BANK OF CANADA
BANQUE DU CANADA

Staff Working Paper/Document de travail du personnel—2022-6

Last updated: February 7, 2022

Monetary Policy and Redistribution in Open Economies

by Xing Guo,[1] Pablo Ottonello[2] and Diego J. Perez[3]

[1] Canadian Economic Analysis Department, Bank of Canada
XingGuo@bankofcanada.ca

[2] University of Michigan and NBER
pottonel@umich.edu

[3] New York University and NBER
diego.perez@nyu.edu

DOI: https://doi.org/10.34989/swp-2022-6 | **ISSN** 1701-9397

Acknowledgements

We thank Yan Bai, Mark Gertler, Simon Gilchrist, Greg Kaplan, Tomasso Monacelli, Federica Romei, Jesse Schreger, Ludwig Straub (discussant), Tom Winberry, and participants at various seminars and conferences.

Abstract

This paper examines how monetary policy affects the asymmetric effects of globalization. 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 effects of monetary policy and external shocks in open economies? And how do alternative exchange-rate regimes compare? Our analysis yields two main takeaways. First, heterogeneity in households' international integration is a central dimension that drives the inequality in the consumption responses to external shocks more so than do income and wealth. Second, households' heterogeneity reveals the presence of a stabilization-inequality trade-off for the conduct of monetary policy in open economies, with fixed exchange-rate regimes leading to amplified but less unequal consumption responses to external shocks.

Topics: Monetary policy, Exchange rate regimes
JEL codes: E32, E52, F41, F44

1. Introduction

The implications of globalization for the conduct of macroeconomic policies have featured prominently in policy debates in recent decades. An influential view, based on the idea of "globalization and its discontents" (Stiglitz, 2002, 2017), argues that international integration has redistributive effects on households and that if traditional policies do not consider this dimension, they can amplify the resulting inequalities. Although the traditional argument for discontent with globalization was formulated with regard to the crises emerging economies encountered during the late 1990s, similar views have become prominent in developed economies over the last decade. Related to this policy discussion, a large body of research on the intersection of international trade and labor has studied the distributional consequences of international integration and trade policies (see, for example, Goldberg and Pavcnik, 2007; Autor, Dorn, and Hanson, 2013). However, less is known in international macroeconomics about the extent to which traditional macroeconomic 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 real and financial markets, and realistic income and wealth distributions. We then use this framework to reassess the three classic questions in international economics that motivated the seminal work of Mundell (1963) and Fleming (1962),[1] but we focus on their distributional aspects: What are the effects of monetary policy in open economies? What are the international spillovers of policies and shocks? And how do alternative exchange-rate regimes compare? We emphasize two main takeaways from our analysis. The first is that heterogeneity in households' international integration is a central dimension that drives the inequality in

[1]For instance, the first sentences in Mundell (1963) read: "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."

the consumption responses to external shocks more so than do income and wealth. The second is that households' heterogeneity reveals the presence of a trade-off between aggregate stabilization and inequality in the conduct of monetary policy in open economies, with fixed exchange-rate regimes leading to amplified but less unequal consumption responses to external shocks.

The model we develop embeds household heterogeneity in a canonical New Keynesian open-economy framework. We consider a small open economy that is 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; Gali and Monacelli, 2005). 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 levels of income and wealth and are 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 being restricted to domestically traded securities. With these ingredients, we aim to construct a laboratory economy that has in play the main mechanisms of the monetary policy 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 as in Kaplan, Moll, and Violante, 2018). We use this framework to study the effects of domestic monetary policy shocks and external shocks (shocks to foreign demand and foreign monetary policy, respectively).

The first takeaway from our analysis is that uneven household integration into international markets plays a central role that drives the inequality in the consumption responses to external shocks. The consumption of households working in tradable sectors is more sensitive to changes in the external demand for exportable goods. Additionally, the consumption of households that have direct or indirect holdings of foreign securities is more sensitive

to international spillovers of foreign monetary policy. Quantitatively, we find that these sources of heterogeneity, which are characteristic of open economies, explain roughly half of the inequalities in households' consumption responses to external macroeconomic shocks.

The second takeaway is that different exchange-rate regimes have different distributional implications. Although fixed exchange-rate regimes amplify aggregate responses to external shocks vis-a-vis floating regimes (e.g., Taylor rules), they are also associated with consumption responses that are less uneven between integrated and nonintegrated households.[2] For instance, an external monetary expansion generates a large response in households that are integrated with international capital markets through direct channels, and this leads to inequality in these households' consumption responses vis-a-vis nonintegrated households. Under a fixed-exchange-rate regime, monetary authorities respond more aggressively by cutting domestic interest rates to avoid currency appreciation, and this has direct effects on the consumption of nonintegrated households, thereby reducing the unequal consumption responses to the external shock. In this sense, distributional considerations in open economies might make a case for a "fear of floating" (Calvo and Reinhart, 2002).

Finally, our paper studies the role of globalization in terms of the aggregate and distributional effects of monetary policy and external shocks. This exercise is motivated by the large increase in real and financial integration observed worldwide over the past few decades (e.g., Rogoff, 2006; Obstfeld, 2007). Economies with larger degrees of real and financial integration naturally experience more-pronounced aggregate effects of changes in foreign demand and monetary policy, respectively. However, we show that in economies with a high degree of international integration, external shocks tend to have less-uneven responses across households. This is because external shocks induce larger dampening forces from prices in the rest of the economy or from 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.

[2]Related to this result, Bilbiie, Monacelli, and Perotti (2020) highlight a stabilization-redistribution trade-off in the context of closed-economy heterogeneous-agent models with fiscal policy.

Related literature Our paper contributes to three strands of the literature. First, our work builds on the large body of literature that studies the effects of monetary policy in open economies (see, for example, the early work of Obstfeld and Rogoff, 1995, 2000; Clarida, Gali, and Gertler, 2001; Chari, Kehoe, and McGrattan, 2002; Devereux and Engel, 2003; Gali and Monacelli, 2005; Schmitt-Grohé and Uribe, 2011).[3] We contribute to this literature by analyzing the distributional aspects of these classic questions in international macroeconomics.

Second, our paper is related to a large body of literature that studies the role of household heterogeneity in the transmission of macroeconomic policies (see Kaplan and Violante, 2018, for a recent survey). On open economies, early contributions include the work of Farhi and Werning (2016, 2017) in a study of fiscal and monetary policy. More recently, a growing body of research has incorporated quantitative elements from the closed-economy literature. De Ferra, Mitman, and Romei (2020) introduce heterogeneity in households' income and wealth to study the transmission of foreign shocks. Auclert, Rognlie, Souchier, and Straub (2020) study monetary transmission in an open-economy model with heterogeneous households; they provide general conditions under which households' heterogeneity matters for aggregate transmission and they identify the presence of a strong real-income channel that can lead to contractionary devaluations. Other papers in this area include Cugat (2019); Zhou (2020) and Oskolkov (2021).[4] We complement this body of work by stressing how international integration constitutes a central source of heterogeneity for the conduct of monetary

[3]The study of monetary policy in open economies is a central topic in international economics and includes work on the role of the international price system in affecting monetary policy (see, for example, Engel, 2006; Corsetti, Dedola, and Leduc, 2010; Mukhin, 2018; Gopinath, Boz, Casas, Díez, Gourinchas, and Plagborg-Møller, 2020; Burstein and Gopinath, 2014, and references therein); the role of international financial intermediaries and currency risk (see, for example, Gabaix and Maggiori, 2015; Rey, 2015; Hassan, Mertens, and Zhang, 2016; Itskhoki and Mukhin, 2017, 2019; Kekre and Lenel, 2021); domestic financial frictions (see, for example, Céspedes, Chang, and Velasco, 2004; Benigno and Romei, 2014; Ottonello, 2021; Fornaro, 2015; Arellano, Bai, and Mihalache, 2020); and international coordination in the conduct of monetary and fiscal policy (see, for example, Corsetti and Pesenti, 2005; Fornaro and Romei, 2019). 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; Giovanni, Kalemli-Ozcan, Ulu, and Baskaya, 2017; Gourinchas, 2018; Kalemli-Ozcan, 2019).

[4]A related empirical literature has documented the heterogeneous 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).

policy in open economies.

Finally, 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; Straub, 2018; Quadrini and Ríos-Rull, 2015, and references therein). Our paper complements this literature by studying the distributional aspects of monetary policy in open economies that are characterized by inequalities that stem from international integration.

Layout The rest of the paper is organized as follows. Section 2 presents the model and Section 3 its parameterization. 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 that is enriched with household heterogeneity. The small open economy is populated by households, firms, and a government. Households consume three goods: home, foreign, and nontradable goods, and can potentially save in two types of assets: domestic and external financial securities. Firms in the economy produce the home tradable goods and nontradable goods. The rest of the world exchanges tradable goods (home and foreign) and external financial securities with the small open economy. Households in the small open economy are heterogeneous along 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 real and financial markets: Some work in tradable sectors and others in nontradable sectors; some are able to save and borrow in both types of financial securities and others only in domestic securities. Section 2.6 discusses the assumptions of the baseline model and Appendix A studies alternative model

environments.

2.1. Households

Households have preferences over consumption as 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 the 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 good, with a constant-elasticity-of-substitution (CES) aggregation technology $c_t = \mathcal{C}_{\mathrm{TN}}(c_{\mathrm{T}t}, c_{\mathrm{N}t}) = \left[\omega_{\mathrm{T}}^{\frac{1}{\eta}} (c_{\mathrm{T}t})^{1-\frac{1}{\eta}} + (1-\omega_{\mathrm{T}})^{\frac{1}{\eta}} (c_{\mathrm{N}t})^{1-\frac{1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$, where $c_{\mathrm{T}t}$ and $c_{\mathrm{N}t}$ denote tradable and nontradable consumption and $\eta > 0$ is the elasticity of substitution between tradable and nontradable goods. The tradable good is, in turn, a composite of the home and foreign tradable goods with a CES aggregation technology $c_{\mathrm{T}t} = \mathcal{C}_{\mathrm{HF}}(c_{\mathrm{H}t}, c_{\mathrm{F}t}) = \left[\omega_{\mathrm{H}}^{\frac{1}{\eta}} (c_{\mathrm{H}t})^{1-\frac{1}{\eta}} + (1-\omega_{\mathrm{H}})^{\frac{1}{\eta}} (c_{\mathrm{F}t})^{1-\frac{1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$, where $c_{\mathrm{H}t}$ and $c_{\mathrm{F}t}$ denote the home and foreign tradable goods and we assume that the substitution between these goods shares the same elasticity with the substitution between tradable and nontradable goods.[5]

We set up the household's problem recursively. The idiosyncratic state vector of a household includes its idiosyncratic income shock, z; its asset holdings, $\mathbf{b} \equiv [b_{\mathrm{D}}, b_{\mathrm{E}}]$, where b_{D} denotes holdings of domestic securities and b_{E} holdings of external securities; and its integration with real and financial international markets, $\mathbf{o} \equiv [o_R, o_F]$, where o_R and o_F are, respectively, variables that describe the real and financial integration of the household. The variable o_R determines the household's source of income, taking the value one if the household receives its labor income from the tradable sector and zero if it receives it from the nontradable sector. The variable o_F determines the household's access to financial securities,

[5] In Appendix A.8, we relax this assumption and study a parameterization with different elasticities of substitution.

taking the value one if the household can save in both external and domestic securities and zero if it can only save in domestic securities. The household's recursive problem is given by

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

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

$$P_{\mathrm{H}t} c_{\mathrm{H}} + P_{\mathrm{F}t} c_{\mathrm{F}} + P_{\mathrm{N}t} c_{\mathrm{N}} + q_{\mathrm{D}t} b'_{\mathrm{D}} + q_{\mathrm{E}t} b'_{\mathrm{E}} + \Phi(b'_{\mathrm{D}}, b'_{\mathrm{E}}, o_F)$$

$$= z(1 - \tau_t) W_t(o_R) l + T_t(z) + b_{\mathrm{D}} + b_{\mathrm{E}}, \tag{4}$$

$$\mathbf{b}' \in \mathcal{B}(o_F),$$

$$\mathbf{o}' = \Gamma(\mathbf{o}),$$

where $P_{\mathrm{H}t}$, $P_{\mathrm{F}t}$, and $P_{\mathrm{N}t}$ are the prices of the home tradable, foreign tradable, and nontradable goods denominated in the local currency; $q_{\mathrm{D}t}$ and $q_{\mathrm{E}t}$ are the prices of the risk-free zero-coupon domestic and external bonds;[6] τ_t is a labor-income tax; $T_t(z)$ is a lump-sum transfer from the government and firms, which potentially depends on the household's idiosyncratic productivity; $\Gamma(\mathbf{o})$ denotes the law of motion of the household's financial and real integration; ξ is the household's death rate; and $\tilde{V}_t(z, \mathbf{b}, \mathbf{o})$ is the value of a household that receives the realization of a shock whereby it dies and retires from the economy in the following period, given by $\tilde{V}_t(z, \mathbf{b}, \mathbf{o}) = \max_{c_{\mathrm{H}}, c_{\mathrm{F}}, c_{\mathrm{N}}, l} u(c, l)$ s.t. $P_{\mathrm{H}t} c_{\mathrm{H}} + P_{\mathrm{F}t} c_{\mathrm{F}} + P_{\mathrm{N}t} c_{\mathrm{N}} = z(1 - \tau_t) W_t(o_R) l + T_t(z) + b_{\mathrm{D}} + b_{\mathrm{E}}$. In each period, a new mass of households, ξ, is born with no assets and with exogenous idiosyncratic states that are drawn from their ergodic distributions, so the total mass of households is always fixed at one.

International integration determines the wage $W_t(o_R)$ and the set of financial securities available for the household $\mathcal{B}(o_F)$. On the real side, the wage of the integrated households is that paid to workers in the home sector $W_t(o_R = 1) = W_{\mathrm{H}t}$, while that of the nonintegrated households is the wage paid to workers in the nontradable sector $W_t(o_R = 0) = W_{\mathrm{N}t}$. On the financial side, the set of financial securities available to the integrated households is $\mathcal{B}(o_F = 1) \equiv \{\mathbf{b}' : q_{\mathrm{D}t} b'_{\mathrm{D}} + q_{\mathrm{E}t} b'_{\mathrm{E}} \geq \bar{b} \cdot P_t\}$, where P_t denotes the ideal price index of the consumption

[6] In the baseline model of this section we assume that bonds are denominated in the local currency. Appendix 4.4 studies the case of bonds that are denominated in foreign currency.

bundle, meaning that these households face a fixed limit for their total borrowing in real terms; and the set of financial securities available for the nonintegrated households is $\mathcal{B}(o_F = 0) \equiv \{\mathbf{b}' : q_{\mathrm{D}t} b'_{\mathrm{D}} \geq \bar{b} \cdot P_t, b'_{\mathrm{E}} = 0\}$, meaning that in addition to the borrowing constraint, these households can neither save nor borrow in external securities. Finally, the function $\Phi(b'_{\mathrm{D}}, b'_{\mathrm{E}}, o_F)$ introduces adjustment costs in the composition of these households' financial portfolios. As further discussed below, this friction gives rise to endogenous deviations from the uncovered interest rate parity (UIP) and nests the case of no UIP deviations for particular parametrizations.

2.2. Firms

The economy has access to technologies to produce two types of goods: home tradable goods (H) and nontradable goods (N). In each sector there are two types of firms: final-good producers and intermediate-good producers. All firms are owned by domestic households.

