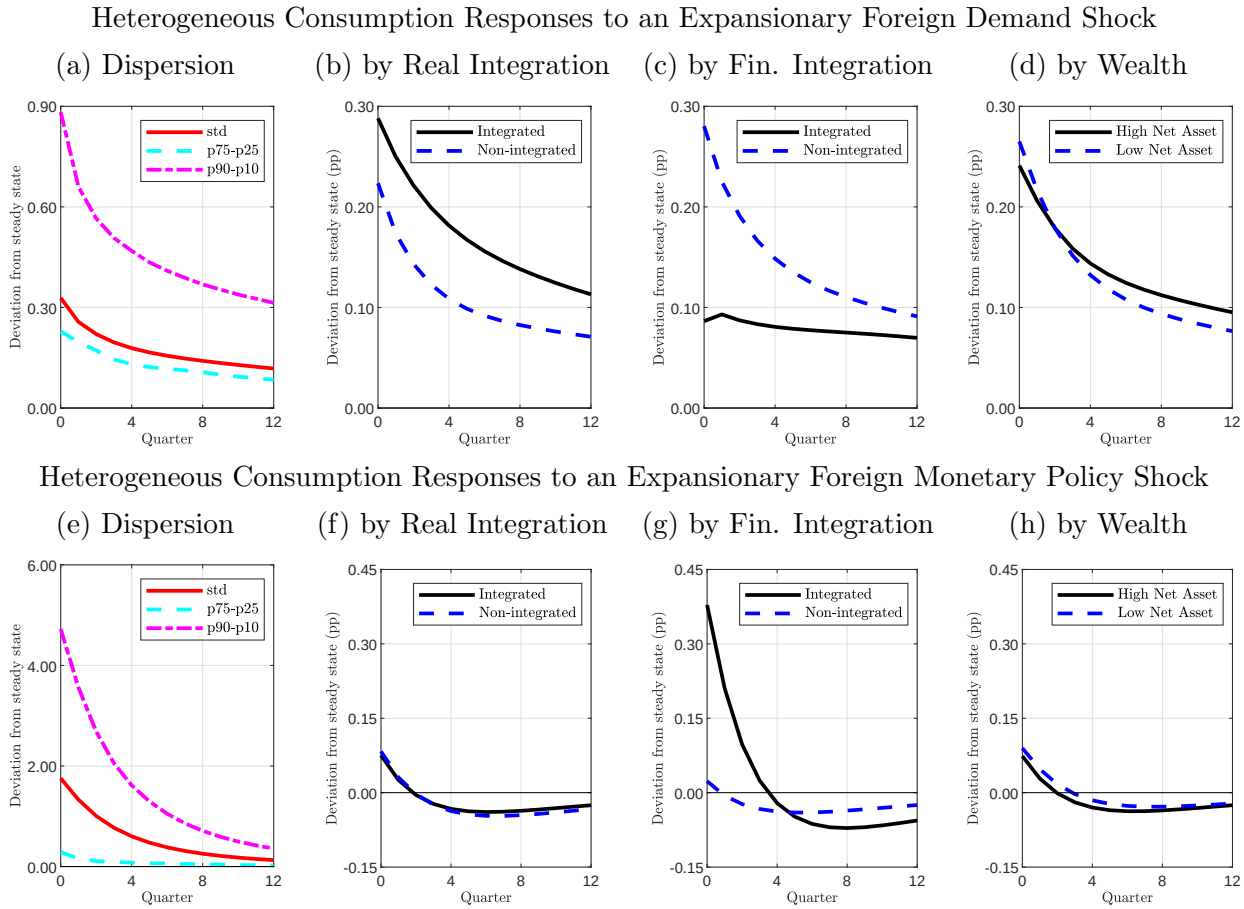


Notes: Panels (a)-(c) show the aggregate impulse responses to a 2% expansionary external demand shock (i.e., $\epsilon_t^{Y_F^*} = 0.02$). Panels (d)-(f) show the aggregate impulse responses to a 25 bp expansionary foreign monetary policy shock (i.e., an innovation to the foreign interest rate $\epsilon_t^{i^*} = -0.0025$). Panels (a) and (d) show the response of nominal and real interest rates, the inflation rate of the ideal price index, and the rate of nominal currency depreciation. Panels (b) and (e) show the response of aggregate consumption, exports, and trade balance to GDP ratio. Panels (c) and (f) show the output of the home tradable good and the nontradable good.

The decline in foreign interest rates increases the consumption of households integrated to international capital markets. Home tradable firms and nontradable firms respond to the increase in demand by increasing their output and prices. The increase in output leads to higher wages, which reinforces the increase in consumption. The increased prices of home tradable goods and nontradable leads to an expenditure switching of domestic households toward foreign tradable goods, which is associated with currency appreciation, pushing down inflation, and leading the monetary authority to cut its policy rate. Currency appreciation ends up leading to a decline in exports and to trade balance deficits, which are financed with the capital inflows generated by lower external interest rates.

The bottom panels in Figure 4 show that the foreign monetary policy shock has un-

Figure 4: Distributional Effects of External Shocks



Notes: Panels (a)-(c) of this figure show the heterogeneous responses of consumption to a 2% expansionary external demand shock (i.e., $\epsilon_t^{Y_F^*} = 0.02$). Panels (d)-(f) show the heterogeneous effects in response to a 25 bp expansionary foreign monetary policy shock (i.e., an innovation to the foreign interest rate $\epsilon_t^{i^*} = -0.0025$). Panels (a) and (e) show the standard deviation of consumption responses across households, and the difference between percentiles 75 and 25 and 90 and 10 of consumption responses, all scaled by the initial response of aggregate consumption. Panels (b) and (f) show the consumption responses of households employed in the home tradable sector (*integrated*) and those employed in the nontradable sector (*not integrated*). Panels (c) and (g) show the consumption responses of households that have access to international capital markets (*integrated*) and those that have access to domestically traded financial securities (*not integrated*). Panels (d) and (h) show the consumption responses of households with high and low levels of assets, defined as those with assets above and below the mean asset position in the economy.

even effects across different households. The main source of these heterogeneous responses comes from the differential response of households integrated to international capital markets and those not integrated to international capital markets: As shown in Panel (b), foreign monetary policy expansions lead to consumption increases for households integrated to in-

ternational capital market that are not accompanied by increases in consumption for households not integrated to international capital markets. Panels (a) and (c) show more modest differences coming from the other two sources of heterogeneity, namely, real international integration and wealth, which suggests that differences in international financial integration are the main source of inequality in consumption responses for periods of external capital flows driven by foreign monetary policy.

4.2. Exchange-rate regimes

The second classic question we address is how different exchange rate regimes compare. To answer this question, we compare the aggregate and distributional responses to external shocks under the flexible exchange-rate regime from the Taylor rule in our baseline model (described in Section 4.1) with those in an economy in which the monetary authority chooses domestic interest rates to set $\mathcal{E}_t = 1$ for all periods.

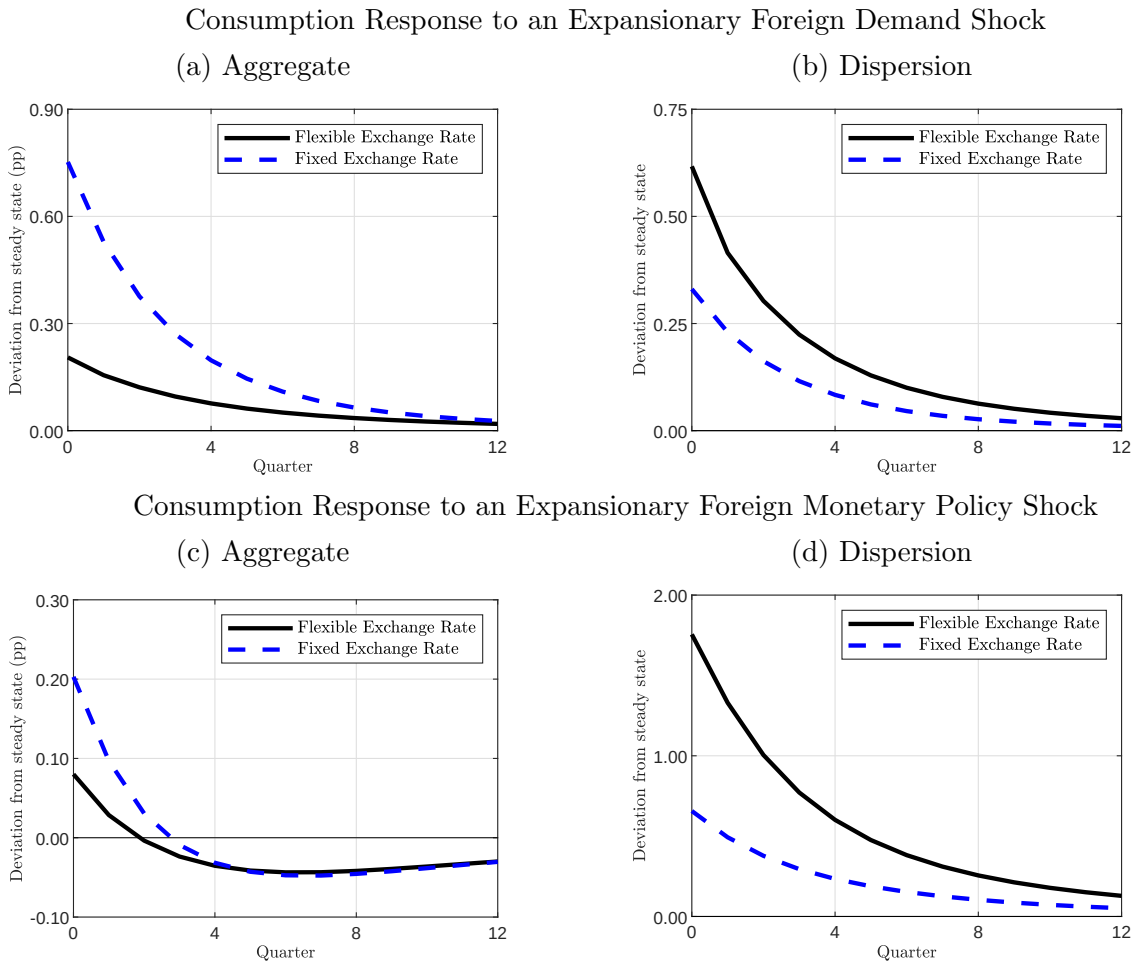
Panels (a) and (c) of Figure 5 show that, as standard in representative-agent open-economy New Keynesian models (e.g., Gali and Monacelli, 2005), aggregate consumption has a larger response to shocks under a fixed-exchange-rate regime that under a flexible regime. As further detailed in Appendix Figures A.4 and A.5, the reason for this is that when there is an expansion induced by either an external demand shock or a foreign monetary policy shock, under a fixed-exchange-rate regime the monetary authority decreases its interest rate more sharply to avoid currency appreciation, which creates additional expansions in domestic demand. As a result, for both increases in external demand or declines in foreign interest rates, the aggregate consumption response is larger under a fixed-exchange-rate regime than under a Taylor rule.[10]

Panels (b) and (d) of Figure 5 compare the distributional implications of the different exchange-rate regimes, as measured by the standard deviation of consumption responses. In both cases, fixed-exchange-rate regimes lead to a lower dispersion of consumption responses relative to the aggregate response. The reason for this result is that, as explained in the

[10]See Broda (2004) for empirical evidence on the larger output response to a terms of trade shock in countries with fixed-exchange-rate regimes vs. those with flexible-exchange-rate regimes.

previous section, in the economy with a flexible exchange rates, expansionary external shocks lead to currency appreciation; this means that to maintain a fixed exchange rate, the monetary authority in the economy with a fixed-exchange-rate regime has to lower its policy rates by more than under the floating regime (see Appendix Figures A.4 and A.5). The larger decline in interest rates, in turn, increases consumption for households not directly exposed to the shock, such as households working in the nontradable sector and households not integrated to international capital markets (see Appendix Figures A.6 and A.7 for detailed consumption responses for different groups under floating and fixed-exchange-rate regimes). From this, it follows that in choosing their exchange rate regime, monetary authorities might face a trade-off between aggregate stabilization and inequality in consumption responses.

Figure 5: Aggregate and Distributional Effects of External Shocks under Alternative Exchange-Rate Regimes



Notes: Panels (a)-(b) show the responses of consumption to a 2 % expansionary external demand shock (i.e., $\epsilon_t^{Y_F^*} = 0.02$), under different exchange-rate regimes. *Flexible exchange rate* corresponds to the baseline model (described in Section 2); *Fixed exchange rate* corresponds to the equilibrium under which the monetary policy sets the nominal rate to target $\epsilon_t = 1$ in all periods. Panels (c) and (d) show the response to a 25 bp expansionary foreign monetary policy shock (i.e., an innovation to the foreign interest rate $\epsilon_t^{i^*} = -0.0025$). Panels (a) and (b) show the response of aggregate consumption. Panels (b) and (d) show the standard deviation of consumption responses across households, scaled by the initial response of aggregate consumption.

4.3. The international price system

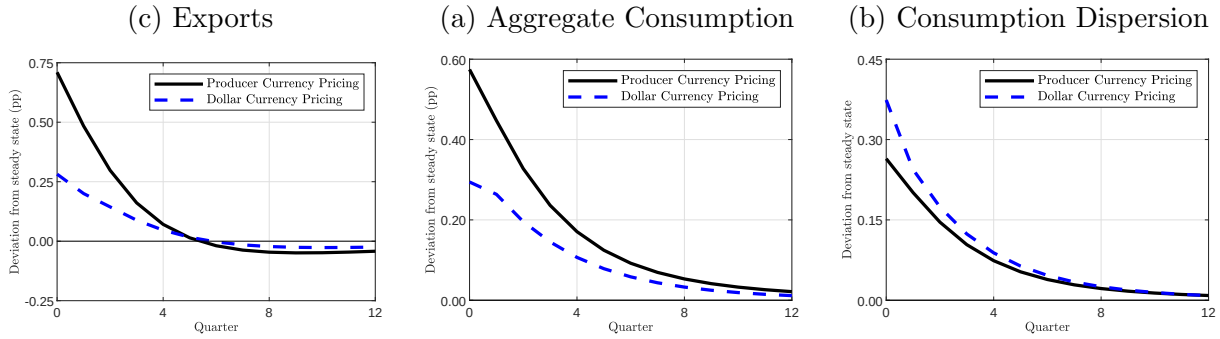
The third classic question we address concerns what are the implications of the international price system for monetary policy. To answer this question, we compare the aggregate and

distributional responses to external shocks under the Producer-currency pricing in our baseline model (described in Section 4.1) with those in an economy with Dollar-currency pricing, in which firms face a cost of adjusting the price in foreign currency.

Panel (a) of Figure 6 shows that, as standard in representative-agent open-economy New Keynesian models, Dollar-currency pricing reduces the ability of monetary policy to stimulate exports through the expenditure-switching channel. Panel (b) shows that this implies a smaller effect of monetary policy on aggregate consumption. This is because, as shown in Appendix Figure A.8, the smaller effect of exports translates into a more modest effect on the wage of workers in the tradable sector and indirect effects through income.

A corollary of the aggregate results in the open-economy HANK is that, as shown in Panel (c) of Figure 6, monetary policy shocks have larger effects on the inequality of consumption responses under Dollar-currency pricing than under Producer-currency pricing. This is because, as shown in Appendix Figures A.8 and A.9, under Dollar-currency pricing, monetary policy has a stronger effect on households employed in nontradable sectors than in households employed in tradable sectors. An implication of this result is that the international price system not only implies challenges for monetary authorities in stimulating the economy, but also additional challenges stemming from more uneven consumption responses to changes in monetary policy.

Figure 6: Aggregate and Distributional Effects to an Expansionary Domestic Monetary Policy Shock under Alternative Price Settings



Notes: This figure shows the aggregate distributional effects of a 25 bp expansionary monetary policy shock (i.e., an innovation to the Taylor rule $\epsilon_t^m = -0.0025$) under alternative price settings. *Producer currency pricing* corresponds to the baseline model (described in Section 2), in which firms face a cost of adjusting their price in local currency; *Dollar currency pricing* corresponds to a variant of the model in which firms face a cost of adjusting their price in foreign currency (described in Section 4.3). Panel (a) shows the response of exports, Panel (b) that of aggregate consumption, and Panel (c) the standard deviation of consumption responses across households, scaled by the initial response of aggregate consumption.

5. The Role of International Integration

So far, we have focused on how monetary policy affects the asymmetric effects of external shocks for a given degree of international integration. In this section, we study how our conclusions are affected by the degree of international integration that characterizes the economy. From a positive perspective, this exercise helps us understand how changes in the international integration that countries often experience is expected to affect the effects of shocks and the ability of monetary policy to influence these effects. From a normative perspective, this is an important input to the debate on the consequences of globalization that motivated this paper.

We study the role of international integration by analyzing how external shocks affect economies with different degrees of real and financial international integration. For real integration, we consider economies with different shares of households working in the home tradable goods sector vs. the nontradable sector and those in which households' consumption baskets are composed of home tradable goods vs. nontradable goods. For financial integra-

tion, we consider economies with different shares of households that have access to financial securities internationally traded.[11] These alternative economies aim to capture changes that occur, for instance, due to trade and financial liberalizations, in which some goods the economy produces switch from only being traded by domestic households to also face demand from the rest of the world, and in which households that only have access to domestically traded securities start having access to financial securities traded with the rest of the world.

Figure 7 shows the aggregate responses of consumption to shocks under alternative degrees of real and financial integration, and Figure 8 shows their distributional effects, measured by the dispersion of consumption responses. These exercises reveal two main takeaways. The first is that monetary policy is less effective in environments of high real and financial integration. In the case of high real integration, monetary policy loses its effects on nontradable sectors, which play an important role in monetary transmission (see panels (a) of Figure 7 and Appendix Figure A.10). In the case of high financial integration, monetary policy loses an important part of its direct channel in stimulating the consumption of households that borrow and save in domestic securities (see panels (b) of Figure 7 and Appendix Figure A.13). In fact, in economies in which most agents borrow and save in foreign securities, the effects of monetary policy on consumption are three times smaller than in our baseline economy.

The second takeaway is that although higher international integration increases the aggregate effect of external shocks, it can dampen the distributional consequences of these shocks. For aggregate effects, Panel (c) of Figure 7 indicates that changes in external demand have larger effects when the share of tradable sector is high; Panel (f) indicates that the effect of changes in foreign monetary policy are larger when the share of households integrated to international capital markets is large. For distributional effects, Panel (c) of Figure 8 shows that the distributional effects of changes in external demand are larger when real integration is low; and Panel (f) shows that the effects of changes in foreign monetary policy are larger when financial integration is low. This is because as shown in Appendix Figures A.11,

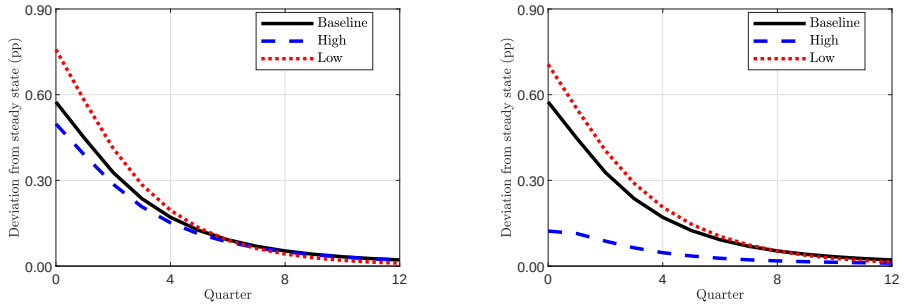
[11] In each scenario, we calibrate the level of government debt to keep the average level of households' wealth at the same level as in the baseline calibration.

A.12, A.14, and A.15, in economies with low international integration, a large share of the aggregate effects of external shocks are borne by a small set of households.

Figure 7: Aggregate Consumption Response to Shocks under Alternative Degrees of International Integration

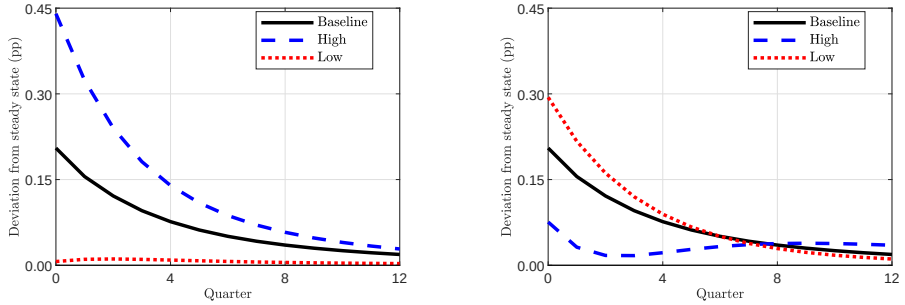
Expansionary Domestic Monetary Policy Shock

(a) by Degree of Real Integration (b) by Degree of Financial Integration



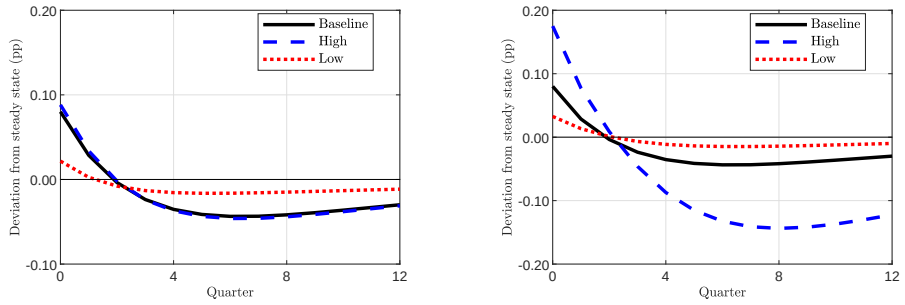
Expansionary Foreign Demand Shock

(c) by Degree of Real Integration (d) by Degree of Financial Integration



Expansionary Foreign Monetary Policy Shock

(e) by Degree of Real Integration (f) by Degree of Financial Integration

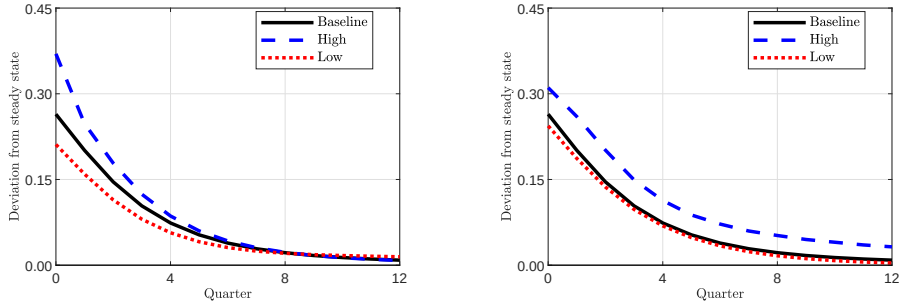


Note: Panels (a) and (b) show aggregate consumption responses to a 25 bp expansionary monetary policy shock ($\epsilon_t^m = -0.0025$); Panels (c) and (d) responses to a 2% expansionary external demand shock ($\epsilon_t^{Y_F^*} = 0.02$); and Panels (e) and (f) the responses to a 25 bp expansionary foreign monetary policy shock ($\epsilon_t^{i^*} = -0.0025$). In all panels, *Baseline* corresponds to the calibrated economy studied in Sections 3 and 4. In Panels (a), (c), and (e), *High* (*Low*) corresponds to responses in economies calibrated with 95% (5%) of households working in home tradable goods sector and 95% (5%) of households' consumption basket is made up of home tradable goods. In Panels (b), (d), and (f), *High* (*Low*) corresponds to responses in economies calibrated with 95% (5%) of households with access to international financial markets.