Final-good producers A continuum of representative final-good producers operates in each sector and transforms intermediate goods $\tilde{y}_{jst}$ into final goods, using production technology

$$Y_{st} = \left(\int \tilde{y}_{jst}^{\frac{\epsilon-1}{\epsilon}} \, \mathrm{d}j \right)^{\frac{\epsilon}{\epsilon-1}},$$

where $j \in [0, 1]$ indicates the variety of each intermediate good and $s \in \{\mathrm{H}, \mathrm{N}\}$. The final-good producers in each sector choose intermediate inputs to maximize their static profits, which leads to a demand function faced by the intermediate-good producers in each sector, $\mathcal{Y}_{jst}(p_{jst}) = \left(\frac{p_{jst}}{P_{st}}\right)^{-\epsilon} Y_{st}$, where $P_{st} = \left(\int p_{jst}^{1-\epsilon} \, \mathrm{d}j\right)^{\frac{1}{1-\epsilon}}$ is the ideal price index in sector s and period t.

Intermediate-good producers A continuum of intermediate-good producers uses labor n_{jst} to produce their product variety j, with constant-returns-to-scale technology $y_{jst} = An_{jst}$. Each intermediate-good producer sets its price in the local currency to maximize the net present value of its profit, and thereby faces price adjustment costs à la Rotemberg

(1982),

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

where $\Pi_{st}(p_t) \equiv \left(\frac{p_{st}}{P_{st}} - w_{st}\right) \left(\frac{p_{st}}{P_{st}}\right)^{-\epsilon} Y_{st} - \Theta_{st}\left(\frac{p_{st}}{p_{st-1}}\right)$ are the profits in period t, $w_{st} \equiv \frac{W_{st}}{AP_{st}}$ is the effective real wage in sector s and $\Theta_{st}\left(\frac{p_{st}}{p_{st-1}}\right) = \frac{\theta}{2}\left(\frac{p_{st}}{p_{st-1}} - 1\right)^2 Y_{st} P_{st}$ is the cost of adjusting the prices; $\pi_t \equiv \frac{P_t}{P_{t-1}} - 1$ and $\pi_{st} \equiv \frac{P_{st}}{P_{st-1}} - 1$ are the inflation rates at the aggregate and sectoral levels; and $r_{t+1} \equiv \frac{1+i_t}{1+\pi_{t+1}} - 1$ is the domestic real interest rate, where i_t is the domestic monetary policy rate.[7] Note that in problem (5) we drop the subindex j because all of the intermediate producers are identical. From the solution to this problem, we can derive the New Keynesian Phillips curve for each sector $s \in \{\mathrm{H}, \mathrm{N}\}$:

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

2.3. Government

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

$$i_t = i_{ss} + \phi \pi_t + v_t, \tag{6}$$

where v_t is an exogenous monetary policy shock that follows the autoregressive process $v_t = \rho_m v_{t-1} + \epsilon_{m,t}$, and i_{ss} is the steady-state nominal interest rate. This interest rate determines the price of the zero-coupon domestic bond, which is given by

$$q_{\mathrm{D}t} = \frac{1}{1+i_t}. \tag{7}$$

[7] We follow Kaplan et al. (2018) and assume that firms discount profits at the domestic real interest rate. Additionally, the choice of the domestic rate for discounting makes the model closer to its representative-agent open-economy counterpart, which features the domestic ownership of firms.

In Section 4.3, we compare the dynamics under a fixed-exchange-rate regime instead of a Taylor rule. On the fiscal side, the government raises a labor-income tax to maintain a constant level of government spending, G_{ss}, transfers to households, T_{ss}, and borrowing, B_{ss}. Its budget constraint is given by

$$\tau_t \left(N_{Ht} W_{Ht} + N_{Nt} W_{Nt} \right) = T_{ss} + G_{ss} + (1 - q_{\mathrm{D}t}) B_{ss}, \tag{8}$$

where $N_{st} \equiv \int n_{jst} \, \mathrm{d}j$ is the aggregate employment in sector s. The total transfers received by households are then given by $\int T_t(z) \, \mathrm{d}z = T_{ss} + \Pi_t$, where Π_t represents the aggregate profits in the home and nontradable sectors expressed in the local currency; in Section 3 we discuss the functional form of $T_t(z)$, which we used in the quantitative analysis.

2.4. Rest of the World

The rest of the world trades external 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 external securities, a foreign demand for the home tradable good, and a foreign supply of the foreign tradable good.

For external financial securities, the small open economy faces a perfectly elastic demand, with a nominal interest rate in the foreign currency, i_t^*, following an exogenous autoregressive process $i_t^* = (1 - \rho_{m^*}) i_{ss}^* + \rho_{m^*} i_{t-1}^* + \epsilon_{m^*,t}$, where i_{ss}^* is the steady-state rate and $0 < \rho_{m^*} < 1$. The shock, $\epsilon_{m^*,t}$, can be interpreted as a foreign monetary policy shock, which we study in Section 4.2, where we analyze international spillovers. This interest rate determines the price of the zero-coupon external bond, which is given by

$$q_{\mathrm{E}t} = \mathbb{E}_t \left[\frac{1}{1 + i_t^*} \frac{\mathcal{E}_t}{\mathcal{E}_{t+1}} \right], \tag{9}$$

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

On the tradable goods side, we assume a completely elastic supply of the foreign good

at a fixed price in the foreign currency, which we denote as P^*_{Ft}, and a downward-sloping foreign demand of the home tradable good, which is given by

$$C^*_{\mathrm{H}t} = \left(\frac{P^*_{Ht}}{P^*_{Ft}}\right)^{-\eta} Y^*_{\mathrm{F}t}, \tag{10}$$

where P^*_{Ht} is the price of the home tradable good expressed in the foreign currency and $Y^*_{\mathrm{F}t}$ is a foreign demand shifter that follows an exogenous autoregressive process $\log Y^*_{\mathrm{F}t} = \rho_{y^*} \log Y^*_{\mathrm{F}t-1} + \epsilon_{y^*,t}$.

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 whose share of consumption of the home tradable good in its consumption basket is infinitely small.[8]

2.5. Equilibrium

We define the competitive equilibrium as follows.

***Definition* 1.** *Given exogenous processes* $\{v_t, Y^*_{\mathrm{F}t}, i^*_t\}$*, government policies* $\{i_t,\ \tau_t\}$*, and transfers to households* $\{T_t(z)\}$*, an equilibrium is a stochastic sequence of households' value functions* $\{V_t(z, \mathbf{b}, \mathbf{o}), \tilde{V}_t(z, \mathbf{b}, \mathbf{o})\}$ *and policy functions* $\{c_{\mathrm{H},t}(z, \mathbf{b}, \mathbf{o}),\ c_{\mathrm{F},t}(z, \mathbf{b}, \mathbf{o}),\ c_{\mathrm{N},t}(z, \mathbf{b}, \mathbf{o}),\ l_t(z, \mathbf{b}, \mathbf{o}),\ b'_{\mathrm{D}t}(z, \mathbf{b}, \mathbf{o})\},\ b'_{\mathrm{E}t}(z, \mathbf{b}, \mathbf{o})\}$*; 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* $\{W_{\mathrm{H},t},\ W_{\mathrm{N},t}\ P_{\mathrm{H}t},\ P_{\mathrm{F}t},\ P_{\mathrm{N}t}, P_t, \mathcal{E}_t, q_{\mathrm{D}t}, q_{\mathrm{E}t}\}$*; and a distribution of households* $\mu_t(z, \mathbf{b}, \mathbf{o})$ *such that we have the following:*

1. *Household optimization: Value function* $V_t(z, \mathbf{b}, \mathbf{o})$ *solves households' problem* (2) *with the associated policy functions* $\{c_{\mathrm{H},t}(z, \mathbf{b}, \mathbf{o}),\ c_{\mathrm{F},t}(z, \mathbf{b}, \mathbf{o}),\ c_{\mathrm{N},t}(z, \mathbf{b}, \mathbf{o}),\ l_t(z, \mathbf{b}, \mathbf{o}),\ b'_{\mathrm{D}t}(z, \mathbf{b}, \mathbf{o})$

[8] 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 because it makes 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 is finite.

$b'_{\mathrm{E}t}(z, \mathbf{b}, \mathbf{o})\}$, *taking as given the equilibrium prices, interest rates, policies, and transfers.*

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

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

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

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

6. *All markets clear.*

2.6. Discussion of the Assumptions

This section discusses the main assumptions of the baseline model. Section 4.4 summarizes how our main quantitative results change under alternative model assumptions.

First, our baseline model introduces heterogeneity in households' international real and financial integration. On the real side, households' heterogeneity builds on the sectoral distinction of tradable and nontradable goods production that is widely used in international macro models. Our model assumes that households work in either of the two sectors, receiving uninsurable labor income from that sector. This gives rise to the heterogeneous effects of aggregate shocks for households working in different sectors, which have been studied in the macro labor and international trade literature (e.g., Goldberg and Pavcnik, 2007; Autor et al., 2013). On the financial side, households' heterogeneity builds on market segmentation, which is another widely studied friction in macro models (e.g., Alvarez, Atkeson, and Kehoe, 2002; Chien, Cole, and Lustig, 2012). Our model assumes that agents differ in their access to international financial markets, consistent with the evidence in the international macro literature (e.g., Maggiori, Neiman, and Schreger, 2017; Maggiori, 2021). In addition, we incorporate rich heterogeneity along the income and wealth dimension. Doing so allows

us to contrast the relevance of heterogeneity in international integration with that in wealth and income, which has been the main focus in the closed-economy literature.

Second, regarding households' mobility along international integration, our baseline model abstracts from endogenous transitions. Although in Appendix A.1 we endogenize these transitions by using techniques from dynamic discrete-choice models, we choose a more parsimonious exogenous specification for transitions because of the low frequencies of the transitions observed in the data.[9] On the real side, the labor literature shows that sectoral transitions occur infrequently and most workers' transitions occur without changing sector (e.g., Lilien, 1982; Loungani and Rogerson, 1989; Pilossoph, 2014; Chodorow-Reich and Wieland, 2020). On the financial side, infrequent transitions between international integration status are consistent with the fact that households infrequently adjust their financial portfolios and maintain sticky relationships with their financial intermediaries (e.g., Agnew, Balduzzi, and Sunden, 2003; Chodorow-Reich, 2013; Giglio, Maggiori, Stroebel, and Utkus, 2019).

Third, our model features the possibility of endogenous deviations from the UIP, which are documented in the data as being sizable (e.g., Fama, 1984; Kalemli-Ozcan, 2019). Our model builds on the literature that links such deviations to frictions in international financial markets (e.g., Gabaix and Maggiori, 2015; Itskhoki and Mukhin, 2017; Maggiori, 2021) and does so through international market segmentation and costly adjustments of portfolios. An advantage of such specifications is that we can nest the particular case of no deviations from the UIP (see Appendix A.3 for details). It is worth noting that our formulation abstracts from UIP deviations that stem from currency risk premiums (see, for example, Lustig and Verdelhan, 2007; Hassan and Zhang, 2020).[10]

Finally, our baseline model assumes that the prices of both goods and financial securities are denominated in the local currency. Appendix A.4 studies an environment in which the

[9] As we show in Appendix A.1, low frequencies of transitions imply that endogenizing such transitions does not lead to quantitatively different results. In that appendix we also study how the results in the baseline model and in the model with endogenous transitions are affected by the degree of persistence in international integration.

[10] While introducing risk considerations in households' portfolio problems is worth analyzing, doing so would require a different solution method to that used in our paper and in the current generation of heterogeneous-agent New Keynesian models.

prices of tradable goods are set in the foreign currency, which has been documented to be commonly used as a unit of account and relevant for the transmission of monetary policy (e.g., Devereux and Engel, 2003; Corsetti et al., 2010; Gopinath, Itskhoki, and Rigobon, 2010; Mukhin, 2018; Gopinath et al., 2020). In addition, Appendix A.5 analyzes the case in which financial securities are denominated in the foreign currency, following the literature of "original sin" (Eichengreen, Hausmann, and Panizza, 2002; Ottonello and Perez, 2019; Du, Pflueger, and Schreger, 2020; Engel and Park, 2021).

3. 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 calibrate the model in three steps.

In the first step, we fix a subset of parameters to the standard values found in the literature. These are reported in Table 1. The exit rate for households is set at $\frac{1}{82.5\times 4}$ to match the average life expectancy of 82.5 years for Canada in 2020. For households' preferences, we assume a separable 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. We set the disutility of labor supply ψ to target a steady-state level of hours of $\frac{1}{3}$, and we set the discount factor to target a steady-state domestic annual interest rate of 4%. For firms, we set the elasticity of substitution in the technology of final-good producers to $\epsilon = 10$, which implies a markup of 11%. We set the parameter that governs the adjustment costs of prices to $\theta = 100$, which implies a slope of the Phillips curve of 0.1, as in Kaplan et al. (2018). For the government, we set transfers to $T_{ss} = 0.12$ and government spending to $G_{ss} = 0.08$ to match the fraction of transfers and tax payments in

Table 1: Fixed Parameters

Parameter	Description	Value
Households		
ξ	Exit rate	$\frac{1}{82.5\times4}$
$1/\nu_c$	Intertemporal elasticity of substitution	1
$1/\nu_l$	Frisch elasticity of labor supply	1
ψ	Disutility of labor	7.93
β	Discount factor	0.96
Firms		
ϵ	Elasticity of substitution for final goods aggregator	10
θ	Adjustment cost of goods price	100
Government and rest of the world		
τ	Income tax rate	0.20
T_{ss}	Total transfer	0.12
B_{ss}	Government debt	0.85
i_{ss}	Steady-state domestic interest rate	0.01
i^*_{ss}	Steady-state international interest rate	0.01

Note: Intermediaries' productivity was set to $A = 3.37$ to normalize the average labor income in the steady state to one.

total household income for Canada, computed from the 2016 Survey of Financial Security (SFS). Regarding government debt, we set $B_{ss} = 0.85$ to target a median liquid wealth-to-income ratio of 0.35 for Canada, also computed from the 2016 SFS. Finally, we set the steady-state domestic and international interest rates to $i_{ss} = i^*_{ss} = 1\%$. Given that there is zero inflation and exchange-rate depreciation in the steady state, this implies that the UIP holds in the steady state.

The second step of our calibration targets steady-state moments with the subset of parameters reported in Table 2. For the parameters that govern households' idiosyncratic income processes, we follow the recent literature on households' heterogeneity applied to the case of Canada. In particular, 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 of households' idiosyncratic income processes. We follow Rouwenhorst (1995) to construct the discretized processes of z_1 and z_2. Under

this construction, each of these two processes is uniquely determined by three moments: first-order autocorrelation ρ_i, standard deviation σ_i, and skewness $skew_i$, for $i = 1, 2$. The mixture of these two processes allows us to match a key set of data moments of log-earnings dynamics, reported in Table D.1: the variance, skewness, and kurtosis of the 1- and 5-year changes in the log annual earnings. For further details on the identification of these moments using the Rowenhorst method, see Gospodinov and Lkhagvasuren (2014) and Lkhagvasuren (2012). Finally, for the distribution of transfers, we follow Kaplan et al. (2018) and assume that the aggregate profits are distributed to households proportional to the level of their idiosyncratic productivity; i.e., $T_t(z) = T_{ss} + \frac{z}{\bar{z}}\Pi_t$, where $\bar{z}$ denotes the average idiosyncratic labor productivity across households.

Given these income processes, the borrowing constraint, $\underline{b}$, is set to one-third of the average quarterly labor income to match the median marginal propensity to consume (MPC) of households. In the steady state of our model, the median MPC is 15%, which is within the range of the estimates for the MPC for nondurable goods as reported by Parker, Souleles, Johnson, and McClelland (2013). Additionally, 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 and the share of tradable goods in the consumption basket, $\omega_{\mathrm{T}} = 0.33$, to target equal wages per efficiency for households working in different sectors, which makes the analysis of the distributional implications of macroeconomic shocks more transparent. In Appendix A.7 we analyze how the quantitative results are affected when we target different wages by sector in the steady state.

Table 2: Calibrated Parameters

Parameter	Description	Value
Panel 1. Parameters Governing the Steady State		
Idiosyncratic risk		
ρ_1	Persistent idiosyncratic income, autocorrelation	0.75
σ_1	—, unconditional standard deviation	0.78
$skew_1$	—, unconditional skewness	-4.07
ρ_2	Transitory idiosyncratic income, autocorrelation	0.25
σ_2	—, unconditional standard deviation	0.31
$skew_2$	—, unconditional skewness	-2.05
$\underline{b}$	Borrowing constraint	-0.29
International integration		
λ_F^1	Financial integration, probability of remaining integrated	92%
λ_F^0	—, probability of remaining nonintegrated	96.06%
λ_R^1	Real integration, probability of remaining integrated	96%
λ_R^0	—, probability of remaining nonintegrated	97.65%
$\bar{\alpha}(o_F = 1)$	Asset home bias of financial integrated households	0.79
Preferences		
ω_T	Fraction of tradable goods in consumption basket	0.33
ω_H	Fraction of home goods in tradable goods consumption basket	0.60
Panel 2. Parameters Governing the Aggregate Responses		
Households and government		
ϕ_b	Portfolio adjustment cost	0.80
η	Intratemporal elasticity of substitution	6.19
ϕ_π	Taylor rule, coefficient of inflation	1.10
ϕ_i	—, coefficient of lagged nominal interest rate	0.87
Aggregate shocks		
ρ_m	Domestic monetary shock, persistence	0.68
σ_m	—, standard deviation	0.25%
ρ_{m^*}	Foreign monetary shock, persistence	0.81
σ_{m^*}	—, standard deviation	0.25%
ρ_{y^*}	Foreign demand shock, persistence	0.50
σ_{y^*}	—, std.	15%

Notes: The value of $\underline{b}$ is expressed as a share of households' quarterly average labor income in the steady state.

The most novel part of our calibration is the group of steady-state moments and parameters that are related to households' international integration. In our baseline calibration, we assume an exogenous evolution of households' real and financial integration and study the case of endogenous transitions in Appendix A.1. We model real and financial integration as independent Markov processes with transition-probability matrices $\begin{bmatrix} \lambda_j^1 & 1-\lambda_j^1 \\ 1-\lambda_j^0 & \lambda_j^0 \end{bmatrix}$ for $j = R, F$, where λ_R^1, λ_R^0 denote the probabilities of remaining in the state of real integration and nonintegration, respectively; and λ_F^1, λ_F^0 denote the probabilities of remaining in the state of financial integration and nonintegration, respectively. Under this process, the unconditional share of integrated households is given by $\frac{1-\lambda_j^0}{2-\lambda_j^1-\lambda_j^0}$.

In each dimension of international integration, we calibrate λ_j^1, λ_j^0 to match the unconditional share of integrated households and the persistence of the integrated status. Regarding real integration, we estimate a 37% share of households working in the tradable sector in Canada. In addition, we target a persistent process for real integration, based on the infrequent changes in sectoral occupations estimated in the labor literature (Loungani and Rogerson, 1989). The calibrated parameters are $\lambda_R^1 = 96\%$ and $\lambda_R^0 = 97.65\%$, which also imply a persistent process for real integration. We present details of these measurements in Appendix B. Additionally, Appendix A.1 studies how the quantitative results vary with alternative targets and endogenous transitions.

Regarding financial integration, we measure households' direct and indirect holdings of external securities. For direct holdings, we use data from the Canadian Financial Monitor (CFM). For indirect holdings, we measure the holdings of external securities of the main intermediary the household is associated with, using intermediaries' balance-sheet data from the Return of the Geographical Distribution of Assets and Liabilities Booked in Canada (GQ return). Using these data, we identify integrated households as those with substantive levels of direct and indirect holdings of external securities. We describe the data, provide descriptive statistics, and present the details of this measurement in Appendix B. We estimate a share of financially integrated households of 33% and an annual probability of remaining integrated of 73.5%. The calibrated parameters are $\lambda_F^1 = 92\%$ and $\lambda_F^0 = 96.06\%$, which

imply fairly persistent financial integration.

We parameterize the portfolio adjustment friction as

$$\Phi(b'_D, b'_E, o_F) = \frac{\phi_b}{2} \cdot \left(\frac{b'_D}{b'_D + b'_E} - \bar{\alpha}(o_F) \right)^2 \cdot |b'_D + b'_E|,$$

where $\bar{\alpha}(o_F)$ is the steady-state portfolio share of domestic securities, which depends on households' financial integration. For nonintegrated households, $\bar{\alpha}(o_F = 0) = 1$ so that they do not face any adjustment cost in equilibrium. For integrated households, we calibrate $\bar{\alpha}(o_F = 1) = 0.79$ to match the average portfolio composition of financially integrated households in Canada.

The last step of our calibration targets aggregate responses to macroeconomic shocks. We do so to highlight the distributional implications of shocks whose aggregate responses are aligned with the data. The first of these targeted aggregate responses are to a domestic monetary policy shock. We focus on the peak responses of aggregate consumption, the nominal policy rate, the CPI, and the UIP deviation to a 25 b.p. monetary policy shock, as documented by Champagne and Sekkel (2018). The parameters that govern these responses are the inflation coefficient in Taylor rule ϕ_π, the persistence of Taylor rule ϕ_i, the persistence of the monetary policy shock, ρ_M, and the strength of the portfolio adjustment costs, ϕ_b.[11] The second set of targeted aggregate responses are those related to the foreign demand shock, as documented by Charnavoki and Dolado (2014). We set the persistence and standard deviation of the foreign demand shock, ρ_Y^H and σ_Y^H, and the intratemporal elasticity of substitution in the consumption aggregator, η, to match the peak responses of the exchange rate, exports, and aggregate consumption to foreign demand shocks. Finally, we set the persistence of the foreign monetary policy shocks to match the autocorrelation of the U.S. policy rates for the period between 1980Q1 and 2007Q1 and set its standard deviation to 25 b.p. to obtain a clear comparison of the effects from the domestic monetary shock and those from the foreign monetary shock. All parameter values are reported in Table 2 and the targeted moments are in Table D.2.

[11] As we show in Appendix A.3, the case of $\phi_b = 0$ corresponds to no deviations from the UIP. The larger the ϕ_b, the stronger the deviations from the UIP.

We solve the model by using 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 of their consumption and savings 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 savings policies, the distribution of households, and the aggregate quantities and prices following the different types of aggregate shocks.

4. Classic Questions in International Macroeconomics from a Distributional Perspective

This section uses our open-economy model to reassess three classic questions in international macroeconomics from a distributional perspective: Section 4.1 analyzes the effects of monetary policy, Section 4.2 analyzes the international spillovers of external shocks and policies, and Section 4.3 studies the implications of different exchange-rate regimes. Finally, Section 4.4 analyzes how the answers to these questions vary under alternative model environments.

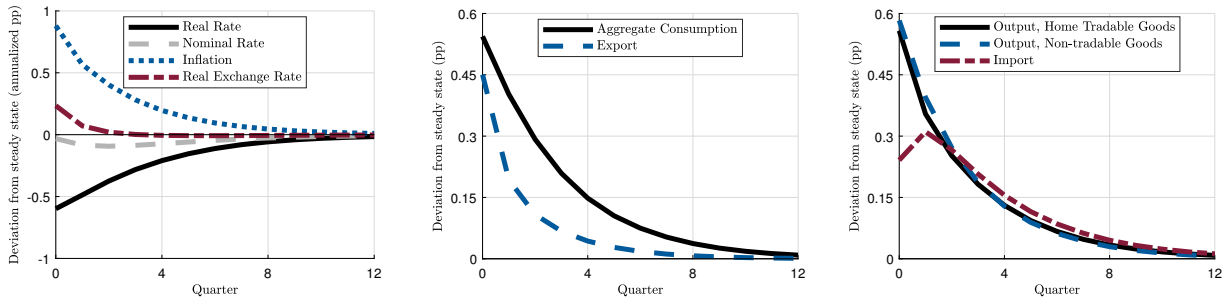
4.1. Effects of Monetary Policy

Aggregate effects We begin by studying the aggregate and distributional effects of changes in domestic monetary policy. Figure 1 shows the aggregate response to an expansionary monetary policy shock: a negative innovation to the Taylor rule, where $\epsilon_t^m = -0.0025$ (more-detailed responses are depicted in Appendix Figure D.1). The peak responses of aggregate consumption, inflation, and the exchange rate are targeted by our calibration and, by design, are aligned with the data. Due to price rigidities, the nominal decline in rates translates to a decline in real rates, which increases consumption with a peak effect close to 0.5%. The currency depreciates in nominal and real terms, 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.

Figure 1: Aggregate Effects of Monetary Policy Shocks

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



Notes: This figure shows the responses of various aggregate variables, in deviations from their steady-state value, to a 25 b.p. expansionary monetary policy shock (i.e., $\epsilon_{m,t} = -0.0025$). Panel (a) shows the responses of nominal and real interest rates, the inflation rate of the ideal price index, and the (log) real exchange rate. Panel (b) shows the log deviations of aggregate consumption and exports. Panel (c) shows the log deviations of the home tradable goods output, nontradable goods output, and imports.

Distributional effects Our main focus is on the distributional consequences of monetary policy in the open-economy model. Panel 1 of Table 3 shows that changes in monetary policy have uneven effects on households, as measured by the standard deviation of the consumption responses, the difference between the 75th and 25th percentiles of the consumption responses, and the difference between the 90th and 10th percentiles, all scaled by the peak effect of aggregate consumption (Appendix Table D.3 presents the unscaled versions of these statistics). All of these measures increase in response to the shock; for instance, the differential consumption effect of households in the 90th and 10th percentiles is 50% of the peak consumption effect.

Panel 2 of Table 3 decomposes the sources of the heterogeneity in the consumption response into the shares that are explained by the differences in wealth, income, and international real and financial integration. This exercise shows that differences in wealth constitute the main source of the heterogeneous responses to a monetary policy shock. Consistent with the findings of closed-economy models, households with lower levels of wealth exhibit larger marginal propensities to consume and are more responsive to changes in mon-

etary policy. In fact, as shown in Appendix C, the heterogeneous responses by wealth are quantitatively similar in our model to those in the closed-economy HANK. For this type of shock, the heterogeneity in international integration does not play a predominant role. On the one hand, as shown in Figure 1, changes in monetary policy induce similar responses in tradable and nontradable production, which lead to similar wage reactions of households with different levels of international real integration. On the other hand, given the high degree of home bias in the assets of integrated households, all households have substantive exposure to changes in the domestic interest rate. In the next subsection, we show that for external shocks, international integration does play a predominant role in accounting for the heterogeneity in the consumption responses.

Table 3: Distributional Effects of Aggregate Shocks

	Domestic monetary shock	Foreign demand shock	Foreign monetary shock
Panel 1. Cross-section dispersion of individual consumption responses			
Standard deviation	0.25	1.47	3.21
Interquantile range	0.30	1.20	1.64
90-10 percentile range	0.50	4.54	10.37
Panel 2. Variance decomposition of the cross-section dispersion (%)			
Real integration	1.1	54.4	19.5
Financial integration	1.2	0.8	26.2
Net wealth	36.3	2.8	19.7
Idiosyncratic labor income	34.2	0.4	0.8

Notes: Panel 1 reports various statistics that measure the cross-section dispersion of individual consumption responses when the aggregate consumption response reaches its peak. All statistics are normalized by the size of the peak aggregate consumption response. Panel 2 reports the contribution of each dimension of heterogeneity to the cross-section variance of individual consumption responses when the aggregate consumption response reaches its peak. The contribution is measured based on the decomposition identity $\mathbb{V}[Y] = \mathbb{E}[\mathbb{V}[Y|X]] + \mathbb{V}[\mathbb{E}[Y|X]]$, where $\mathbb{V}[Y]$ denotes the cross-sectional variance of consumption responses Y; $\mathbb{E}[\mathbb{V}[Y|X]]$ denotes the average of within-group consumption-response variance across the groups categorized by household characteristic X (i.e., real integration, financial integration, net wealth, idiosyncratic labor income); and $\mathbb{V}[\mathbb{E}[Y|X]]$ denotes the variance of the corresponding within-group averages. The reported contributions of different dimensions of heterogeneity are measured by $\frac{\mathbb{V}[\mathbb{E}[Y|X]]}{\mathbb{V}[Y]}$.

Appendix C decomposes the channels through which monetary policy shocks affect

the aggregate economy and different households, comparing these results with two benchmark models: a representative-agent open-economy model and a heterogeneous-agent closed-economy model. We show that, consistent with the findings of Auclert et al. (2020), introducing heterogeneity in households' income and wealth leads to strong labor-income channels in the transmission of monetary policy shocks. As we show in the next section, the main difference that is introduced by the open-economy aspect of the heterogeneous-agent model is linked to external shocks and the heterogeneity in international integration, which we study next.

4.2. International Spillovers

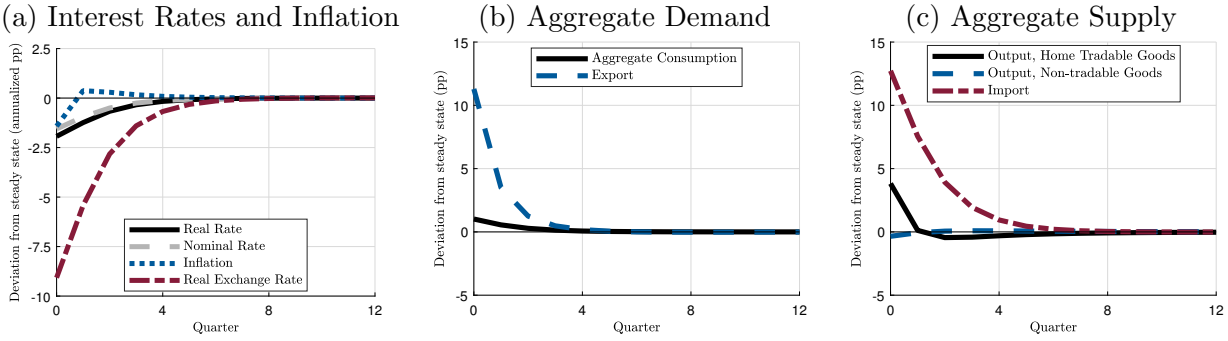
Our second set of exercises studies the aggregate and distributional effects of external shocks. We consider two sources of shocks that are important for open economies: shocks to external demand and those to foreign monetary policy.

External demand The top panels in Figure 2 show the aggregate responses of a positive shock to the external demand of home tradable goods (i.e., a positive innovation of $\epsilon_{y^*,t} = 0.15$), with more details provided in Appendix D Figure D.2. Firms in the home tradable goods 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. On the other hand, the relative price of home and foreign tradable goods adjusts through a currency appreciation and leads to an expenditure switching of domestic households toward foreign tradable goods.[12] Currency appreciation pushes down inflation, leading the monetary authority to cut its policy rate, which further amplifies the increase in domestic demand. The net effect of the external demand shock in the nontradable sector is modest. This is because the expansion in demand is offset by the expenditure switching that is induced by real exchange-rate appreciation.