Figure 8: Dispersion of Consumption in Response to Shocks under Alternative Degrees of International Integration

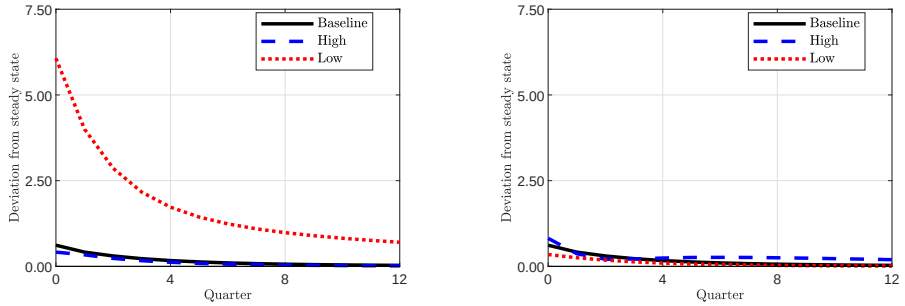
Expansionary Domestic Monetary Policy Shock

(a) by Degree of Real Integration (b) by Degree of Financial Integration



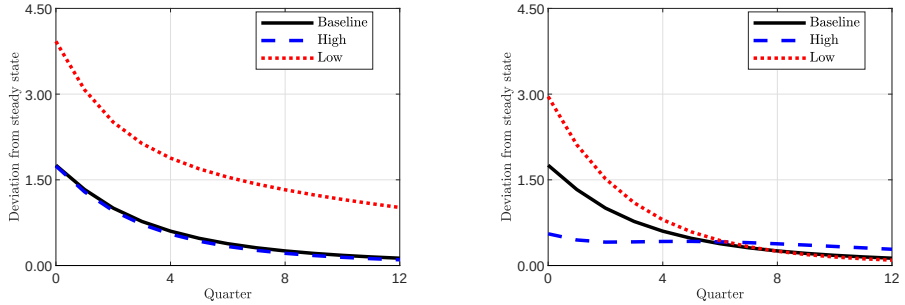
Expansionary Foreign Demand Shock

(c) by Degree of Real Integration (d) by Degree of Financial Integration



Expansionary Foreign Monetary Policy Shock

(e) by Degree of Real Integration (f) by Degree of Financial Integration



Note: Panels (a) and (b) show the the standard deviation of consumption responses across households, scaled by the initial response of aggregate consumption, to a 25 bp expansionary monetary policy shock ($\epsilon_t^m = -0.0025$); Panels (c) and (d) responses to a 2 percent expansionary external demand shock ($\epsilon_t^{Y_F^*} = 0.02$); and Panels (e) and (f) the responses to a 25 bp expansionary foreign monetary policy shock ($\epsilon_t^{i^*} = -0.0025$). In all panels, *Baseline* correspondS to the calibrated economy studied in Sections 3 and 4. In Panels (a), (c), and (e), *High* (*Low*) correspondS to responses in economies calibrated with 95% (5%) of households working in home tradable goods sector and 95% (5%) of households' consumption basket is made up of home tradable goods. In Panels (b), (d), and (f), *High* (*Low*) corresponds to responses in economies calibrated with 95% (5%) of households with access to international financial markets.

6. Conclusion

Motivated by the asymmetric effects of globalization documented over the last three decades, we study how monetary policy shapes the effects of external shocks in open economies. External shocks have larger effects on households employed in tradable sectors or that have access to international capital markets. In confronting these shocks, monetary authorities might face a trade-off between maintaining aggregate stability and reducing income and consumption inequalities. Fixed-exchange-rate regimes, which typically amplify the aggregate effects of an external shock, can reduce the consumption inequalities that stem from external shocks. Our paper also shows that although lower international integration dampens the aggregate exposure to external shocks, it also increases the distributional impacts of these shocks. From this, we conclude that the discontents of globalization might arise, perhaps paradoxically, from international integration's not being sufficiently generalized. Overall, our results indicate that redistribution constitutes a relevant consideration for monetary policy in open economies. This suggests that an important area for future research is the interaction between monetary and fiscal policies with households' heterogeneity in open economies.

References

Aguiar, M. and Bils, M. (2015). Has consumption inequality mirrored income inequality? *American Economic Review*, **105** (9), 2725–56.

Attanasio, O., Battistin, E. and Ichimura, H. (2004). *What really happened to consumption inequality in the US?* Tech. rep., National Bureau of Economic Research.

Auclert, A. (2019). Monetary policy and the redistribution channel. *American Economic Review*, **109** (6), 2333–67.

—, Rognlie, M., Souchier, M. and Straub, L. (2020). Monetary policy and exchange rates with heterogeneous agents: Resurrecting the real income channel.

—, — and Straub, L. (2018). *The intertemporal keynesian cross*. Tech. rep., National Bureau of Economic Research.

Autor, D. H., Dorn, D. and Hanson, G. H. (2016). The China shock: Learning from labor-market adjustment to large changes in trade. *Annual Review of Economics*, **8**, 205–240.

Blanco, A., Drenik, A. and Zaratiegui, E. (2020). Devaluations, inflation, and labor income dynamics.

Bowlus, A., Gouin-Bonenfant, E., Liu, H., Lochner, L. and Park, Y. (2020). *Four Decades of Canadian Earnings Dynamics Across Workers and Firms*. Tech. rep.

Broda, C. (2004). Terms of trade and exchange rate regimes in developing countries. *Journal of International economics*, **63** (1), 31–58.

Burstein, A. and Gopinath, G. (2014). International prices and exchange rates. In *Handbook of international economics*, vol. 4, Elsevier, pp. 391–451.

Champagne, J. and Sekkel, R. (2018). Changes in monetary regimes and the identification of monetary policy shocks: Narrative evidence from Canada. *Journal of Monetary Economics*, **99**, 72 – 87.

Clarida, R., Gali, J. and Gertler, M. (2001). Optimal monetary policy in open versus closed economies: an integrated approach. *American Economic Review*, **91** (2), 248–252.

Corsetti, G., Crowley, M., Han, L. and Song, H. (2019). Markets and markup: A new empirical framework and evidence on exporters from china.

—, Dedola, L. and Leduc, S. (2010). Optimal monetary policy in open economies. In *Handbook of monetary economics*, vol. 3, Elsevier, pp. 861–933.

Cravino, J. and Levchenko, A. A. (2017). The distributional consequences of large devaluations. *American Economic Review*, **107** (11), 3477–3509.

Cugat, G. (2019). Emerging markets, household heterogeneity, and exchange rate policy.

De Ferra, S., Mitman, K. and Romei, F. (2020). Household heterogeneity and the transmission of foreign shocks. *Journal of International Economics*, p. 103303.

Devereux, M. B. and Engel, C. (2003). Monetary policy in the open economy revisited: Price setting and exchange-rate flexibility. *The Review of Economic Studies*, **70** (4), 765–783.

Doepke, M. and Schneider, M. (2006). Inflation and the redistribution of nominal wealth. *Journal of Political Economy*, **114** (6), 1069–1097.

Drenik, A., Pereira, G. and Perez, D. J. (2018). Wealth redistribution after exchange rate devaluations. In *AEA Papers and Proceedings*, vol. 108, pp. 552–56.

Egorov, K. and Mukhin, D. (2020). *Optimal Policy Under Dollar Pricing*. Tech. rep.

Engel, C. (2006). Equivalence results for optimal pass-through, optimal indexing to exchange

rates, and optimal choice of currency for export pricing. *Journal of the European Economic Association*, **4** (6), 1249–1260.

Fleming, J. M. (1962). Domestic financial policies under fixed and under floating exchange rates. *Staff Papers*, **9** (3), 369–380.

Forbes, K. J. and Rigobon, R. (2002). No contagion, only interdependence: measuring stock market comovements. *The journal of Finance*, **57** (5), 2223–2261.

Gabaix, X. and Maggiori, M. (2015). International liquidity and exchange rate dynamics. *The Quarterly Journal of Economics*, **130** (3), 1369–1420.

Gali, J. and Monacelli, T. (2005). Monetary policy and exchange rate volatility in a small open economy. *The Review of Economic Studies*, **72** (3), 707–734.

Giovanni, J. d., Kalemli-Ozcan, S., Ulu, M. F. and Baskaya, Y. S. (2017). *International spillovers and local credit cycles*. Tech. rep., National Bureau of Economic Research.

Goldberg, L. S. and Tille, C. (2008). Vehicle currency use in international trade. *Journal of international Economics*, **76** (2), 177–192.

Goldberg, P. K. and Pavcnik, N. (2007). Distributional effects of globalization in developing countries. *Journal of economic Literature*, **45** (1), 39–82.

Gopinath, G. (2015). *The international price system*. Tech. rep., National Bureau of Economic Research.

—, Boz, E., Casas, C., Díez, F. J., Gourinchas, P.-O. and Plagborg-Møller, M. (2020). Dominant currency paradigm. *American Economic Review*, **110** (3), 677–719.

—, Itskhoki, O. and Rigobon, R. (2010). Currency choice and exchange rate pass-through. *American Economic Review*, **100** (1), 304–36.

— and Neiman, B. (2014). Trade adjustment and productivity in large crises. *American Economic Review*, **104** (3), 793–831.

Gourinchas, P.-O. (2018). Monetary policy transmission in emerging markets: an application to chile. *Series on Central Banking Analysis and Economic Policies no. 25*.

— and Rey, H. (2007). International financial adjustment. *Journal of political economy*, **115** (4), 665–703.

Guntin, R., Ottonello, P. and Perez, D. (2020). *The Micro Anatomy of Macro Consumption Adjustments*. Tech. rep., National Bureau of Economic Research.

Kaplan, G., Moll, B. and Violante, G. L. (2018). Monetary policy according to hank. *American Economic Review*, **108** (3), 697–743.

— and Violante, G. L. (2018). Microeconomic heterogeneity and macroeconomic shocks. *Journal of Economic Perspectives*, **32** (3), 167–94.

Krueger, D. and Perri, F. (2006). Does income inequality lead to consumption inequality? evidence and theory. *The Review of Economic Studies*, **73** (1), 163–193.

Mendoza, E. G. (1995). The terms of trade, the real exchange rate, and economic fluctuations. *International Economic Review*, pp. 101–137.

Mukhin, D. (2018). *An Equilibrium Model of the International Price System*. Tech. rep., Society for Economic Dynamics.

Mundell, R. A. (1963). Capital mobility and stabilization policy under fixed and flexible exchange rates. *The Canadian Journal of Economics and Political Science/Revue canadienne d'Economique et de Science politique*, **29** (4), 475–485.

Obstfeld, M. and Rogoff, K. (2000). New directions for stochastic open economy models.

Journal of international economics, **50** (1), 117–153.

Quadrini, V. and Ríos-Rull, J.-V. (2015). Inequality in macroeconomics. In *Handbook of Income Distribution*, vol. 2, Elsevier, pp. 1229–1302.

Reiter, M. (2009). Solving heterogeneous-agent models by projection and perturbation. *Journal of Economic Dynamics and Control*, **33** (3), 649–665.

Rey, H. (2015). *Dilemma not trilemma: the global financial cycle and monetary policy independence*. Tech. rep., National Bureau of Economic Research.

Rotemberg, J. J. (1982). Sticky prices in the united states. *Journal of Political Economy*, **90** (6), 1187–1211.

Rouwenhorst, K. G. (1995). *Asset Pricing Implications of Equilibrium Business Cycle Models*, Princeton University Press, pp. 294–330.

Schmitt-Grohé, S. and Uribe, M. (2011). *Pegs and pain*. Tech. rep., National Bureau of Economic Research.

— and Uribe, M. (2018). How important are terms-of-trade shocks? *International Economic Review*, **59** (1), 85–111.

Stiglitz, J. E. (2002). *Globalization and its Discontents*, vol. 500. New York Norton.