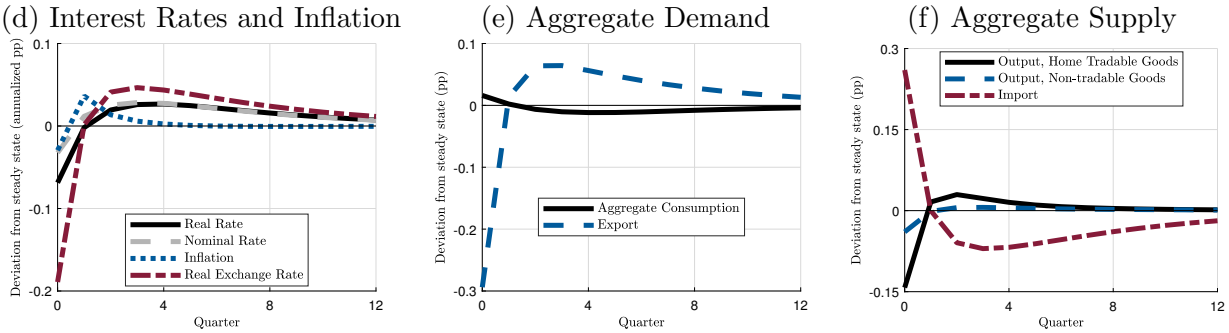
[12]The aggregate effects of the foreign demand shock on the exchange rate can be understood in terms of the classic textbook argument: An increase in exports generates a current account surplus, which induces capital outflows through an exchange-rate appreciation. These responses are qualitatively consistent with the effects of the terms-of-trade shocks documented in the literature (see, for example, Mendoza, 1995; Schmitt-Grohé and Uribe, 2018)

Figure 2: 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 responses of various aggregate variables in deviations from their steady-state values to a one-standard-deviation expansionary external demand shock (i.e., $\epsilon_{y^*,t} = 0.15$). Panels (d)-(f) show the responses of the same variables to a 25 b.p. expansionary foreign monetary policy shock (i.e., $\epsilon_{m^*,t} = -0.0025$). Panels (a) and (d) show the responses of nominal and real interest rates, the inflation rate of the ideal price index, and the (log) real exchange rate. Panels (b) and (e) show the log deviations of aggregate consumption and exports. Panels (c) and (f) show the log deviations of the home tradable goods output, nontradable goods output, and imports.

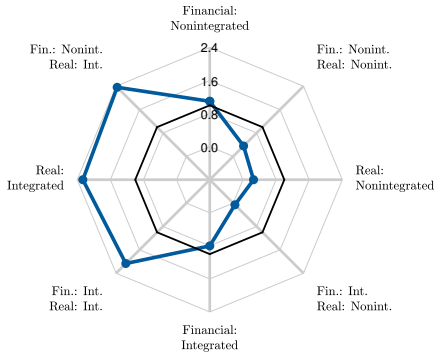
Panel 1 of Table 3 shows that the external demand shock leads to uneven responses in consumption across households, as measured by the standard deviation of the consumption responses and the difference between the 75th and 25th percentiles and the 90th and 10th percentiles. Panel 2 of Table 3 shows that the uneven real integration of households constitutes the most relevant dimension that drives the heterogeneity in the consumption responses to the external demand shocks, accounting for 54% of the cross-sectional variance of consumption responses.

To visualize the heterogeneous effects on the consumption responses along the novel dimensions of the heterogeneity in our model, Figure 3 depicts the peak consumption response

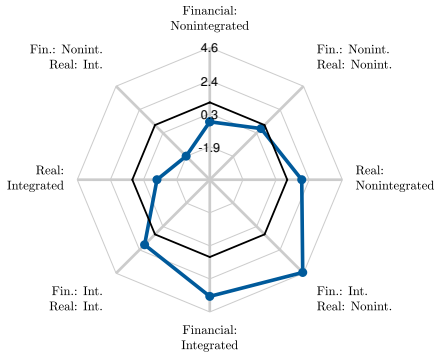
for households with different international integration status, normalized by the peak aggregate consumption response.[13] We vary the real integration of households along the horizontal axis, with the western (respectively, eastern) point showing the responses of households working in the tradable (respectively, nontradable) sector. Similarly, we vary the financial integration of households along the vertical axis, with the northern (respectively, southern) point showing the responses of households not integrated (respectively, integrated) with international capital markets. The diagonals show different cases, conditioning on both dimensions of international integration. The results show that the consumption of households working in the tradable sector is one order of magnitude more responsive to external demand shocks than that of households working in the nontradable sector. As shown in Appendix C Table C.1, this is mostly due to the effect of external demand shocks on labor income, as these shocks are mostly concentrated in households working in the tradable sector.

Figure 3: Heterogeneous Consumption Responses to Expansionary External Shocks

(a) Foreign Demand Shock



(b) Foreign Monetary Policy Shock



Notes: Panel (a) shows the distributional effects of a one-standard-deviation expansionary external demand shock (i.e., $\epsilon_{y^*,t} = 0.15$) on consumption. Panel (b) shows the distributional effects of a 25 b.p. expansionary foreign monetary policy shock (i.e., $\epsilon_{m^*,t} = -0.0025$) on consumption. Each figure shows the responses of the average consumption of different subgroups of households in the period when the aggregate consumption response reaches its peak. Households are categorized by their type of *real* and *financial* integration. We denote "Real" and "Fin." to refer to real and financial integration, and "Int." and "Nonint." to refer to *integrated* and *nonintegrated*. All responses are normalized by the peak responses of aggregate consumption. As a benchmark, the black solid line corresponds to the case of homogeneous consumption responses.

[13]The peak consumption responses at the individual level in this paper refer to the individual consumption responses in the period when the aggregate consumption response reaches its peak. Under the current calibration, the consumption responses of almost all of the households reach their peaks in the same period in which the aggregate consumption response reaches its peak.

Foreign monetary policy The bottom panels in Figure 2 show the aggregate responses to a foreign monetary policy expansion, with more details provided in Appendix D Figure D.3. The decline in foreign interest rates makes the returns to domestic securities relatively more attractive, inducing financially integrated households to tilt their portfolios toward domestic securities. This creates a sharp appreciation of the local currency, on impact, leading to an expenditure switching of domestic households toward foreign tradable goods and a contraction in the output of tradable and nontradable goods. This contraction occurs in spite of the fact that the shock leads to a mild increase in domestic consumption that is triggered by direct channels from the decline in foreign rates. Appendix A.8 shows how the aggregate effects of foreign monetary policy shocks are governed by the elasticity of substitution between the home and the foreign goods and the degree of the home bias in the financial portfolios of integrated households. For our baseline parameterization, this shock has a modest effect on consumption, which is one order of magnitude lower than the effect of domestic monetary policy.

Panel 1 of Table 3 shows that the foreign monetary policy shock has uneven effects across different households, with increases in the standard deviation of the consumption responses and the difference between the 75th and 25th percentiles and between the 90th and 10th percentiles. As shown in Appendix C Table C.1, this is to a large extent because the foreign monetary policy shock induces direct channels that only affect financially integrated households. Panel (b) of Figure 3 shows that because of these direct channels, the consumption of financially integrated households responds around four times more than aggregate consumption. Table 3 shows that the heterogeneity in households' financial integration accounts for 26% of the cross-sectional variance in the consumption responses. In addition, this table shows that real integration plays an important role in the heterogeneous responses to a foreign monetary policy shock. This is because the real exchange-rate appreciation has a negative impact on households' wages, which is more pronounced for those working in the tradable sector (see Figure 3 and Table 3).

The relevance of heterogeneity in households' international integration We conclude by emphasizing a key takeaway from this section. It is well documented that an important part of fluctuations in open economies stems from foreign macroeconomic shocks. Our analysis shows that the uneven international integration of households gives rise to inequality in the individual responses to these shocks more so than does the heterogeneity in income and wealth, which has been the main focus of the closed-economy literature on household heterogeneity.

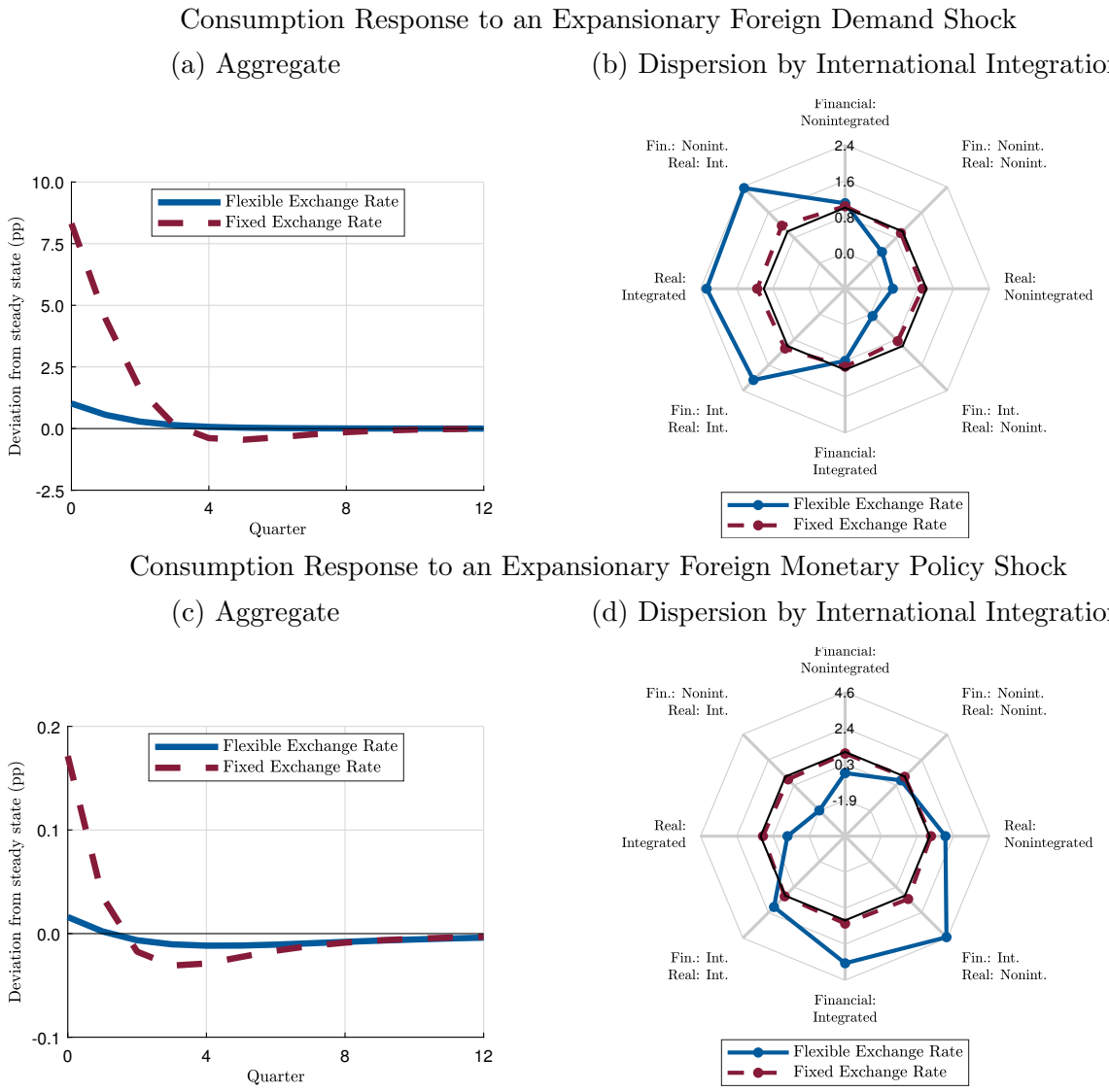
4.3. Exchange-rate Regimes

The third classic question we address is how the 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 4.2) 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 4 show that, as is 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 than under a flexible regime. As further detailed in Appendix D Figures D.4 and D.5, this is because 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 expansion in domestic demand. As a result, for both increases in external demand and declines in foreign interest rates, the aggregate consumption response is larger under a fixed-exchange-rate regime than under a Taylor rule.[14]

[14]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.

Figure 4: Aggregate and Distributional Effects of External Shocks under Alternative Exchange-rate Regimes



Notes: Panels (a)-(b) show the impact of a one-standard-deviation external demand shock (i.e., $\epsilon_{y^*,t} = 0.15$) on consumption under different exchange-rate regimes. Panels (c)-(d) show the impact of a 25 b.p. expansionary foreign monetary policy shock (i.e., $\epsilon_{m^*,t} = -0.0025$) on consumption under different exchange-rate regimes. Panels (a) and (c) show the responses of aggregate consumption. Panels (b) and (d) show the responses of the total consumption of different subgroups of households in the period in which the aggregate consumption response reaches its peak. Households are categorized by their type of *real* and *financial* integration. We denote "Real" and "Fin." to refer to real and financial integration, and "Int." and "Nonint." to refer to *integrated* and *nonintegrated*. All responses are normalized by the peak responses of aggregate consumption. As a benchmark, the black solid line corresponds to the case of homogeneous consumption responses. *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 $\mathcal{E}_t = 1$ in all periods.

Figure 4 also compares the distributional implications of the different exchange-rate regimes by depicting the relative consumption responses of households with different degrees of international integration. Panel (b) shows the case of external demand shocks, which indicates that a flexible-exchange-rate regime leads to more-unequal responses between households working in different sectors, relative to a fixed-exchange-rate regime. As shown in Appendix D Table D.4, this is due to the differential effect of the external demand shock on their labor income, which is more uneven under a flexible exchange rate. Under a fixed exchange rate, as the monetary authority reduces interest rates to prevent currency appreciation, it stimulates aggregate demand. This increases the labor income of households working in nontradable sectors and attenuates the differential consumption responses of households along the real integration dimension.

Panel (d) shows that a fixed-exchange-rate regime is also associated with consumption responses that are less uneven between integrated and nonintegrated households in the case of foreign monetary policy shocks. In this case, the main source of inequality in the consumption responses under the flexible-exchange-rate regime is the uneven impact of direct changes in interest rates for households that are integrated with international financial markets vis-à-vis those that are not integrated with international markets (see Appendix D Table D.4). Under the fixed-exchange-rate regime, the reduction in the domestic policy rate to prevent currency appreciation triggers direct expansionary channels for households those are not integrated with international financial markets, which causes the interest rate channel to be more even for both integrated and nonintegrated households. An implication of this analysis is that the dispersion of relative consumption responses can be smaller under a fixed-exchange-rate regime than under a flexible one (see Appendix D Figure D.6).

The stabilization-inequality trade-off of exchange-rate regimes. A second takeaway is that the choice of monetary policy in open economies–and, in particular, the choice of exchange-rate regimes–entails the distributional consequences for households with different degrees of international integration. To the extent that the objective of monetary authorities includes inequality considerations, our results indicate the presence of a trade-off between

aggregate stabilization and consumption inequality in the conduct of monetary policy.

4.4. Extensions

Appendix A analyzes the results of the aggregate and redistributional effects of monetary policy under different model extensions. First, we study the role of mobility in international integration. For this, Appendix A.1 endogenizes households' international integration. If we target the same persistence of international integration as in our baseline model, endogenizing transitions does not alter our quantitative conclusions. However, Table A.2 shows that for economies with more-frequent transitions between integration and nonintegration, the distributional effects of aggregate shocks are dampened with endogenous transitions.

Second, we study the role of international integration to financial markets in driving the aggregate and distributional responses to shocks. Appendix A.2 analyzes an economy in which financially integrated households do not have home bias in their asset portfolios. In that economy, the direct effects of changes in the foreign monetary policy rate are larger and so are their aggregate effects on consumption. Additionally, financial integration is a more-relevant source of the heterogeneity in the consumption responses to domestic monetary policy shocks, which do not affect financially integrated households through direct channels. Appendix A.3 analyzes an economy without deviations from the UIP; in this economy, financial integration ceases to be a relevant source of households' heterogeneity.

Third, we study the role of currencies as units of account. Appendix A.4 studies an economy in which the price of tradable goods is denominated in the foreign currency. Appendix A.5 considers an economy in which financial securities are denominated in the foreign currency. Both of these economies feature larger distributional effects of domestic monetary policy shocks. In the case of the foreign currency denomination of prices, currency depreciation stimulates more income and consumption by workers in nontradable sectors, which generates more-uneven responses along real integration. In the case of the foreign currency denominated securities, currency depreciation triggers heterogeneous wealth effects that depend on the households' net asset positions, which generates more-uneven consumption responses.

Finally, Appendix A considers two additional model extensions. First, we extend the model to an economy with investment. The main difference is that this economy features milder consumption responses because expansionary shocks lead to large investment responses, which lead to more-aggressive monetary policy reactions. Second, we study economies in which households' wealth is correlated with their international integration. The main takeaway from this analysis is that the interaction between wealth and international integration becomes a relevant source of heterogeneity in accounting for the dispersion of consumption responses to shocks.

5. Globalization and Monetary Policy

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 examine how our conclusions are affected by two dimensions of globalization: the degree of international integration and the capital flow mobility that characterizes an economy. From a positive perspective, this exercise helps us understand how changes in the international integration and capital flow mobility that countries often experience are expected to influence 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, a topic that motivates this paper.

5.1. The Role of International Integration

To study the role of international integration, we compare the baseline economy's responses to macro shocks with the responses of an identical economy whose levels of real and financial integration are half those of the baseline economy.[15] In this exercise, to decrease the level of real integration, we jointly decrease the share of households working in the tradable

[15] Subramanian and Kessler (2013) document that real integration, as measured by the global trade flows of goods and services, roughly doubled since 1980. Obstfeld (2007) shows that financial integration, as measured by global capital flows, increased by a similar magnitude. Our exercise is motivated by these global trends.

home goods sector relative to those working in the nontradable sector and the share of tradable home goods in the consumption basket relative to that of nontradable goods; to decrease the level of financial integration, we decrease the share of households that have access to financial securities that are internationally traded. This exercise aims to capture the 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 facing 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 that are traded with the rest of the world.

Panel (a) of Table 4 shows the aggregate responses to macro shocks, with two main results. First, the aggregate effects of domestic monetary policy are relatively unaffected by integration. This is because all households, including those that are financially integrated, hold most of their savings in domestic assets due to the large degree of home bias in the financial portfolios that are exhibited in the data. Second, higher international integration amplifies the aggregate effect of external shocks. This is because changes in external demand have larger effects when the share of the tradable sector is high, and changes in foreign monetary policy are larger when the share of households integrated with international capital markets is large.

Table 4: Effects of External Shocks under Different Levels of International Integration

	Baseline Level	Low Level
Panel (a): Aggregate consumption responses (%)		
Domestic monetary shock	0.54	0.56
Foreign demand shock	1.02	0.41
Foreign monetary shock	0.02	0.01
Panel (b): Cross-section standard deviation of individual consumption responses		
Domestic monetary shock	0.25	0.24
Foreign demand shock	1.47	2.33
Foreign monetary shock	3.21	7.71

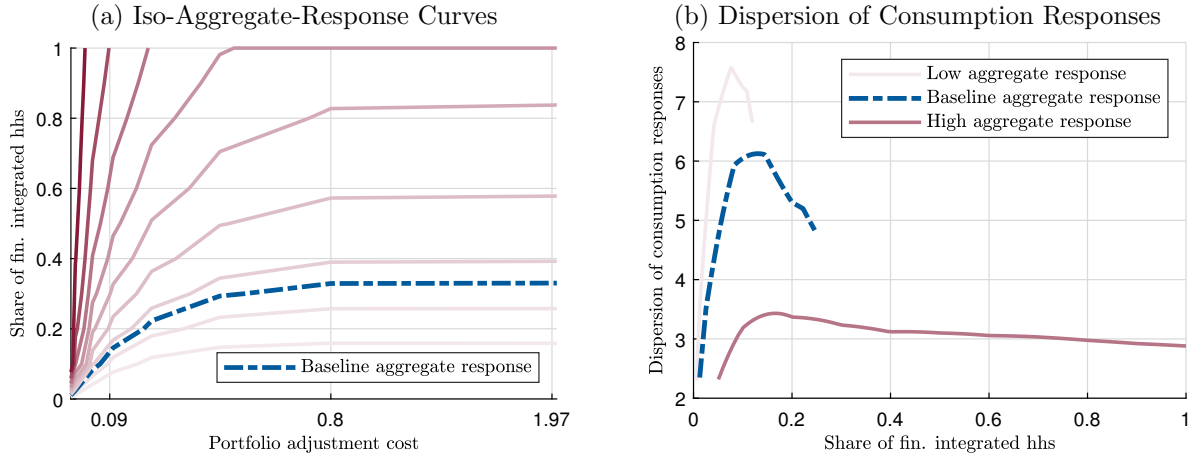
Note: This table reports the effects of a 25 b.p. expansionary monetary policy shock ($\epsilon_{m,t} = -0.0025$), a one-standard-deviation expansionary external demand shock ($\epsilon_{y^*,t} = 0.15$), and a 25 b.p. expansionary foreign monetary policy shock ($\epsilon_{m^*,t} = -0.0025$) in two economies with different degrees of international integration. "*Baseline level*" corresponds to the baseline calibration of the model, where the fractions of the financially and real integrated households are 33% and 37%, respectively. "*Low level*" corresponds to a parametrization in which we recalibrate the degrees of international integration to be half the baseline levels; i.e., the percentages of financially integrated and real integrated households are 16.5% and 18.5%, respectively. In the "Low level" case, we also recalibrate the model to have the same wealth distribution as the baseline model. Panel (a) reports the peak consumption responses. Panel (b) reports the cross-section standard deviation of individual consumption responses when aggregate consumption reaches its peak after being normalized by the size of the peak aggregate responses.

Panel (b) compares the distributional effects of macroeconomic shocks with different levels of international integration. The main takeaway is that a higher degree of international integration dampens the distributional impacts of external shocks. This is because in an economy with a low degree of international integration, external shocks have little impact on aggregates and the small share of households that are integrated experience large swings relative to the aggregate responses to international shocks.[16] In this sense, an economy with

[16]To further explain this result, Appendix D Figure D.7 shows how the distributional effects of macro shocks vary when we vary the degree of real and financial integration separately. We show these results by tracing the standard deviation of the consumption responses, with and without normalizing by the aggregate response to the shocks. Panels (a)-(b) of Appendix D Figure D.7 show that without normalizing for the aggregate response, there is a nonmonotonic relationship between the dispersion of the consumption responses and the degree of international integration. The dispersion is maximal in economies that have considerable shares of both integrated and nonintegrated households. Panels (c)-(d) show that once we normalize by the aggregate response, the dispersion becomes monotonically decreasing (increasing) in the degree of international integration in response to external (domestic) shocks.

a low degree of international integration can suffer more-unequal responses to globalization.

Figure 5: Consumption Responses to Foreign Monetary Shocks: The Role of Portfolio Adjustment Costs and Degrees of Financial Integration



Notes: In Panel (a), each line depicts a combination of portfolio adjustment costs and the share of financially integrated households that generate a fixed level of aggregate consumption responses to a 25 b.p. expansionary foreign monetary shock ($\epsilon_{m^*,t} = -0.25\%$). In Panel (b), each line depicts the cross-sectional dispersion of consumption responses for different shares of financially integrated households and their corresponding portfolio adjustment costs that keep the same aggregate consumption responses. The lighter colored lines indicate a lower level of aggregate consumption response. The dashed line corresponds to the level of aggregate consumption response under the baseline calibration. The dispersion of the consumption responses is measured by the standard deviation of individual consumption responses normalized by the size of the aggregate consumption response in the period when it reaches its peak.

5.2. Financial Integration and Capital Flow Mobility

We now focus on the financial dimension of globalization. Economies can open their capital accounts by making foreign securities available to a larger share of their populations or by reducing the capital controls or portfolio frictions faced by financially integrated households. In this section, we assess the aggregate and distributional effects of foreign monetary shocks in economies with different shares of financial integration and capital controls. Panel (a) of Figure 5 shows that increasing pairs of financially integrated households and portfolio adjustment costs can be associated with the same aggregate consumption response to a foreign monetary expansion (i.e., iso-aggregate response curves). A higher share of integrated households can amplify the aggregate effects, but larger adjustment costs increase the UIP deviations and limit the pass-through of the foreign interest rate shock to both the local

interest rate and the exchange rate. We argue that calibrations that are associated with the same aggregate effects can have different distributional implications. Panel (b) shows the cross-sectional standard deviation of consumption responses to a foreign monetary shock associated with different parameterizations of the share of financial integration and portfolio adjustment costs that have the same associated aggregate consumption response. Consistent with the results from the previous analysis, the cross-sectional dispersion is maximized with low shares of financially integrated households.

6. Conclusion

Motivated by the asymmetric effects of globalization documented over the last four decades, we study how monetary policy shapes the effects of external shocks on open economies. We focus on new sources of household heterogeneity that are linked to their international integration; namely, the sector in which households work and their access to international capital markets. We argue that these dimensions are more relevant in accounting for the distributive effects of external shocks rather than income and wealth, which are the main focus of closed-economy heterogeneous-agents models. In confronting these shocks, monetary authorities may 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 over globalization might arise, perhaps paradoxically, from international integration 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

Agnew, J., P. Balduzzi, and A. Sunden (2003). Portfolio choice and trading in a large 401 (k) plan. *American Economic Review 93*(1), 193–215.

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

Alvarez, F., A. Atkeson, and P. J. Kehoe (2002). Money, interest rates, and exchange rates with endogenously segmented markets. *Journal of Political Economy 110*(1), 73–112.

Arellano, C., Y. Bai, and G. P. Mihalache (2020). Monetary policy and sovereign risk in emerging economies (nk-default). Technical report, National Bureau of Economic Research.

Artuç, E., S. Chaudhuri, and J. McLaren (2010). Trade shocks and labor adjustment: A structural empirical approach. *American Economic Review 100*(3), 1008–45.

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

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

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

Autor, D. H., D. Dorn, and G. H. Hanson (2013, October). The China syndrome: Local labor market effects of import competition in the United States. *American Economic Review 103*(6), 2121–68.

Benigno, P. and F. Romei (2014). Debt deleveraging and the exchange rate. *Journal of International Economics 93*(1), 1–16.

Bianchi, J. and L. Coulibaly (2021). Liquidity Traps and International Spillovers. Federal Reserve Bank of Minneapolis Working Paper.

Bilbiie, F. O., T. Monacelli, and R. Perotti (2020). Stabilization vs redistribution: The optimal monetary-fiscal mix. *Centre for Economic Policy Research Working Paper*.

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

Bowlus, A., E. Gouin-Bonenfant, H. Liu, L. Lochner, and Y. Park (2020). Four decades of Canadian earnings dynamics across workers and firms. *Unpublished manuscript*.

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

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

Calvo, G. A. and C. M. Reinhart (2002). Fear of floating. *The Quarterly Journal of Economics 117*(2), 379–408.

Céspedes, L. F., R. Chang, and A. Velasco (2004). Balance sheets and exchange rate policy. *American Economic Review 94*(4), 1183–1193.

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

Chari, V. V., P. J. Kehoe, and E. R. McGrattan (2002). Can sticky price models generate volatile and persistent real exchange rates? *The Review of Economic Studies 69*(3), 533–563.

Charnavoki, V. and J. J. Dolado (2014, April). The effects of global shocks on small commodity-exporting economies: Lessons from Canada. *American Economic Journal: Macroeconomics 6*(2), 207–37.

Chien, Y., H. Cole, and H. Lustig (2012). Is the volatility of the market price of risk due to intermittent portfolio rebalancing? *American Economic Review 102*(6), 2859–96.

Chodorow-Reich, G. (2013). The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis. *The Quarterly Journal of Economics 129*(1), 1–59.

Chodorow-Reich, G. and J. Wieland (2020). Secular labor reallocation and business cycles. *Journal of Political Economy 128*(6), 2245–2287.

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

Corsetti, G., L. Dedola, and S. Leduc (2010). Optimal monetary policy in open economies. In *Handbook of Monetary Economics*, Volume 3, pp. 861–933. Elsevier.

Corsetti, G. and P. Pesenti (2005). International dimensions of optimal monetary policy. *Journal of Monetary Economics 52*(2), 281–305.

Cravino, J. and A. A. Levchenko (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. *Unpublished manuscript*.

De Ferra, S., K. Mitman, and F. Romei (2020). Household heterogeneity and the transmission of foreign shocks. *Journal of International Economics*, 103–303.

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

Drenik, A. (2016). Labor market dynamics after nominal devaluations. Unpublished manuscript.

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

Du, W., C. E. Pflueger, and J. Schreger (2020). Sovereign debt portfolios, bond risks, and the credibility of monetary policy. *The Journal of Finance 75*(6), 3097–3138.

Dvorkin, M. (2013). Sectoral shocks, reallocation and unemployment in a model of competitive labor markets. Unpublished manuscript.

Eichengreen, B. J., R. Hausmann, and U. Panizza (2002). Original sin: the pain, the mystery, and the road to redemption. Technical report, "Currency and Maturity Matchmaking: Redeeming Debt from Original Sin" Conference Organized by IADB.

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.

Engel, C. and J. Park (2021). Debauchery and Original Sin: The Currency Composition of Sovereign Debt. Unpublished manuscript, University of Wisconsin Madison.

Fama, E. F. (1984). Forward and spot exchange rates. *Journal of Monetary Economics 14*(3), 319–338.

Farhi, E. and I. Werning (2016). Fiscal multipliers: Liquidity traps and currency unions. In *Handbook of macroeconomics*, Volume 2, pp. 2417–2492. Elsevier.

Farhi, E. and I. Werning (2017). Fiscal unions. *American Economic Review 107*(12), 3788–3834.

Fleming, J. M. (1962). Domestic financial policies under fixed and under floating exchange rates.

IMF Staff Papers 9(3), 369–380.

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

Fornaro, L. (2015). Financial crises and exchange rate policy. *Journal of International Economics 95*(2), 202–215.

Fornaro, L. and F. Romei (2019). The paradox of global thrift. *American Economic Review 109*(11), 3745–79.

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

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

Giglio, S., M. Maggiori, J. Stroebel, and S. Utkus (2019). Five facts about beliefs and portfolios. Technical report, National Bureau of Economic Research.

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

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

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

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

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

Gospodinov, N. and D. Lkhagvasuren (2014). A moment-matching method for approximating vector autoregressive processes by finite-state Markov chains. *Journal of Applied Econometrics 29*(5), 843–859.

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

Hassan, T. A., T. M. Mertens, and T. Zhang (2016). Currency manipulation. Technical report, National Bureau of Economic Research.

Hassan, T. A. and T. Zhang (2020). The economics of currency risk. *Annual Review of Economics 13*.

Itskhoki, O. and D. Mukhin (2017). Exchange rate disconnect in general equilibrium. Technical report, National Bureau of Economic Research.

Itskhoki, O. and D. Mukhin (2019). Mussa puzzle redux. *Available at SSRN 3423438*.

Kalemli-Ozcan, S. (2019). US monetary policy and international risk spillovers. Technical report, National Bureau of Economic Research.

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

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

Kekre, R. and M. Lenel (2021). The flight to safety and international risk sharing. Technical report, National Bureau of Economic Research.

Krueger, D. and F. Perri (2006). Does income inequality lead to consumption inequality? Evidence

and theory. *The Review of Economic Studies 73*(1), 163–193.

Li, J. (2021). Predicting the demand for central bank digital currency: A structural analysis with survey data. Technical report.

Lilien, D. M. (1982). Sectoral shifts and cyclical unemployment. *Journal of Political Economy 90*(4), 777–793.

Lkhagvasuren, D. (2012). Key moments in the Rouwenhorst method. Technical report, Unpublished manuscript.

Loungani, P. and R. Rogerson (1989). Cyclical fluctuations and sectoral reallocation: Evidence from the PSID. *Journal of Monetary Economics 23*(2), 259–273.

Lustig, H. and A. Verdelhan (2007). The cross section of foreign currency risk premia and consumption growth risk. *American Economic Review 97*(1), 89–117.

Maggiori, M. (2021). International macroeconomics with imperfect financial markets. *Unpublished manuscript*.

Maggiori, M., B. Neiman, and J. Schreger (2017). International Currencies and Capital Allocation. Unpublished manuscript, Harvard University.