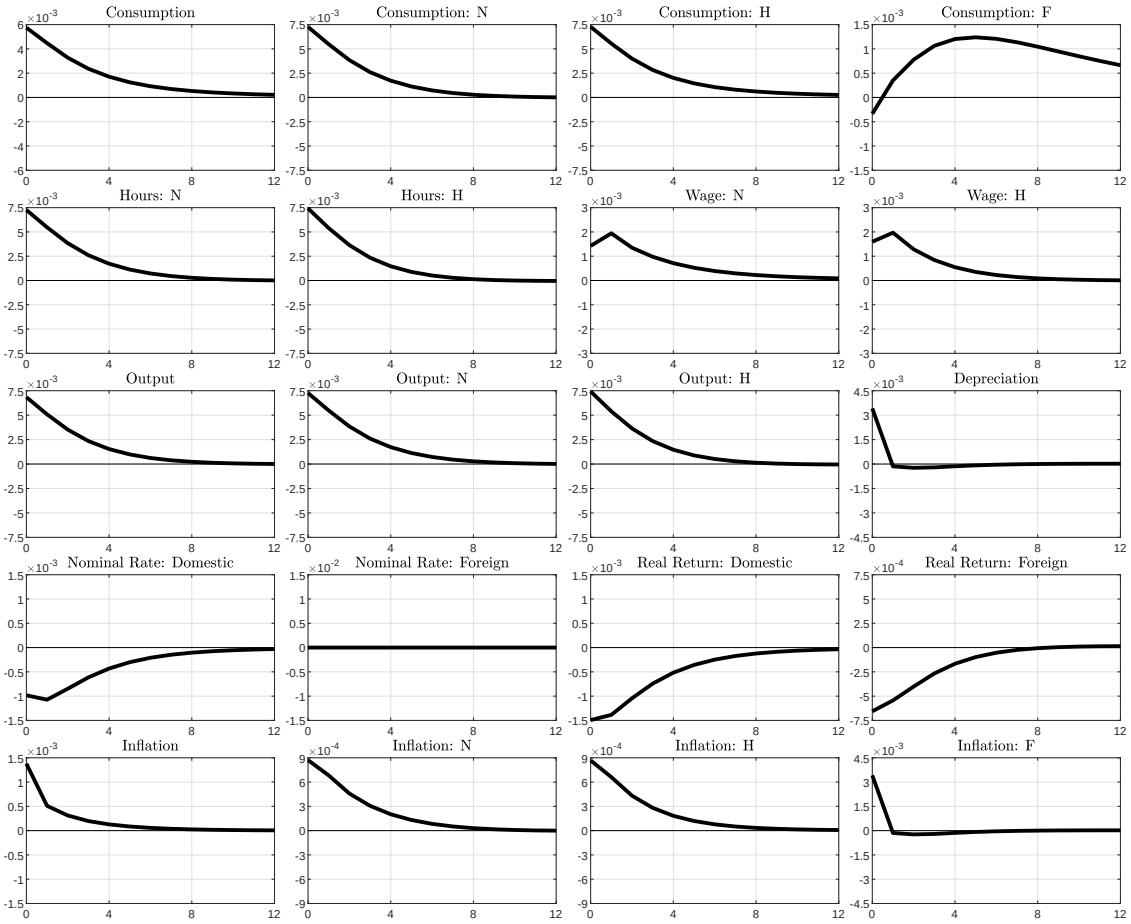
— (2017). *Globalization and its discontents revisited*. WW Norton & Company, Inc.: New York, NY, USA.

Zhou, H. (2020). *Open economy, redistribution, and the aggregate impact of external shocks*. Tech. rep.

A. Appendix: Additional Results

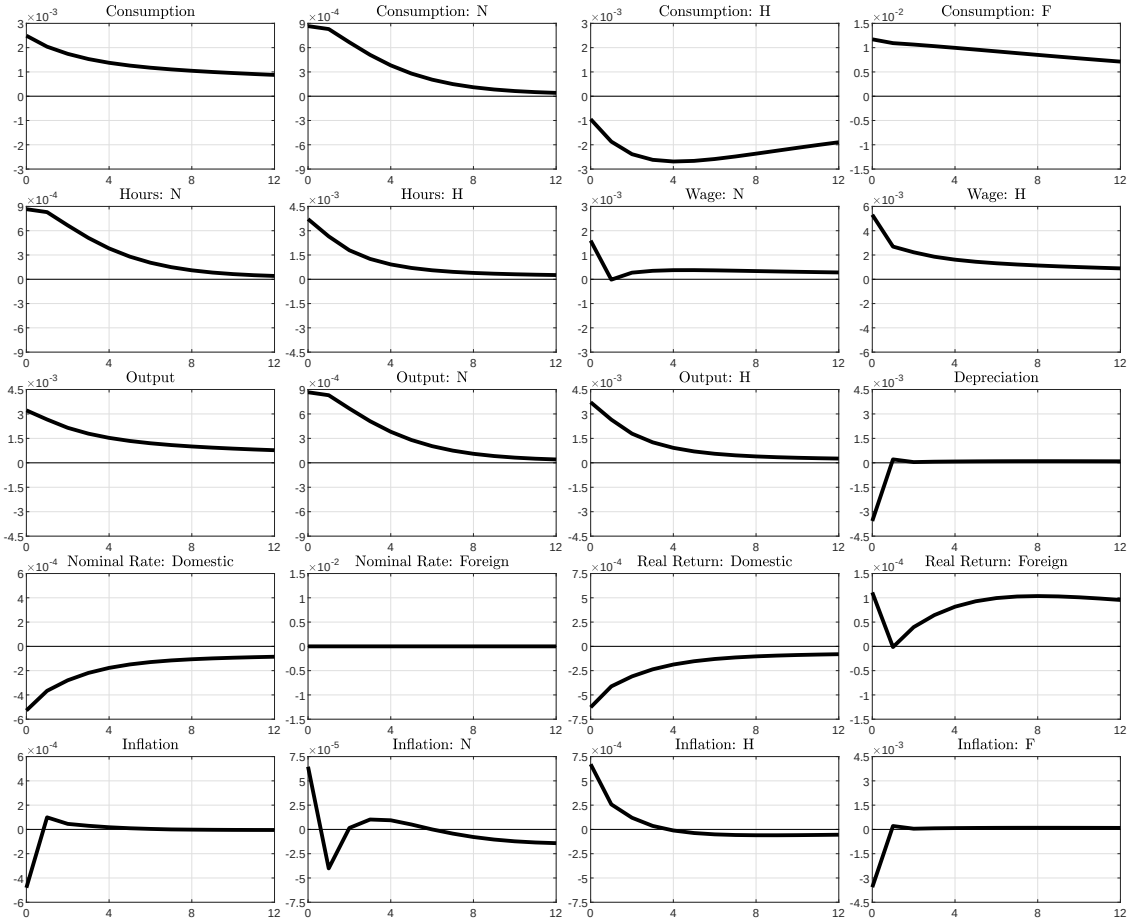
A.1. Aggregate Responses to Shocks: Additional Details

Figure A.1: Aggregate Effects of Monetary Policy Shocks



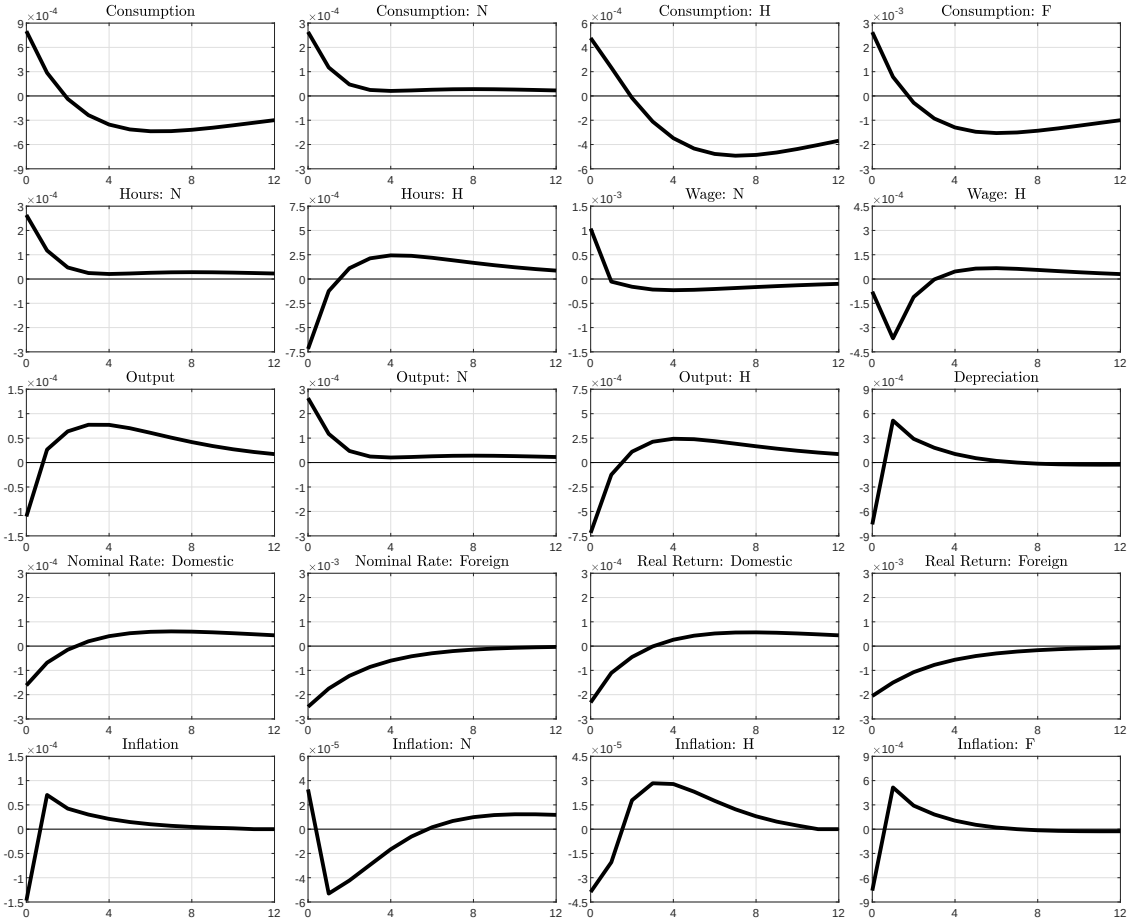
Note: This figure shows impulse responses to a 25 bp expansionary monetary policy shock (i.e., an innovation to the Taylor rule $\epsilon_t^m = -0.0025$).

Figure A.2: Aggregate Effects of Foreign Demand Shock



Note: This figure shows impulse responses to a 2% expansionary external demand shock (i.e., $\epsilon_t^{Y_F^*} = 0.02$).

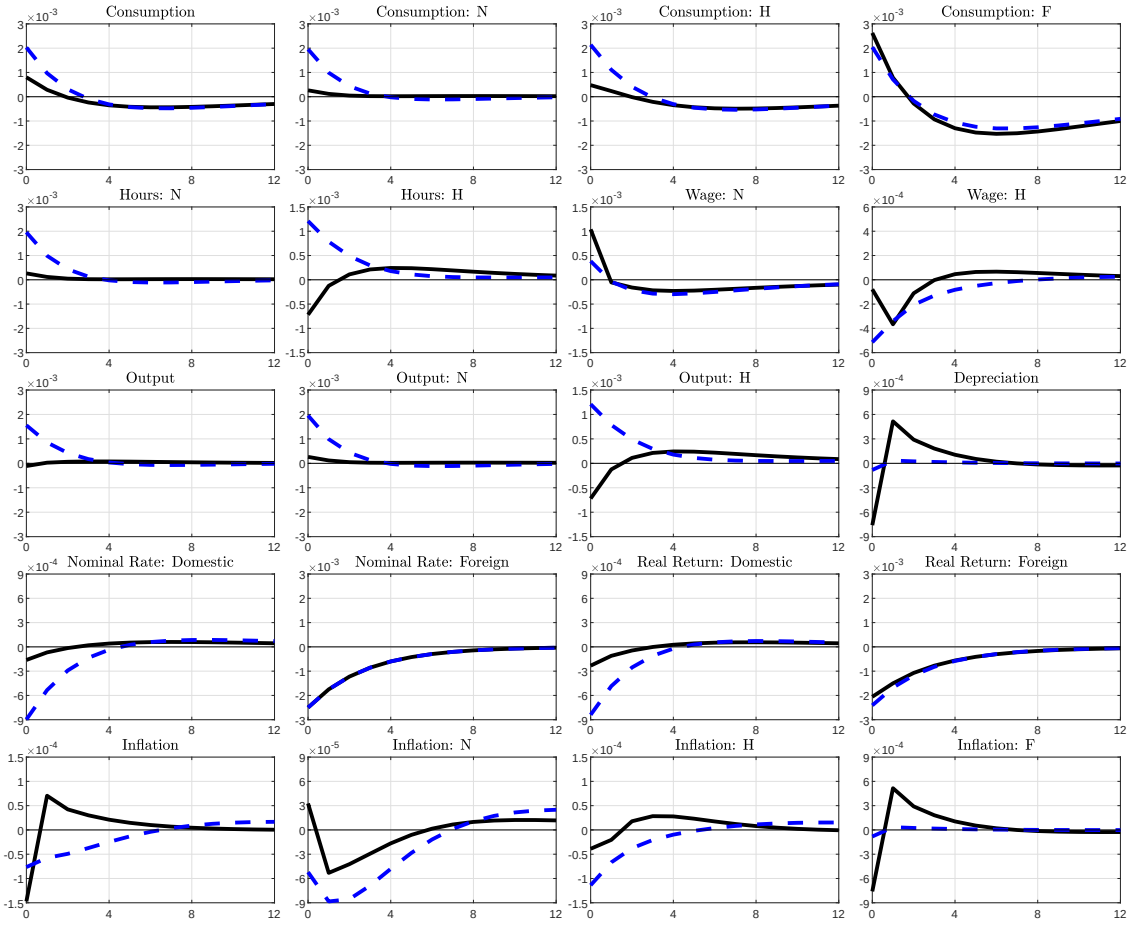
Figure A.3: Aggregate Effects of Foreign Monetary Policy Shocks



Note: This figure shows impulse responses to a 25 bp expansionary foreign monetary policy shock (i.e., an innovation to the foreign interest rate $\epsilon_t^{i^*} = -0.0025$).