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

Mukhin, D. (2018). An equilibrium model of the international price system. Technical report, 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. (2007). International risk sharing and the costs of trade. *Unpublished manuscript*.

Obstfeld, M. and K. Rogoff (1995). Exchange rate dynamics redux. *Journal of Political Economy 103*(3), 624–660.

Obstfeld, M. and K. Rogoff (2000). New directions for stochastic open economy models. *Journal of International Economics 50*(1), 117–153.

Oskolkov, A. (2021). Exchange rate policy and heterogeneity in small open economies. *Unpublished manuscript*.

Ottonello, P. (2021). Optimal exchange-rate policy under collateral constraints and wage rigidity. *Journal of International Economics 131*, 103–478.

Ottonello, P. and D. J. Perez (2019). The currency composition of sovereign debt. *American Economic Journal: Macroeconomics 11*(3), 174–208.

Parker, J. A., N. S. Souleles, D. S. Johnson, and R. McClelland (2013, October). Consumer spending and the economic stimulus payments of 2008. *American Economic Review 103*(6), 2530–53.

Pilossoph, L. (2014). Sectoral shocks and move unemployment. Technical report. Federal Reserve Bank of New York.

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

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. Technical report, National Bureau of Economic Research.

Rogoff, K. (2006). Impact of globalization on monetary policy. In *a symposium sponsored by*

the Federal Reserve Bank of Kansas City on "The new economic geography: effects and policy implications," Jackson Hole, Wyoming, pp. 24–26.

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*, pp. 294–330. Princeton University Press.

Schmitt-Grohé, S. and M. Uribe (2011). Pegs and pain. Technical report, National Bureau of Economic Research.

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

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

Stiglitz, J. E. (2017). *Globalization and its Discontents Revisited*. WW Norton & Company, Inc.: New York, NY, USA.

Straub, L. (2018). Consumption, savings, and the distribution of permanent income. *Unpublished manuscript, Harvard University*.

Subramanian, A. and M. Kessler (2013). The hyperglobalization of trade and its future. *Unpublished manuscript*.

Zhou, H. (2020). Open economy, redistribution, and the aggregate impact of external shocks. Technical report. Princeton University.

A. Model Extensions

This appendix presents various model extensions and analyzes their quantitative results by comparing them with those of the baseline model. We study seven model extensions: endogenous transitions between international integration, no home bias for integrated households, no UIP deviations, tradable prices in foreign currency, financial securities in foreign currency, investment, and correlated wealth and integration.

A.1. Endogenous Transition of International Integration Status

Model This extension studies a model with endogenous choices of international integration by households. We model this choice using techniques from dynamic discrete-choice models, by assuming that households face a fixed cost of switching their international integration status and have a preference shock that is associated with each international integration status and follows an extreme value distribution. In particular, households enter the period with their integration status from the previous period, receive a vector of preference shocks, and decide their new integration status. Then they choose their consumption and savings for the following period.

The recursive problem of the households under this setup is given by

$$U_t(z, \mathbf{b}, \mathbf{o}^-, \varepsilon) = \max_{o_R, o_F} \left\{ (1-\xi) \cdot V_t(z, \mathbf{b}, \mathbf{o}) + \xi \cdot \tilde{V}_t(z, \mathbf{b}, \mathbf{o}) + \varepsilon_{\mathbf{o}} - c_{\mathbf{o}^-, \mathbf{o}} \right\},$$

where $U_t(z, \mathbf{b}, \mathbf{o}', \varepsilon)$ denotes the value after choosing their integration status, with $\mathbf{o}'$ denoting the integration status from the previous period; $V_t(z, \mathbf{b}, \mathbf{o})$ and $\tilde{V}_t(z, \mathbf{b}, \mathbf{o})$ denote the household's value after they choose their integration status, conditional on their survival status; $c_{\mathbf{o}^-, \mathbf{o}}$ denotes the cost of switching their integration status from $\mathbf{o}^-$ to $\mathbf{o}$, and $\varepsilon_{\mathbf{o}}$ denotes an i.i.d. preference shock associated with these households' integration status. We assume that the preference shock follows a Gumbel distribution with C.D.F. as $e^{-e^{-\varepsilon_{\mathbf{o}}}}$ and adjustment costs $\mathbf{c}_{\mathbf{o}^-, \mathbf{o}} = \mathbf{c}^R_{o_R^-, o_R} + \mathbf{c}^F_{o_F^-, o_F}$, where $\mathbf{c}^R_{o_R^-, o_R}$ and $\mathbf{c}^F_{o_F^-, o_F}$ denote the cost of switching the real and financial integration statuses, respectively. Finally, we assume there are no costs of maintaining the previous integration status; i.e., $\mathbf{c}^R_{o_R^-, o_R} = 0$ if $o_R^- = o_R$ and $\mathbf{c}^F_{o_F^-, o_F} = 0$ if $o_F^- = o_F$.

The value of consuming and saving is given by

$$
\begin{aligned}
V_t(z, \mathbf{b}, \mathbf{o}) = & \max_{c_{\mathrm{H}}, c_{\mathrm{F}}, c_{\mathrm{N}}, l, \mathbf{b}'} u(c, l) + \beta \cdot \mathbb{E}_t \left[U_{t+1} \left(z', \mathbf{b}', \mathbf{o}, \varepsilon' \right) \right] \\
\text{s.t.} \quad & c = \mathcal{C}_{\mathrm{TN}}(c_{\mathrm{T}}, c_{\mathrm{N}}), \ c_{\mathrm{T}} = \mathcal{C}_{\mathrm{HF}}(c_{\mathrm{H}}, c_{\mathrm{F}}), \\
& P_{\mathrm{H},t} c_{\mathrm{H}} + P_{\mathrm{F},t} c_{\mathrm{F}} + P_{\mathrm{N},t} c_{\mathrm{N}} + q_{\mathrm{D}t} \cdot b'_{\mathrm{D}} + q_{\mathrm{E}t} \cdot b'_{\mathrm{E}} + \Phi(b'_{\mathrm{D}}, b'_{\mathrm{E}}, o_{\mathrm{F}}) \\
& = z \cdot (1 - \tau_t) \cdot W_t(o_R) \cdot l + T_t(z) + b_{\mathrm{D}} + b_{\mathrm{E}} \\
& \mathbf{b}' \in \mathcal{B}(o_F) \\
& z' \in \Gamma_z(z)
\end{aligned}
$$

where all variables are defined as in the baseline model and $\Gamma_z(z)$ denotes the same exogenous transition rules for the idiosyncratic labor income.

The above Bellman equation system shares most of the elements of the baseline setup and provides an endogenous evolution of the integration status. The endogenous transition probability from $\mathbf{o}^-$ to $\mathbf{o}$ is

$$
\frac{\exp\left(\bar{V}_t(z, b, \mathbf{o}) - \mathbf{c}_{\mathbf{o}^-, \mathbf{o}}\right)}{\sum_{\tilde{\mathbf{o}}} \exp\left(\bar{V}_t(z, b, \tilde{\mathbf{o}}) - \mathbf{c}_{\mathbf{o}^-, \tilde{\mathbf{o}}}\right)},
$$

where $\bar{V}_t(z, b, \mathbf{o}) \equiv (1-\xi) \cdot V_t(z, \mathbf{b}, \mathbf{o}) + \xi \cdot \tilde{V}_t(z, \mathbf{b}, \mathbf{o})$ denotes the expected value of choosing integration status $\mathbf{o}$. The transition probability depends on households' idiosyncratic states z and $\mathbf{b}$.

Calibration We calibrate the adjustment costs to target the same steady-state moments as in the baseline model. This way, the average transition probability of the international integration status under this extension matches that of the baseline model in the steady state. We also recalibrate the level of government debt and the borrowing constraint so that the current model has the same median wealth-to-income ratio and median MPC as in the baseline model. The calibration of these parameters is summarized in Table A.1. For the parameters with directly targeting moments, including ψ, β, ω_T, we use the same targets as in the baseline model to calibrate them.[17] All other parameters are set to the same values as in the baseline model. The main results from this model are summarized in the column labeled "Endogenous transition" of Table A.6.

[17] More specifically, we calibrate ω_T to equalize the wages across sectors in the steady state; ψ to target the steady-state hours at $\frac{1}{3}$; and β to target a steady-state domestic annual interest rate of 4%.

To better understand the impacts from the endogenous transition, we also conduct a comparison between the baseline model and this extension, calibrated to match a lower persistence in households' international integration status. We recalibrate the average persistence of households' financial and real integration status to be 90% in both the baseline model and in this extension (see Table A.1 for the details of this calibration). In Table A.2, we collect the effects of various aggregate shocks within these two models. When calibrated to a lower persistence, the model with endogenous transitions features dampened cross-sectional dispersion in the responses to the external macroeconomic shocks.

A.2. Financially Integrated Households without Home Bias in Assets

Model This extension studies how the results vary when financially integrated households save/borrow exclusively in external securities. This corresponds to a particular parameterization of the portfolio-adjustment costs of financially integrated households such that the steady state of domestic securities $\bar{\alpha}(o_F = 1) = 0$, and there is sufficiently large ϕ_b, which parameterizes the costs of deviating from the steady-state portfolio.

Calibration We recalibrate the level of government debt, B_{ss}, and the borrowing constraint to match the median wealth-to-income ratio and the median MPC in the baseline model. We also recalibrate ψ, β, ω_T to target the same moments as in the baseline model. We set the remaining parameters to the same values as in the baseline model. The recalibrated parameters are collected in Table A.3, and the results from this extension are summarized in the column "No home bias" in Table A.6.

A.3. No UIP Deviations

Model This extension studies a variant of the baseline model in which the UIP holds in equilibrium. This corresponds to a particular case without portfolio-adjustment costs for financially integrated households; i.e., $\phi_b = 0$.

Under this parameterization, the inter-temporal first-order conditions of financially integrated households imply equal returns on domestic and external securities, $q_{D,t} = q_{E,t}$, which is approxi-

Table A.1: Calibration of the Model with Endogenous Transition in Integration Status

		Baseline persistence		Lower persistence	
		Exo--genous	Endo--genous	Exo--genous	Endo--genous
Panel 1: Parameters					
Cost to adjust integration status					
$\mathbf{c}^R_{0,1}$	Real integration, to be integrated	-	4.13	-	3.87
$\mathbf{c}^R_{1,0}$	–, to be nonintegrated	-	2.78	-	1.10
$\mathbf{c}^F_{0,1}$	Financial integration, to be integrated	-	4.20	-	4.31
$\mathbf{c}^F_{1,0}$	–, to be nonintegrated	-	1.43	-	0.85
Wealth level and financial frictions					
B_{ss}	Government debt	0.85	0.87	0.85	0.76
$\underline{b}$	Borrowing constraint	-0.29	-0.20	-0.29	-0.37
Households' preference					
β	Discounting factor	0.96	0.96	0.96	0.96
ψ	Disutility of labor	7.93	7.91	7.93	7.93
ω_{T}	Fraction of tradable goods consumption	0.33	0.33	0.33	0.33
Panel 2: Key moments in steady state					
Average transition probability of international integration status (%)					
Real integration, remaining integrated		96	96	90	90
–, remaining nonintegrated		97.65	97.66	94.13	94.13
Financial integration, remaining integrated		92	92	90	90
–, remaining nonintegrated		96.06	96.06	95.07	95.09
Wealth-to-income ratio and MPC					
Median wealth-to-income ratio		0.35	0.35	0.35	0.35
Median MPC		0.15	0.15	0.15	0.15

Notes: This table reports the calibration and key steady-state moments of different models with different levels of persistence of international integration status. "Baseline persistence" refers to models with the baseline calibration of the average transition probability across households' integration status (see Table 2 for details); "Lower persistence" refers to models with the persistence of both the real and financially integrated status at 90%. "Exogenous" refers to the model in which the transition of international integration status is exogenous, as specified in Section 2; "Endogenous" refers to the model in which the transition is endogenous and subject to adjustment costs, as specified in Appendx A.1. The value of adjustment costs, B_{ss}, and $\underline{b}$ are expressed in units of households' quarterly average labor incomes in the corresponding steady state.

mately equivalent to

$$i_t = i_t^* + \mathbb{E}_t \left[\Delta \mathcal{E}_{t+1} \right],$$

Table A.2: Implications of Exogenous and Endogenous Transition with Less Persistent Integration Status

	Domestic monetary shock		Foreign demand shock		Foreign monetary shock	
	Exo--genous	Endo--genous	Exo--genous	Endo--genous	Exo--genous	Endo--genous
Panel 1. Aggregate responses (%)						
Consumption	0.54	0.54	1.01	0.97	0.02	0.02
Nominal interest rate	-0.03	-0.03	-1.56	-1.51	-0.03	-0.03
Inflation	0.88	0.89	-1.42	-1.37	-0.03	-0.03
Exchange rate	0.28	0.28	-2.63	-2.68	-0.05	-0.06
Panel 2. Cross-sectional dispersion of consumption responses						
Standard deviation	0.25	0.24	1.47	1.18	3.19	2.71
Gap by real integration	0.05	0.03	-2.00	-1.60	2.65	1.96
Gap by financial integration	0.06	0.05	0.29	0.26	-3.67	-2.85
Gap by net wealth	0.36	0.37	0.36	0.37	-2.50	-2.30

Notes: This table reports the effects of a 25 b.p. expansionary monetary shock ($\epsilon_{m,t} = -0.25\%$), a 15% expansionary foreign demand shock ($\epsilon_{y^*,t} = 15\%$), and a 25 b.p. expansionary foreign monetary shock ($\epsilon_{m^*,t} = -0.25\%$) in two models with different setups for the transition of integration status. "Exogenous" and "Endogenous" label the models with exogenous and endogenous transitions in households' international integration status. Panel 1 reports the responses of various aggregate variables in the period in which the aggregate consumption responses reach their peaks. In Panel 2, "Gap by real integration" refers to the consumption-response difference between real nonintegrated households and real integrated households; "Gap by financial integration" refers to the consumption-response difference between financially nonintegrated households and financially integrated households; "Gap by net wealth" refers to the consumption-response difference between households with net wealth below the median and those with net wealth above the median. All statistics of the cross-sectional dispersion are normalized by the size of the peak consumption responses.

where $\Delta\mathcal{E}_t \equiv \log\left(\frac{\mathcal{E}_t}{\mathcal{E}_{t-1}}\right)$ denotes the depreciation of the domestic currency.

Calibration For all other parameters, we use the same parameterization as in the baseline model. The results from this extension are summarized in the column labeled "No UIP deviation" in Table A.6.

Table A.3: Calibration of the Model without Asset Home Bias

		Baseline	Extension
Panel 1: Parameters			
Wealth level and financial frictions			
B_{ss}	Government debt	0.85	0.61
$\underline{b}$	Borrowing constraint	-0.29	-0.29
Households' preferences			
β	Discounting factor	0.96	0.96
ψ	Disutility of labor	7.93	7.93
ω_{T}	Fraction of tradable goods in consumption basket	0.33	0.33
Panel 2: Key moments in steady state			
Wealth-to-income ratio and MPC			
Median wealth-to-income ratio		0.35	0.35
Median MPC		0.15	0.15

Notes: The values of B_{ss} and $\underline{b}$ are expressed in units of households' quarterly average labor income in the steady state.

A.4. Tradable Prices Denominated in Foreign Currency

Model In this extension, we analyze a variant of the model in which the prices of the home tradable good are sticky in the foreign currency. In particular, we assume that firms face the following cost to adjust prices of home tradable goods in terms of the foreign currency; i.e.,

$$\Theta_{H,t}\left(\frac{p_{H,t}}{p_{H,t-1}}\right) = \frac{\theta}{2}\cdot\left(\frac{p_{H,t}/\mathcal{E}_t}{p_{H,t-1}/\mathcal{E}_{t-1}}-1\right)^2\cdot Y_{H,t}\cdot P_{H,t} \tag{11}$$

Under this setup, the inflation dynamics of the price of home goods can be characterized by the modified Philips curve

$$\tilde{\pi}_{H,t} - \widetilde{\Delta\mathcal{E}}_t = \frac{\epsilon}{\theta}\cdot(\widetilde{mc}_{H,t} - \tilde{p}_{H,t}) + \frac{1}{1+i_{ss}}\cdot\mathbb{E}_t\left[\tilde{\pi}_{H,t+1} - \widetilde{\Delta\mathcal{E}}_{t+1}\right], \tag{12}$$

where $\tilde{x}$ denotes the deviation of x from its steady-state level.

Calibration We parameterize this model with the same values for all parameters as in the baseline model. The results of this extension are summarized in the column labeled "Foreign currency prices" in Table A.6.

A.5. Financial Securities Denominated in the Foreign Currency

Model This extension studies a model in which domestic and external bonds are denominated in the foreign currency. Under this assumption, the budget constraint for households is given by

$$\begin{aligned} &P_{\mathrm{H}t}c_{\mathrm{H}} + P_{\mathrm{F}t}c_{\mathrm{F}} + P_{\mathrm{N}t}c_{\mathrm{N}} + q_{\mathrm{D}t}\cdot b'_{\mathrm{D}}\cdot\mathcal{E}_t + q_{\mathrm{E}t}\cdot b'_{\mathrm{E}}\cdot\mathcal{E}_t + \Phi(b'_{\mathrm{D}}, b'_{\mathrm{E}}, o_F) \\ &= z(1-\tau_t)W_t(o_R)l + T_t(z) + (b_{\mathrm{D}} + b_{\mathrm{E}})\cdot\mathcal{E}_t, \end{aligned} \tag{13}$$

and the prices of zero-coupon bonds are

$$q_{D,t} = \frac{1}{1+i_t}\cdot\mathbb{E}_t\left[\frac{\mathcal{E}_t}{\mathcal{E}_{t+1}}\right] \tag{14}$$

$$q_{E,t} = \frac{1}{1+i^*_t} \tag{15}$$

Calibration We use the same parameterization as in the baseline model, and the results of this extension are summarized in the column labeled "Foreign currency securities" in Table A.6.

A.6. Physical Capital and Investment

Model In this extension, we introduce physical capital and investment. For this, we assume that the intermediate-good producers' technology uses capital and labor as inputs:

$$Y_{s,t} = AK^{\alpha}_{s,t}N^{1-\alpha}_{s,t},$$

for $s \in \{N, H\}$. To render the structure more comparable to that of our baseline model, we introduce, to the economy, a separate firm that accumulates capital and rents it to intermediate-good producers in a competitive market. These capital-good producers have access to the technology

required to produce capital goods using foreign goods as inputs:

$$K_{t+1} = (1-\delta)K_t + \Phi\left(I_t, K_t\right) K_t,$$

where I_t denotes investment in terms of foreign goods and $\Phi(I,K) = I - \frac{\phi_k}{2}\left(\frac{I}{K} - \delta\right)^2 K$ is a function that introduces capital adjustment costs, which are important in open-economy models as they match the investment volatility observed in the data. The capital-good producers' problem is

$$\begin{aligned} \max_{I_t, K_{t+1}} \; & \frac{R_t}{\mathcal{E}_t} K_t - I_t P^*_{F,t} + \sum_{s=1}^{\infty} \mathbb{E}_t \left[\left(\prod_{\iota=1}^{s} \frac{1}{1+i_{t+\iota-1}} \right) \cdot \left(\frac{R_{t+s}}{\mathcal{E}_{t+s}} K_{t+s} - I_{t+s} P^*_{F,t+s} \right) \right] \\ \text{s.t.} \quad & K_{t+s+1} = (1-\delta)K_{t+s} + \Phi\left(I_{t+s}, K_{t+s}\right) K_{t+s}, \end{aligned}$$

where R_t is the rental rate of capital expressed in the domestic currency. The capital-good producers' profits are assumed to be transferred to households in the same way as profits are from the intermediate-good producers.

Calibration We follow a strategy similar to our baseline calibration. For the new parameters, we set the capital share to $\alpha = 0.3$ and the depreciation rate to $\delta = 0.025$, which are standard values in the literature; we calibrate ϕ_k to match an investment response to the domestic monetary shock of 2.5%, which is in the mid-range of the estimated response for Canada documented by Champagne and Sekkel (2018). We recalibrate ψ, β, ω_T to target the same moments as in the baseline model and we set the rest of the parameter values as in our baseline calibration. The recalibrated parameters are collected in Table A.4, and the main results from this extension are summarized in the column "w/ capital and investment" in Table A.6.

Table A.4: Calibration of the Model with Capital and Investment

		Baseline	Extension
Panel 1: Parameters			
Capital related			
α	Capital share	-	0.30
δ	Depreciation rate	-	0.025
ϕ_k	Capital adjustment cost	-	0.10
Wealth level and financial frictions			
B_{ss}	Government debt	0.85	0.80
$\underline{b}$	Borrowing constraint	-0.29	-0.37
Households' preference			
β	Discounting factor	0.96	0.96
ψ	Disutility of labor	7.93	7.11
ω_{T}	Fraction of tradable goods in consumption basket	0.33	0.13
Panel 2: Key moments in steady state			
Wealth-to-income ratio and MPC			
Median wealth-to-income ratio		0.35	0.35
Median MPC		0.15	0.15

Notes: The values of B_{ss} and $\underline{b}$ are expressed in the unit of households' quarterly average labor income in the steady state.

Table A.5: Effects of Aggregate Shocks within the Model with Capital and Investment

	Domestic monetary shock	Foreign demand shock	Foreign monetary shock
Aggregate quantities (%)			
Consumption	0.27	-0.44	0.02
Investment	2.61	17.08	-0.22
Export	1.92	12.04	-0.09
Import	-1.63	1.56	0.16
Aggregate prices (%)			
Nominal interest rate	0.20	0.61	0.01
Inflation	1.09	0.55	0.01
Exchange rate	0.64	-0.25	-0.02

Notes: This table reports the effects of a 25 b.p. expansionary monetary shock ($\epsilon_{m,t} = -0.25\%$), a 15% expansionary foreign demand shock ($\epsilon_{y^*,t} = 15\%$), and a 25 b.p. expansionary foreign monetary shock ($\epsilon_{m^*,t} = -0.25\%$). All of the responses correspond to the period during which aggregate consumption response reaches its peak.

Table A.6: Summary of Model Extensions

	Baseline	Endogenous transition	No home bias	No UIP deviations	Foreign curr prices	Foreign curr securities	Capital & investment
Panel 1. Domestic monetary shocks							
Aggregate responses (%)							
Consumption	0.54	0.54	0.46	0.49	0.39	0.55	0.27
Inflation	0.88	0.88	0.90	1.08	1.04	0.84	1.09
Exchange rate	0.28	0.28	0.32	0.50	0.33	0.23	0.64
Cross-sectional dispersion of consumption responses							
Standard deviation	0.25	0.26	0.33	0.48	0.62	0.23	1.07
Gap by real integration	0.05	0.04	-0.04	-0.27	0.89	0.11	-1.55
Gap by financial integration	0.06	0.05	0.31	0.00	0.05	0.07	-0.02
Gap by net wealth	0.37	0.36	0.46	0.78	0.47	0.22	0.51
Panel 2. Foreign demand shocks							
Aggregate responses (%)							
Consumption	1.02	1.00	0.51	0.85	3.10	0.93	-0.44
Inflation	-1.42	-1.40	-1.55	0.30	-4.77	-0.68	0.55
Exchange rate	-2.62	-2.65	-2.59	-0.71	-3.77	-1.71	-0.25
Cross-sectional dispersion of consumption responses							
Standard deviation	1.47	1.35	3.42	3.11	1.65	2.17	4.92
Gap by real integration	-2.01	-1.85	-4.30	-3.93	-2.29	-2.87	-7.23
Gap by financial integration	0.30	0.25	2.87	0.00	0.18	0.18	0.00
Gap by net wealth	0.36	0.37	0.81	2.13	0.25	1.52	-0.29
Panel 3. Foreign monetary shocks							
Aggregate responses (%)							
Consumption	0.02	0.02	0.11	0.15	0.06	0.02	0.02
Inflation	-0.03	-0.03	-0.01	-0.41	-0.12	-0.01	0.01
Exchange rate	-0.05	-0.06	-0.09	-0.48	-0.08	-0.03	-0.02
Cross-sectional dispersion of consumption responses							
Standard deviation	3.21	3.18	1.56	2.21	1.15	2.50	1.44
Gap by real integration	2.57	2.51	0.84	2.38	-1.33	1.51	1.60
Gap by financial integration	-3.83	-3.27	-2.76	0.00	-0.93	-3.97	-1.73
Gap by net wealth	-2.50	-2.75	-0.76	-2.62	-0.46	-0.97	0.41

Note: This table reports the effects of a 25 b.p. expansionary monetary shock ($\epsilon_{m,t} = -0.25\%$), a 15% expansionary foreign demand shock ($\epsilon_{y^*,t} = 15\%$), and a 25 b.p. expansionary foreign monetary shock ($\epsilon_{m^*,t} = -0.25\%$) in the period when the aggregate consumption response reaches its peak in various models. "Gap by real integration" refers to the consumption-response difference between real nonintegrated households and real integrated households; "Gap by financial integration" refers to the consumption-response difference between financially nonintegrated households and financially integrated households; and "Gap by net wealth" refers to the consumption-response difference between the households with net wealth below the median and those with net wealth above the median. All statistics of the cross-sectional dispersion are normalized by the size of the peak consumption response.

A.7. Correlation between Integration Status and Net Wealth

Model In this extension we allow for integrated and nonintegrated households to have different income and wealth levels in the steady state. We do so by allowing the integration status to scale the idiosyncratic productivity of households. In particular, the households' budget constraint is given by

$$\begin{aligned} &P_{\mathrm{H}t}c_{\mathrm{H}} + P_{\mathrm{F}t}c_{\mathrm{F}} + P_{\mathrm{N}t}c_{\mathrm{N}} + q_{\mathrm{D}t}b'_{\mathrm{D}} + q_{\mathrm{E}t}b'_{\mathrm{E}} + \Phi(b'_{\mathrm{D}}, b'_{\mathrm{E}}, o_F) \\ &= z(1 + \delta^R_{o_R} + \delta^F_{o_F})(1-\tau_t)W_t(o_R)l + T_t(z) + b_{\mathrm{D}} + b_{\mathrm{E}}\mathcal{E}_t, \end{aligned} \tag{16}$$

where households' individual incomes depend on their international integration status.

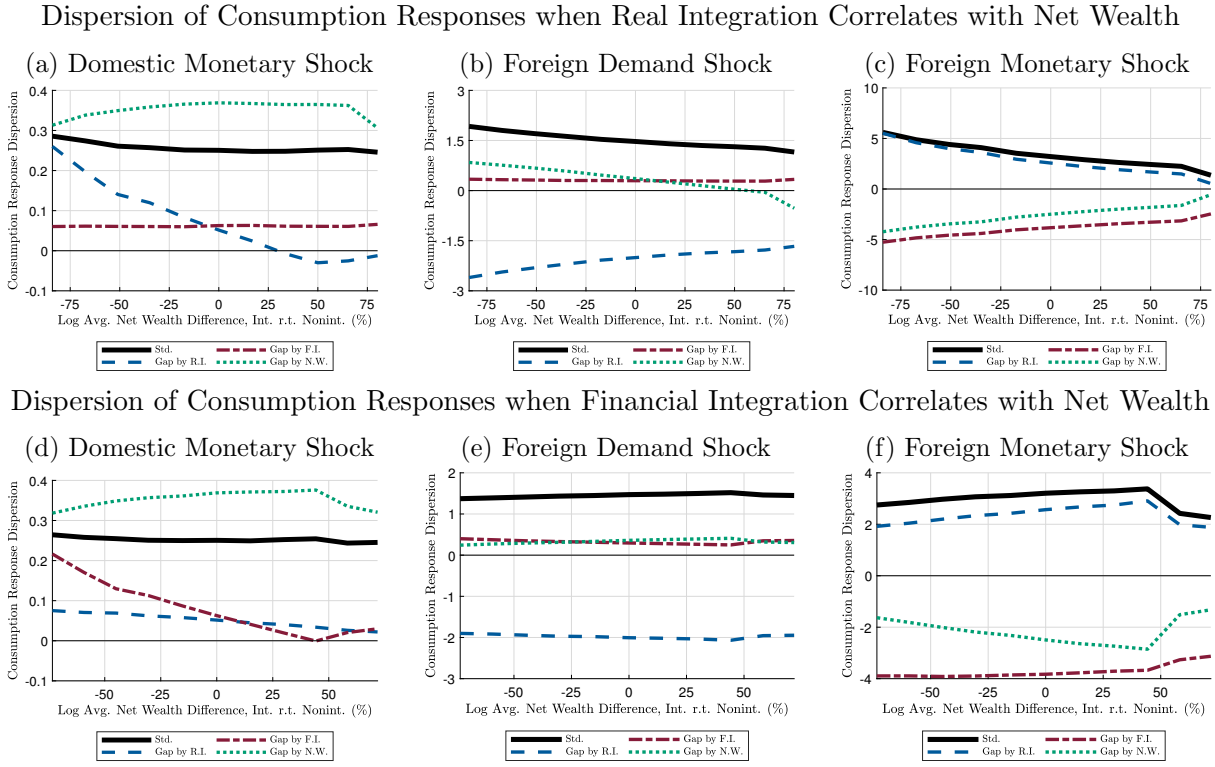
Calibration We calibrate all other parameters to share the same values as in the baseline model except for $\delta^R_{o^R}$ and $\delta^F_{o^F}$, which we parameterize as follows::

$$\delta^R_1 = \frac{\delta^R}{\bar{P}^R_1},\ \delta^R_0 = -\frac{\delta^R}{\bar{P}^R_0}, \tag{17}$$

$$\delta^F_1 = \frac{\delta^F}{\bar{P}^F_1},\ \delta^F_0 = -\frac{\delta^F}{\bar{P}^F_0}, \tag{18}$$

where $\bar{P}^s_{o^s}$ denotes the fraction of households with status o^s in integration dimension s in the steady state, and δ^R and δ^F control the correlation between the net wealth level and the international integration status. When we set $\delta^R = \delta^F = 0$, the model collapses to the baseline model. To study to what extent the correlation between the wealth level and the international integration status affects our baseline results, we perform a comparative static analysis in which we vary the values for δ^F and δ^R. The results are presented in Figure A.1. The main takeaway is that as real integrated households become wealthier relative to nonintegrated households, the dispersion of consumption responses by real integration to an expansionary foreign demand shock is dampened, since wealthy households have lower MPCs. Similarly, as financially integrated households become wealthier relative to nonintegrated households, the dispersion of consumption responses by financial integration to an expansionary foreign monetary policy shock is dampened.

Figure A.1: Distributional Effects when International Integration Correlates with Net Wealth



Note: Panels (a) and (d) report the effects of a 25 b.p. expansionary monetary policy shock (i.e., $\epsilon_{m,t} = -0.0025$); Panels (b) and (e) report the effects of a 15% expansionary external demand shock ($\epsilon_{y^*,t} = 0.15$); and Panels (c) and (f) report the effects of a 25 b.p. expansionary foreign monetary policy shock ($\epsilon_{m^*,t} = -0.0025$). Panels (a) to (c) summarize the variation in the correlation between the net wealth and real integration status (i.e., $\delta^R \neq 0$ and $\delta^F = 0$), and the x-axis is the log difference in the average net wealth between financially integrated and nonintegrated households. Panels (d) to (f) summarize the variation in the correlation between the net wealth and the financial integration status (i.e., $\delta^R = 0$ and $\delta^F \neq 0$), and the x-axis is the log difference in the average net wealth between real integrated and nonintegrated households. In each panel, "Gap by real integration" refers to the consumption-response difference between real nonintegrated households and real integrated households; "Gap by financial integration" refers to the consumption-response difference between financially nonintegrated households and financially integrated households; and "Gap by net wealth" refers to the consumption-response difference between households with net wealth below the median and those with net wealth above the median. All statistics of the cross-sectional dispersion are normalized by the size of the peak consumption responses.