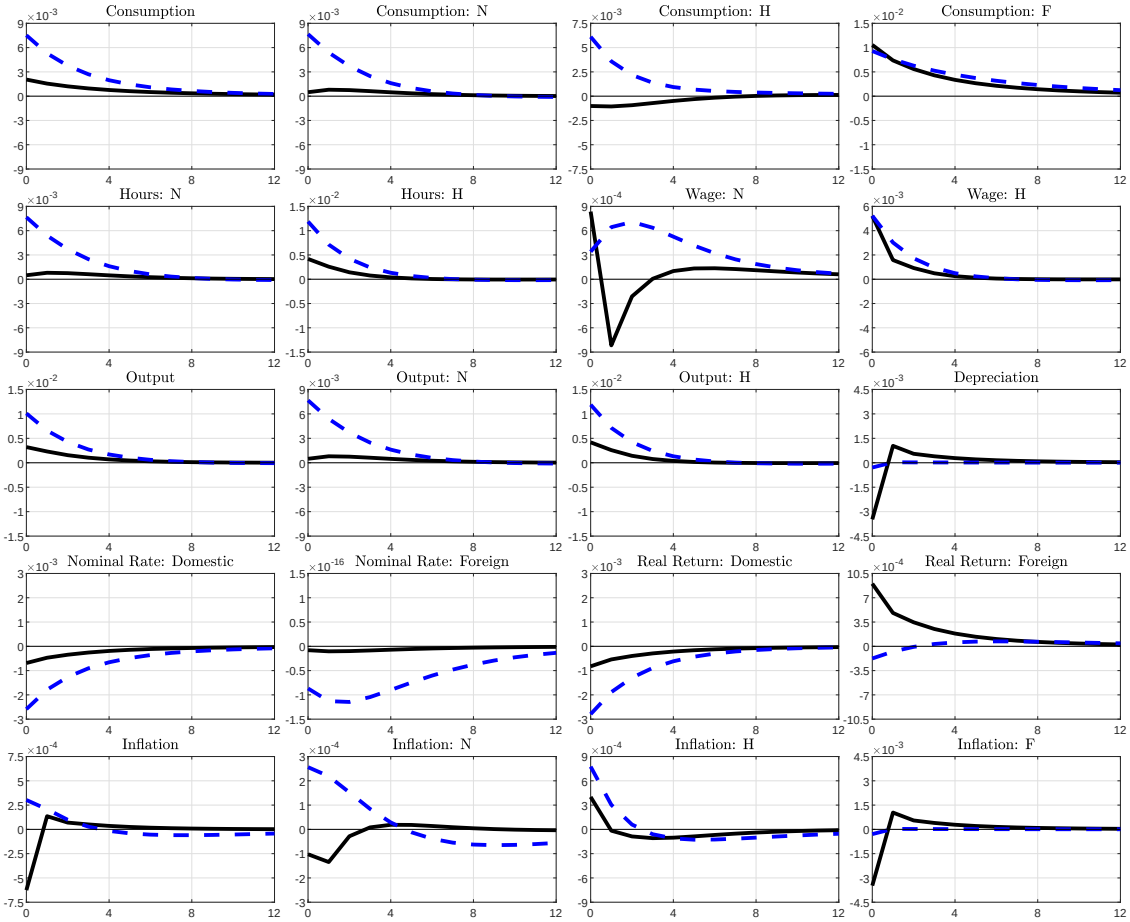
A.2. Aggregate and Distributional Responses under Alternative Exchange-rate Regimes

Figure A.4: Aggregate Effects of Foreign Demand Shock under Alternative Exchange-rate Regimes



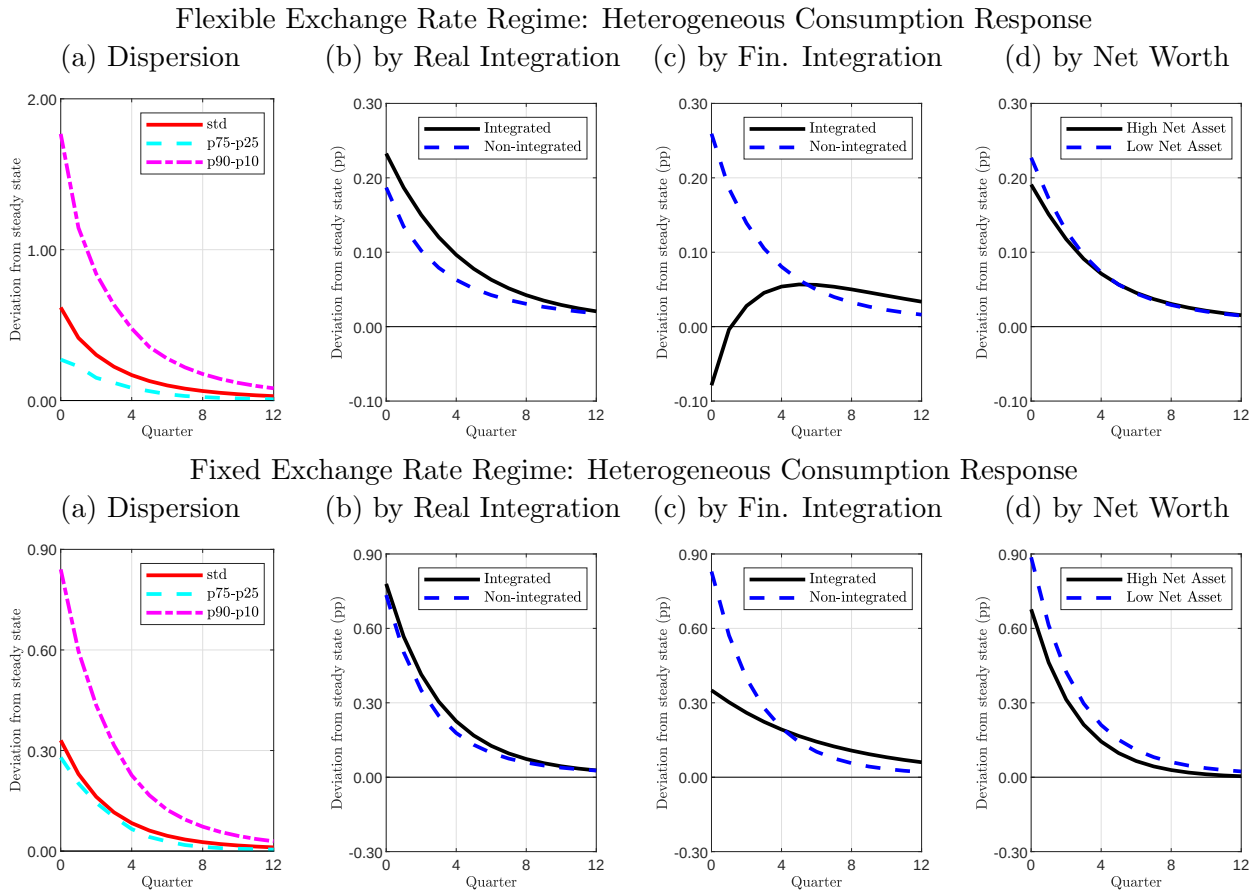
Note: This figure shows impulse responses to a 2% expansionary external demand shock (i.e., $\epsilon_t^{Y_F^*} = 0.02$), under different exchange-rate regimes. *Flexible exchange rate*, represented by the solid black line, corresponds to the baseline model (described in Section 2); *Fixed exchange rate*, represented by the dotted blue line, corresponds to the equilibrium under which the monetary policy sets the nominal rate to target $\epsilon_t = 1$ in all periods.

Figure A.5: Aggregate Effects of Foreign Monetary Policy Shocks under Alternative Exchange-rate Regimes



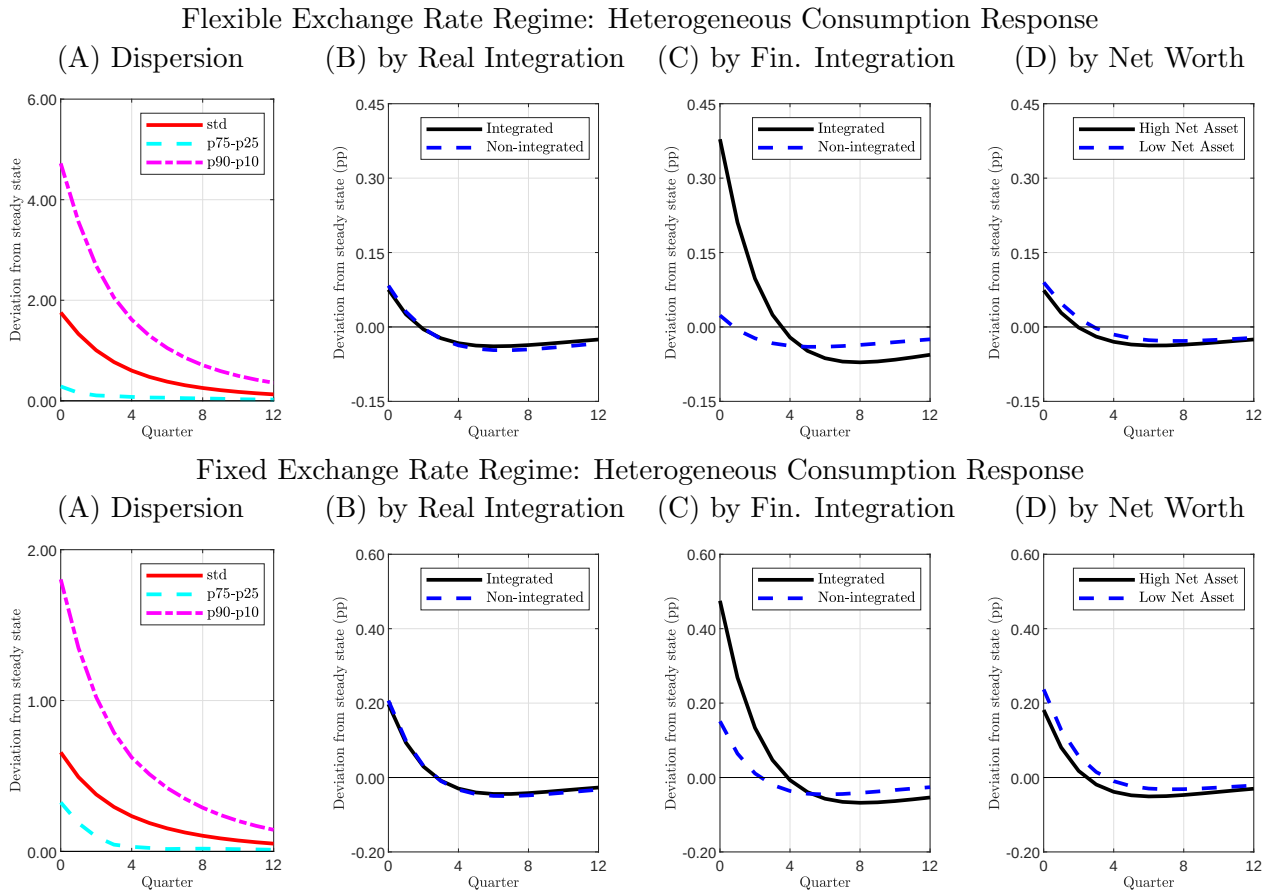
Note: This figure shows impulse responses to a 25 bp expansionary foreign monetary policy shock (i.e., an innovation to the foreign interest rate $\epsilon_t^{i^*} = -0.0025$) under different exchange rate regimes. *Flexible exchange rate*, represented by the solid black line, corresponds to the baseline model (described in Section 2); *Fixed exchange rate*, represented by the dotted blue line, corresponds to the equilibrium under which the monetary policy sets the nominal rate to target $\epsilon_t = 1$ in all periods.

Figure A.6: Distributional Effects of Foreign Demand Shocks under Alternative Exchange Rate Regimes



Notes: This figure shows the distributional effects of a 1 percent expansionary external demand shock ($\epsilon_t^{Y_F^*} = 0.01$). The Panel (a) shows the standard deviation of consumption responses across households and the difference between percentiles 75 and 25 and 90 and 10 of consumption responses, all scaled by the initial response of aggregate consumption. The Panel (b) shows the consumption responses of households employed in the home tradable sector (*integrated*) and those employed in the nontradable sector (*not integrated*). Panel (c) shows the consumption responses of households that have access to international capital markets (*integrated*) and those that have access to domestically traded financial securities (*not integrated*). The Panel (d) shows consumption responses of households with high and low levels of assets, defined as those with assets above and below the mean asset position in the economy. *Flexible exchange rate regime* corresponds to the baseline model (described in Section 2); *Fixed exchange rate regime* corresponds to the equilibrium under which the monetary policy sets the nominal rate to target $\epsilon_t = 1$ in all periods.

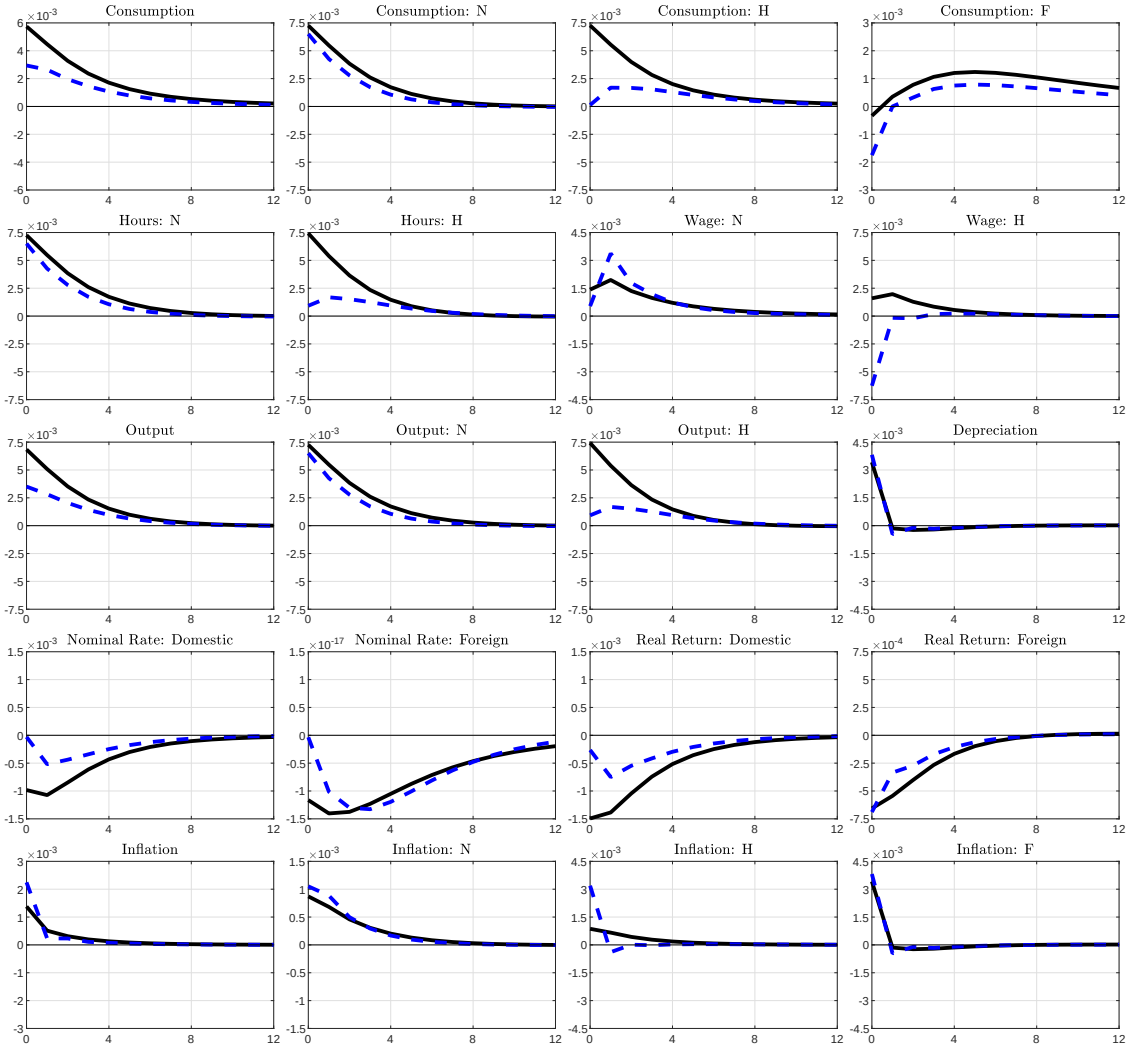
Figure A.7: Distributional Effects of Foreign Monetary Policy Shocks under Alternative Exchange Rate Regimes



Notes: This figure shows the distributional effects of a 25bp expansionary foreign monetary policy shock ($\epsilon_t^{i^*} = -0.0025$). The Panel (a) shows the standard deviation of consumption responses across households and the difference between percentiles 75 and 25 and 90 and 10 of consumption responses, all scaled by the initial response of aggregate consumption. The Panel (b) shows the consumption responses of households employed in the home tradable sector (*integrated*) and those employed in the nontradable sector (*not integrated*). Panel (c) shows the consumption responses of households that have access to international capital markets (*integrated*) and those that have access to domestically traded financial securities (*not integrated*). The Panel (d) shows consumption responses of households with high and low levels of assets, defined as those with assets above and below the mean asset position in the economy. *Flexible exchange rate regime* corresponds to the baseline model (described in Section 2); *Fixed exchange rate regime* corresponds to the equilibrium under which the monetary policy sets the nominal rate to target $\epsilon_t = 1$ in all periods.

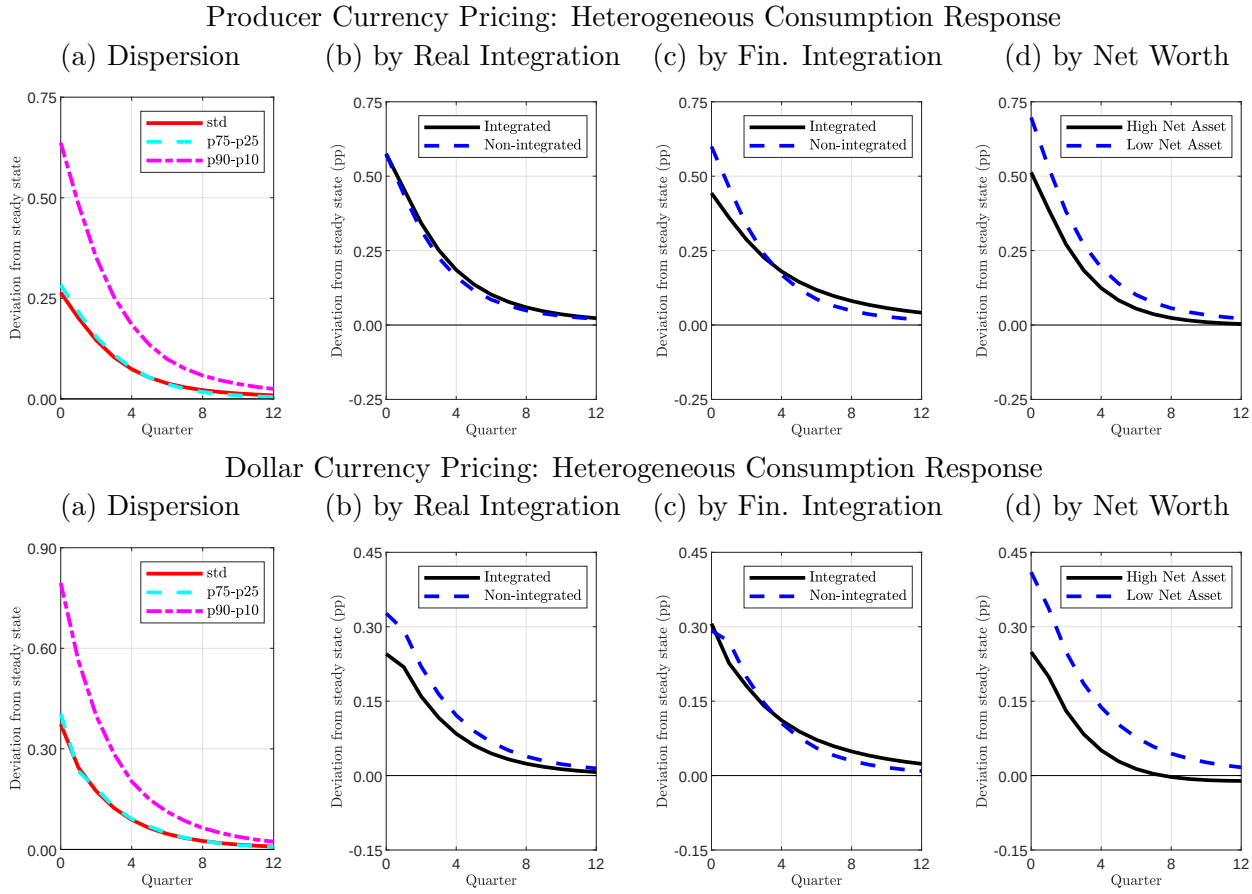
A.3. Aggregate and Distributional Responses to Monetary Policy Shocks under Alternative Price Settings

Figure A.8: Aggregate Effects of Monetary Policy Shocks under Alternative Price Settings



Note: This figure shows impulse responses to a 25 bp expansionary monetary policy shock (i.e., an innovation to the Taylor rule $\epsilon_t^m = -0.0025$) under alternative price settings. *Producer currency pricing*, represented by the solid black line, corresponds to the baseline model (described in Section 2), in which firms face a cost of adjusting their price in local currency; *Dollar currency pricing*, represented by the dotted blue line, corresponds to a variant of the model in which firms face a cost of adjusting their price in foreign currency (described in Section 4.3).

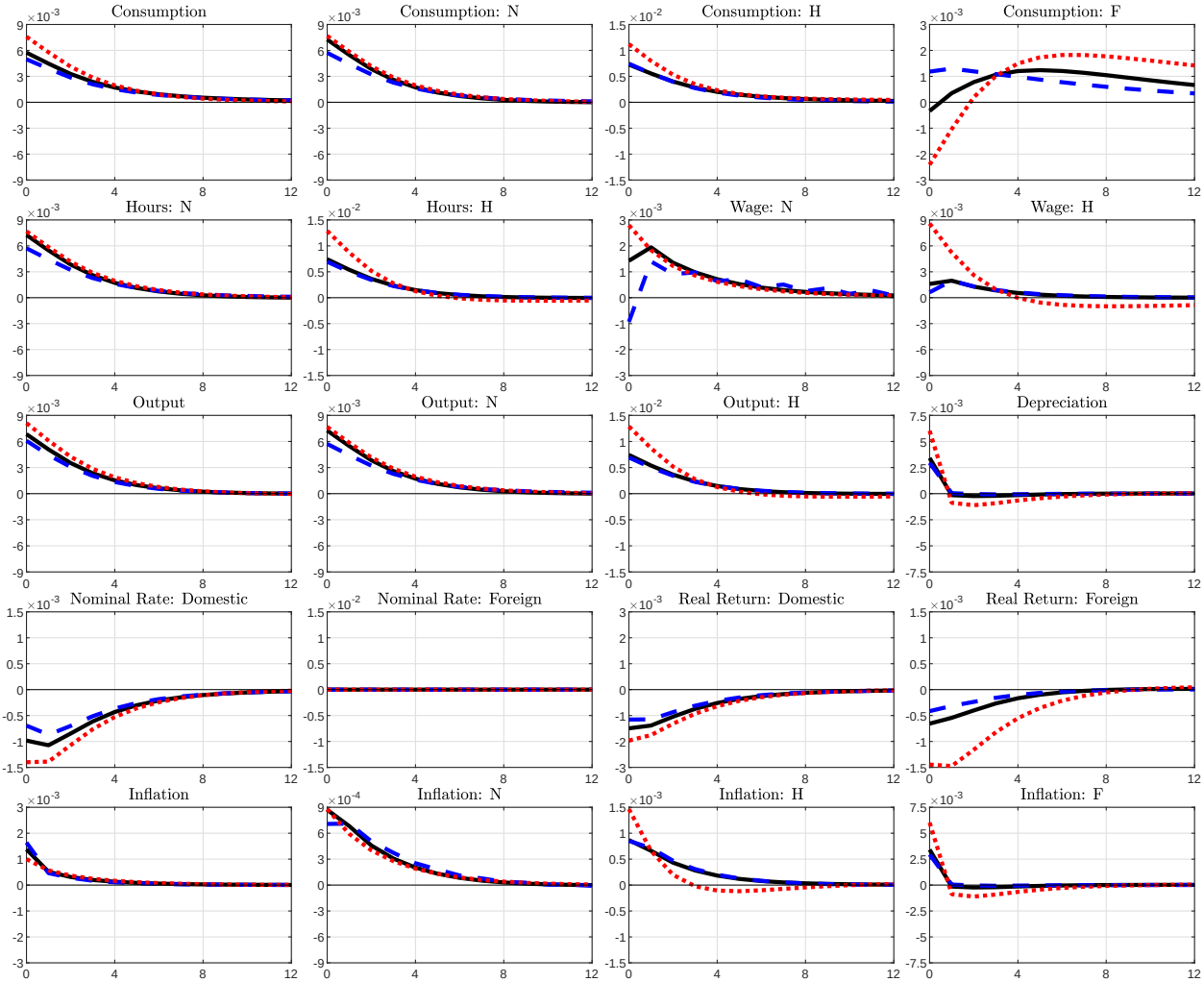
Figure A.9: Distributional Effects of Domestic Monetary Policy Shocks under Alternative Price Systems



Notes: This figure shows the distributional effects of a 25 bp expansionary monetary policy shock (i.e., an innovation to the Taylor rule $\epsilon_t^m = -0.0025$). The Panel (a) shows the standard deviation of consumption responses across households and the difference between percentiles 75 and 25 and 90 and 10 of consumption responses, all scaled by the initial response of aggregate consumption. The Panel (b) shows the consumption responses of households employed in the home tradable sector (*integrated*) and those employed in the nontradable sector (*not integrated*). Panel (c) shows the consumption responses of households that have access to international capital markets (*integrated*) and those that have access to domestically traded financial securities (*not integrated*). The Panel (d) shows consumption responses of households with high and low levels of assets, defined as those with assets above and below the mean asset position in the economy. *Producer currency pricing* corresponds to the baseline model (described in Section 2), in which firms face a cost of adjusting their price in local currency; *Dollar currency pricing* corresponds to a variant of the model in which firms face a cost of adjusting their price in foreign currency (described in Section 4.3).

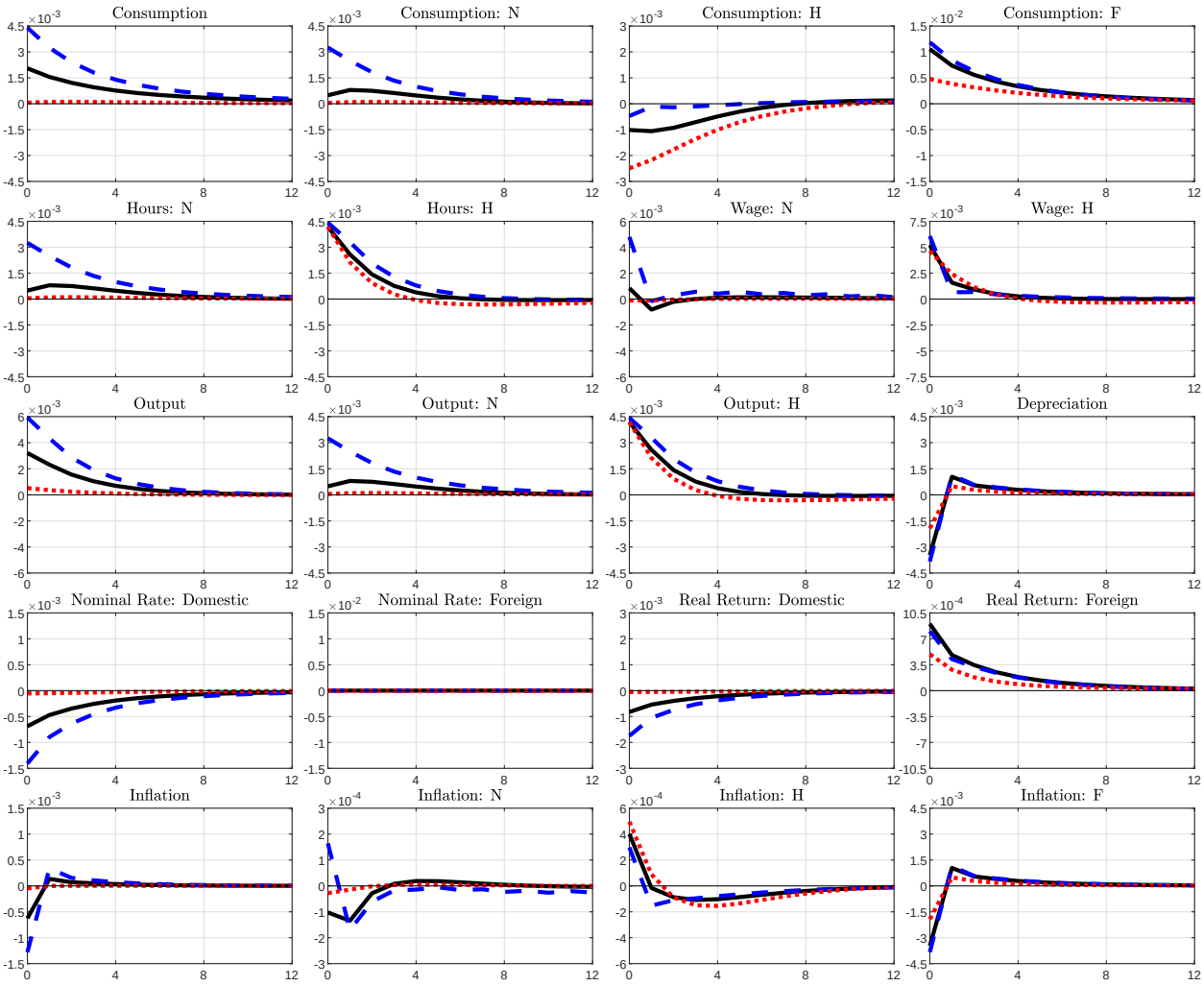
A.4. Aggregate Responses under Alternative Degrees of Real Integration

Figure A.10: Aggregate Effects of Monetary Policy Shocks with Different Degrees of Real Integration



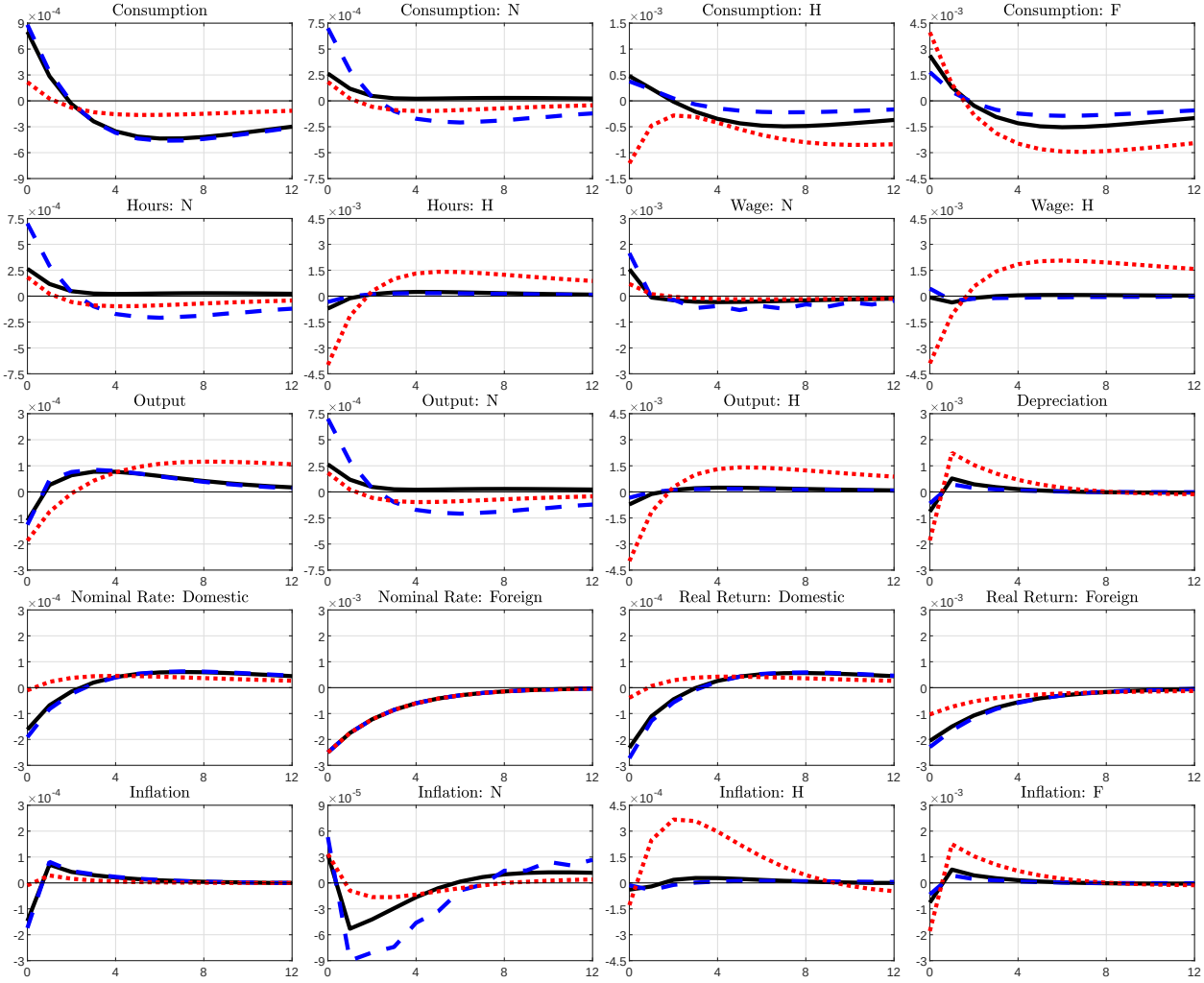
Notes: This figure shows impulse responses to a 25 bp expansionary monetary policy shock ($\epsilon_t^m = -0.0025$). *Baseline*, represented with the solid black line, corresponds to the calibrated economy studied in Sections 3 and 4. *High*, represented with the dashed blue line, corresponds to responses in economies calibrated with 95% of households working in home tradable goods sector and 95% of households' consumption basket is made up of home tradable goods. *Low*, represented with the dotted red line, corresponds to responses in economies calibrated with 5% of households working in home tradable goods sector and 5% of households' consumption basket is made up of home tradable goods.

Figure A.11: Aggregate Effects of Foreign Demand Shock with Different Degrees of Real Integration



Notes: This figure shows impulse responses to a 1 percent expansionary external demand shock ($\epsilon_t^{Y_F^*} = 0.01$). *Baseline*, represented with the solid black line, corresponds to the calibrated economy studied in Sections 3 and 4. *High*, represented with the dashed blue line, corresponds to responses in economies calibrated with 95% of households working in home tradable goods sector and 95% of households' consumption basket is made up of home tradable goods. *Low*, represented with the dotted red line, corresponds to responses in economies calibrated with 5% of households working in home tradable goods sector and 5% of households' consumption basket is made up of home tradable goods.

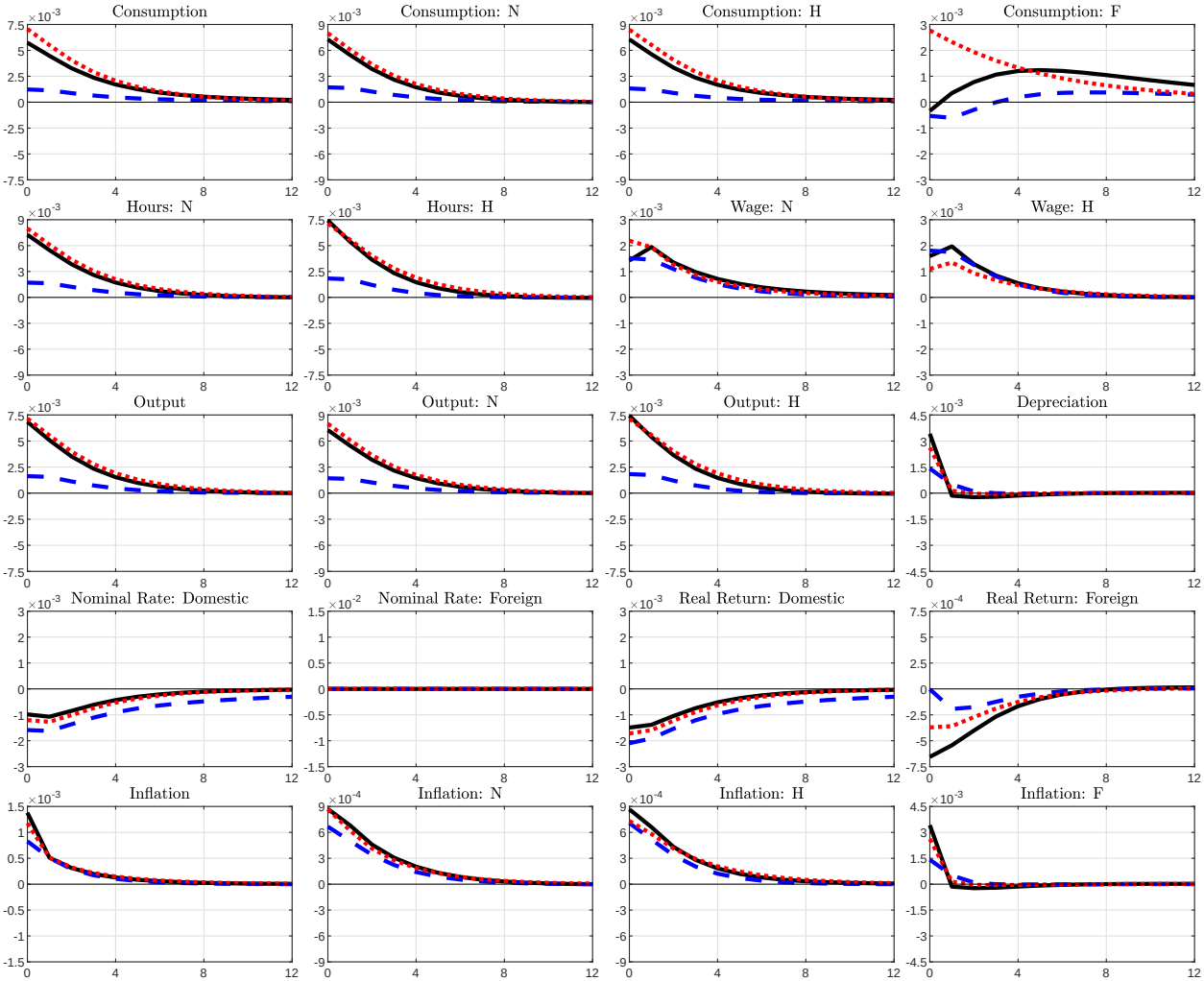
Figure A.12: Aggregate Effects of Foreign Monetary Policy Shocks with Different Degrees of Real Integration



Notes: This figure shows impulse responses to a 25bp expansionary foreign monetary policy shock ($\epsilon_t^{i^*} = -0.0025$). *Baseline*, represented with the solid black line, corresponds to the calibrated economy studied in Sections 3 and 4. *High*, represented with the dashed blue line, corresponds to responses in economies calibrated with 95% of households working in home tradable goods sector and 95% of households' consumption basket is made up of home tradable goods. *Low*, represented with the dotted red line, corresponds to responses in economies calibrated with 5% of households working in home tradable goods sector and 5% of households' consumption basket is made up of home tradable goods.

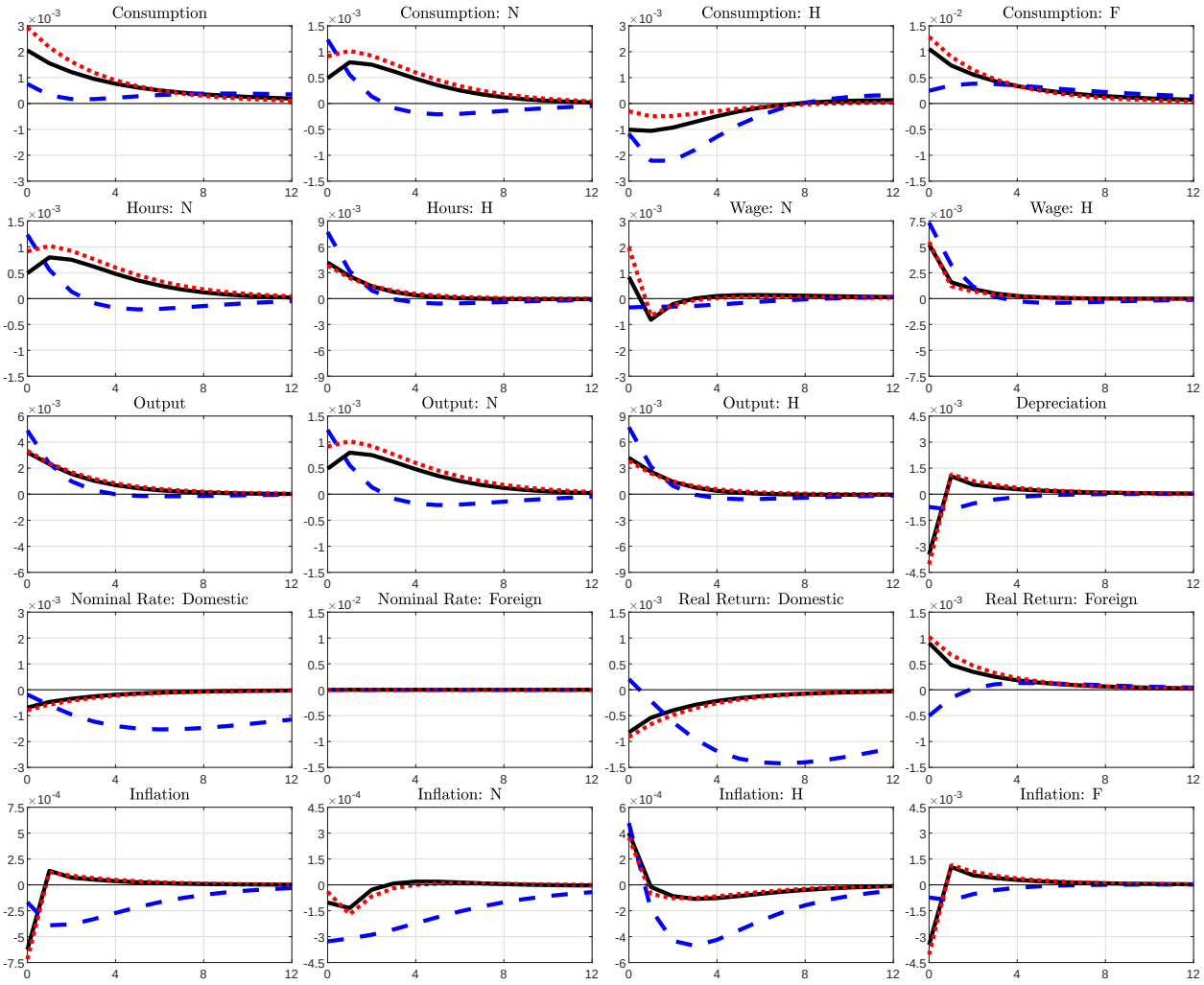
A.5. Aggregate Responses under Alternative Degrees of Financial Integration

Figure A.13: Aggregate Effects of Monetary Policy Shocks with Different Degrees of Financial Integration



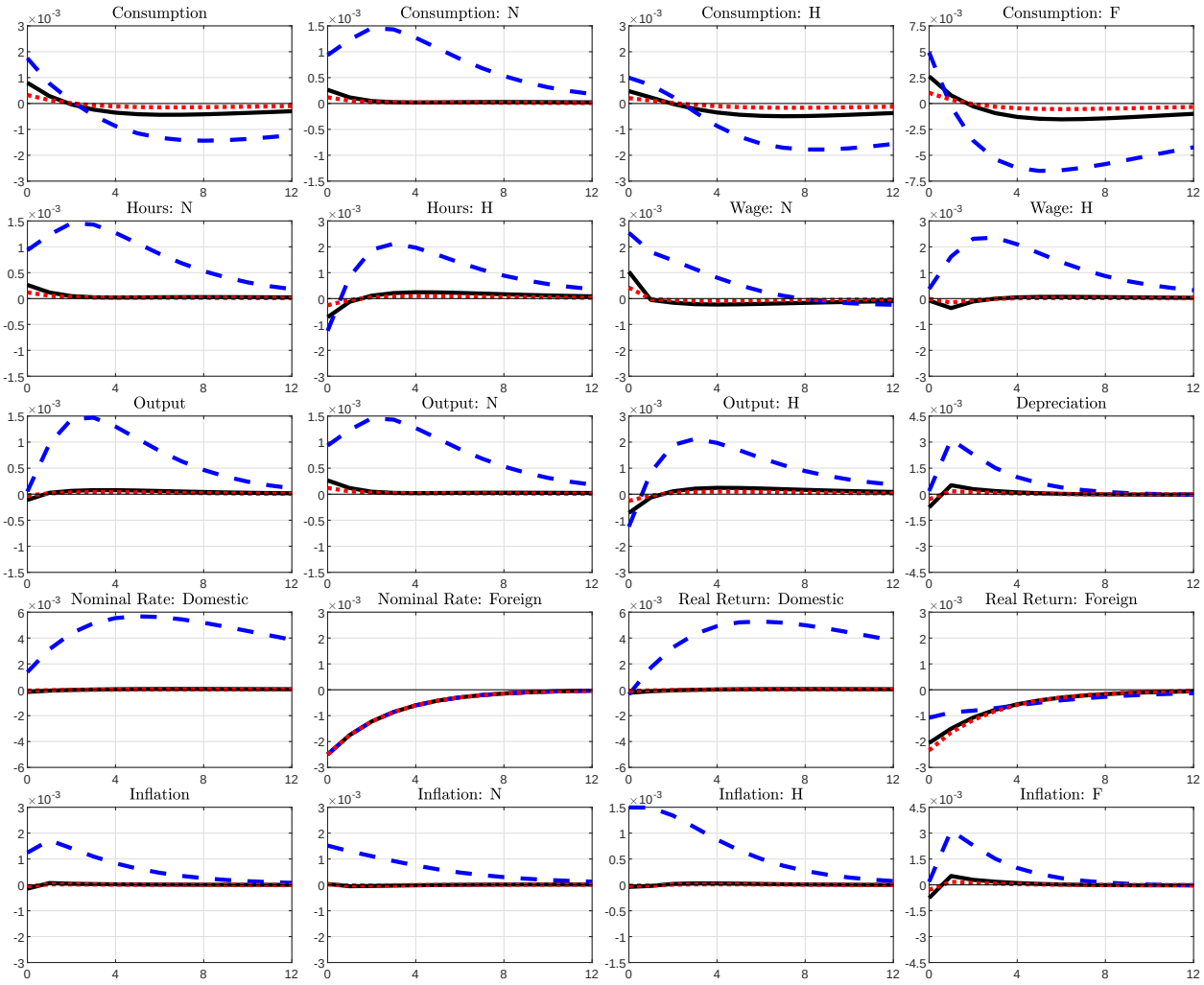
Notes: This figure shows impulse responses to a 25 bp expansionary monetary policy shock ($\epsilon_t^m = -0.0025$). *Baseline*, represented with the solid black line, corresponds to the calibrated economy studied in Sections 3 and 4. *High*, represented with the dashed blue line, corresponds to responses in economies calibrated with 95% of households with access to international financial markets. *Low*, represented with the dotted red line, corresponds to responses in economies calibrated with with 5% of households with access to international financial markets.

Figure A.14: Aggregate Effects of Foreign Demand Shock with Different Degrees of Financial Integration



Notes: This figure shows impulse responses to a 1 percent expansionary external demand shock ($\epsilon_t^{Y_F^*} = 0.01$). *Baseline*, represented with the solid black line, corresponds to the calibrated economy studied in Sections 3 and 4. *High*, represented with the dashed blue line, corresponds to responses in economies calibrated with 95% of households with access to international financial markets. *Low*, represented with the dotted red line, corresponds to responses in economies calibrated with with 5% of households with access to international financial markets.

Figure A.15: Aggregate Effects of Foreign Monetary Policy Shocks with Different Degrees of Financial Integration



Notes: This figure shows impulse responses to a 25bp expansionary foreign monetary policy shock ($\epsilon_t^{i^*} = -0.0025$). *Baseline*, represented with the solid black line, corresponds to the calibrated economy studied in Sections 3 and 4. *High*, represented with the dashed blue line, corresponds to responses in economies calibrated with 95% of households with access to international financial markets. *Low*, represented with the dotted red line, corresponds to responses in economies calibrated with with 5% of households with access to international financial markets.