A.8. Sensitivity Analysis to Elasticity of Substitution

In the baseline model, we assume that the elasticity of substitution between tradable and nontradable goods and between home and foreign tradable goods are the same and we calibrate them at

6.19. We analyze the sensitivity of our results to changes in the substitution elasticities. We first lower these two elasticities separately to half their baseline values and then lower them together. The effects of the aggregate shocks within each of these robustness checks are reported in Table A.7. The main takeaway from this analysis is that as we lower the elasticity of substitution between home and foreign goods, the expenditure-switching channel becomes weaker and the aggregate effects on the consumption of expansionary external shocks are larger. This result is consistent with the findings of Auclert et al. (2020) who analyze a model with time-varying elasticities of substitution that are low in the short run.

Table A.7: Effects of Aggregate Shocks with Lower Elasticities of Substitution

	Baseline	Lower elasticity of substitution		
		η_{TN}	η_{HF}	η_{TN} & η_{HF}
Panel 1. Domestic monetary shocks				
Aggregate responses (%)				
Consumption	0.54	0.51	0.49	0.48
Inflation	0.88	0.92	0.95	0.97
Exchange rate	0.28	0.32	0.36	0.39
Cross-sectional dispersion of individual consumption responses				
Standard deviation	0.25	0.31	0.25	0.28
Gap by real integration	0.05	-0.26	-0.04	-0.19
Gap by financial integration	0.06	0.06	0.05	0.05
Gap by net wealth	0.37	0.38	0.38	0.39
Panel 2. Foreign demand shocks				
Aggregate responses (%)				
Consumption	1.02	1.34	2.32	2.52
Inflation	-1.42	-1.93	-3.21	-3.48
Exchange rate	-2.62	-2.71	-4.60	-4.97
Cross-sectional dispersion of individual consumption responses				
Standard deviation	1.47	0.97	1.29	0.91
Gap by real integration	-2.01	-1.29	-1.80	-1.23
Gap by financial integration	0.30	0.25	0.23	0.23
Gap by net wealth	0.36	0.32	0.28	0.28
Panel 3. Foreign monetary shocks				
Aggregate responses (%)				
Consumption	0.02	0.03	0.04	0.04
Inflation	-0.03	-0.05	-0.07	-0.08
Exchange rate	-0.05	-0.06	-0.08	-0.09
Cross-sectional dispersion of individual consumption responses				
Standard deviation	3.21	2.17	0.98	1.08
Gap by real integration	2.57	2.13	0.20	0.90
Gap by financial integration	-3.83	-2.21	-1.57	-1.36
Gap by net wealth	-2.50	-1.36	-0.88	-0.74

Note: This table reports the effects of a 25 b.p. expansionary monetary shock ($\epsilon_{m,t} = -0.25\%$), a 15% expansionary foreign demand shock ($\epsilon_{y^*,t} = 15\%$), and a 25 b.p. expansionary foreign monetary shock ($\epsilon_{m^*,t} = -0.25\%$) in the period when the aggregate consumption response reaches its peak under different calibrations. Column η_{TN} summarizes the results when the substitution of elasticity between tradable and nontradable goods is recalibrated to half the baseline value. Column η_{HF} summarizes the results when the elasticity of substitution between home and foreign tradable goods is recalibrated to half the baseline value. Columns η_{TN} & η_{HF} summarize the results when both of these elasticities of substitution are recalibrated to half the baseline value. "Gap by real integration" refers to the consumption-response difference between real nonintegrated households and real integrated households; "Gap by financial integration" refers to the consumption-response difference between financially nonintegrated and financially integrated households; and "Gap by net wealth" refers to the consumption-response difference between the households with net wealth below the median and those with net wealth above the median. All statistics of the cross-sectional dispersion are normalized by the size of the peak consumption responses.

B. Measurement of International Integration

B.1. Real International Integration

The first dimension of the international integration in the model is real integration, which refers to whether households are employed in tradable sectors. We measure the share of households employed in tradable sectors in Canada by using employment data from *Statistics Canada*, which is Canada's national statistical office. We follow the standard classifications of tradable and nontradable sectors used in the international macro literature. Tradable sectors include agriculture, forestry, fishing, mining, quarrying, oil and gas; information, culture, and recreation; finance and insurance; manufacturing; professional, scientific, and technical services; and wholesale trade. Nontradable sectors include utilities; real estate, rental and leasing; accommodation and food services; construction; transportation and warehousing; public administration; retail trade; and other private services. Table B.1 reports the share of employment for each of these sectors for the period 1976-2019, which we use for the calibration, which shows 63% of employment in nontradable sectors and 37% in tradable sectors. To calibrate the transition probabilities across sectors, we target the 14% annual switching rate across industries as reported by Loungani and Rogerson (1989). For more-recent studies documenting infrequent sectoral reallocations, see Pilossoph (2014); Dvorkin (2013); and Artuç, Chaudhuri, and McLaren (2010). Consistent with these findings, Drenik (2016) documents infrequent worker reallocations between tradable and nontradable sectors for Argentina.

B.2. Financial International Integration

The second dimension of international integration in the model is financial integration, which refers to whether households have access to external financial securities. We measure financial integration in Canada by using micro-level data on households' direct and indirect holdings of external securities. We first describe these data and then discuss how we use them to inform the degree of financial integration in the model and the transition between states of international integration.

Direct holdings To measure households' direct holdings of external securities, we use the *Canadian Financial Monitor* (CFM) produced by *Ipsos Reid Canada*, which collects detailed in-

Table B.1: Employment Share by Sector in Canada (in %)

Nontradable	63
Utilities	1
Real estate, rental and leasing	2
Accommodation and food services	6
Construction	6
Transportation and warehousing	5
Public administration	6
Retail trade	12
Other private services	25
Tradable	37
Agriculture, mining, and energy	5
Information, culture, and recreation	4
Finance and insurance	4
Manufacturing	14
Professional and technical services	6
Wholesale trade	4

Notes: This table reports the average employment share by sector for the period 1976-2019. Employment is measured by the total number of workers above 15 years old and working in either part-time or full-time positions.

formation on households' balance sheets, income, and consumption. Since 2009, the survey has been conducted monthly, with roughly 1,000 households participating in each round. The CFM provides statistical weights designed to render statistics from the CFM that are representative of the Canadian population. To further assess the representativeness of the data, Table B.2 reports descriptive statistics on basic households' demographics information and financial status in the CFM, and shows that these are aligned with those in the 2016 Census.[18]

The CFM provides information on households' holdings in five broad categories of financial assets: checking and savings accounts; guaranteed investment certificates; bonds and other guaranteed investments; individual stocks and income trusts; and mutual funds, segregated funds, hedge funds, and principal-protected notes. Some of these categories present further levels of disaggre-

[18]The survey switched from telephone interviews to online questionnaires in 2019. To avoid the statistical inconsistency introduced by different ways of conducting the survey, we only use survey data collected before 2019. Since our measurement of households' indirect holdings combines the CFM with the *Geographical Distribution of Assets and Liabilities Booked in Canada* (further described below), we compute CFM statistics for the period with available information from both datasets; i.e., 2014Q4 to 2018Q4.

Table B.2: Households' characteristics in CFM and Census datasets (%)

	Census (2016)	CFM (2014Q4–2018Q4)		
		Full sample	Nonintegrated	Integrated
Region				
Ontario	37	36	34	40
Quebec	25	26	31	16
British Columbia	13	13	12	15
Others	25	25	23	28
Household size				
1	28	28	29	27
2	34	35	35	36
3	15	15	15	14
4 or more	23	21	21	23
Household head age				
Under 34	17	14	14	13
35-44	17	16	16	15
45-54	20	21	21	22
55-64	20	23	24	24
65 or older	26	26	26	26
Income group				
Less than 30K	18	21	22	20
30-60K	25	28	29	27
60-100K	25	30	29	31
More than 100K	32	21	20	22
Household home ownership				
Rent	32	27	27	27
Own	68	73	73	73

Notes: This table compares household characteristics in the CFM (Canadian Financial Monitor) and the Census. For the CFM sampling statistics, we first calculate the frequency of households along each dimension in each monthly sample by using the statistical weight provided by Ipsos Reid Canada. Then we take the average of these monthly statistics between October 2014 and December 2018. For the subsample statistics, households are divided into two groups in each period, based on the foreign share of their assets: those with foreign asset shares above 10% are categorized as financially integrated households and others are categorized as financially nonintegrated households. The statistics of the 2016 Census are documented in Li (2021).

gation. We define direct external assets as those issued by foreign governments and corporations. The CFM also features information on households' claims on individual financial intermediaries,

which we use next to measure indirect holdings of external securities.

Indirect holdings To measure households' indirect holdings of external securities, we combine the CFM with the balance-sheet information of financial intermediaries operating in Canada. For the latter, we use the *Return of the Geographical Distribution of Assets and Liabilities Booked in Canada* (GQ return). The GQ return is a quarterly dataset collected by the *Office of the Superintendent of Financial Institutions*, based on the regulatory filings submitted by federally regulated and internationally active financial institutions in Canada.[19] Each quarter, financial institutions report the balance of their claims of external securities denominated in different currencies. The dataset covers all internationally active financial institutions in Canada. To be consistent with the coverage period of the CFM sample, we focus on the sample period from 2014Q4 to 2018Q4. Financial institutions in the GQ return cover 90% of households' accounts disaggregated by financial institutions reported in the CFM and account for 95% of total assets.

We construct our measure of households' indirect holdings in two steps. The first consists of measuring the share of external securities of each financial institution. For each institution in each quarter, we measure this as the ratio of the total value of its claims to residents outside Canada to the total value of its claims to the residents of all countries. Figure B.1 summarizes the distribution of the financial institutions' shares of external securities in the GQ return, with Panel (a) depicting the time variation of various distributional statistics and Panel (b) the average distribution across the sample period. This figure indicates that there is dispersion in the share of external securities across institutions. On average, 25% of the financial institutions do not hold external assets, and around 5% of these institutions have an external-asset share above 50%. Most of these financial institutions' shares of external assets range between 5% and 30%.[20]

The second step of our measurement of households' indirect holdings consists of merging the CFM data on households' claims on individual financial intermediaries with the share of external securities of each intermediary computed in the previous step.[21] We compute indirect foreign

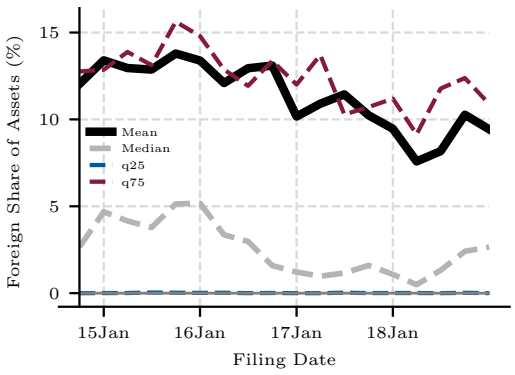
[19] See https://www.osfi-bsif.gc.ca/Eng/fi-if/rtn-rlv/fr-rf/dti-id/Pages/GM_GQ.aspx for more information on these data.

[20] There is also a high degree of asset concentration across financial institutions, with the big six banks accounting for 85% of total assets. These banks are Toronto Dominion Bank (TD), Royal Bank of Canada (RBC), Bank of Montreal (BMO), Bank of Nova Scotia (Scotiabank), Canadian Imperial Bank of Commerce (CIBC), and National Bank. Their shares of external securities range from 9% to 19%. (For confidentiality reasons, we cannot provide details about their individual shares of external securities.)

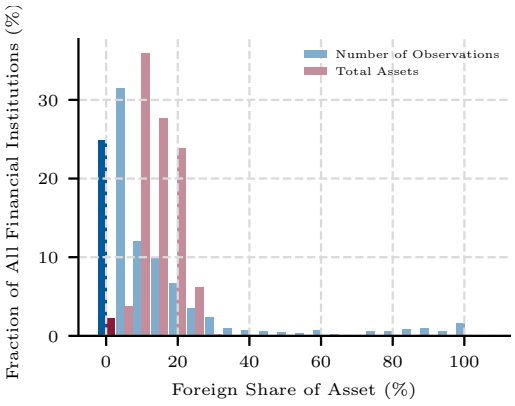
[21] We merge data at quarterly frequencies and match accounts for 90% of the households in the sample,

Figure B.1: Distribution of the Shares of External Securities by Financial Institutions

(a) Distribution over Time



(b) Average Distribution across Time



Notes: In Panel (a), we tabulate the mean and different quantiles of asset external exposure across different financial institutions in each quarter. In Panel (b), we first divide financial institutions into groups by their asset external exposure by using a series of 5% intervals between 0 and 100%. Then we average the frequency and asset shares of each group across the sample period. The highlighted bars on the left indicate the average frequency and asset shares accounted for by the institutions with assets, for an external exposure of zero.

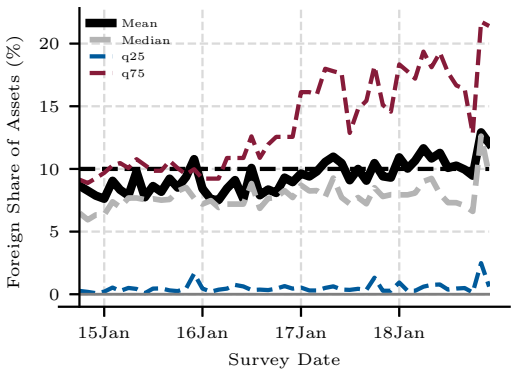
asset holdings by multiplying the household's claims on a particular financial institution by the institution's share of external securities. For example, if one household holds one deposit in bank A of 10,000 CAD and bank's A share of external securities is 15%, then the household's estimated indirect holdings are 1,500 CAD. Finally, we compute the household's share of external securities as the ratio of the sum of the direct and indirect holdings to the total financial assets. Figure B.2 provides descriptive statistics of our measure of households' direct and indirect holdings of external securities. Panel (a) depicts cross-sectional distributional statistics over time. Panel (b) shows that on average, around 67% of households have external-asset exposure below 10%, and these households hold around 67% of the total financial assets.

Financial integration and transitions To calibrate the share of households in the model with access to financial securities, we measure households that, in the data, have at least 10% of their portfolio held in external securities. According to this measure, on average, 33% of households are financially integrated, holding 33% of total assets. Of the financially integrated households, the

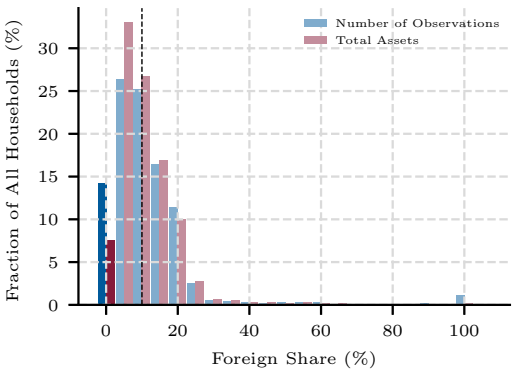
whose assets account for 95% of the total financial assets. Of the unmatched records, most are associated with local credit unions, which are more likely to invest in foreign financial markets, so we assign an asset foreign exposure of zero for these institutions.

Figure B.2: Distribution of the Shares of External Assets by Households

(a) Distribution over Time



(b) Average Distribution across Time



Notes: In Panel (a), we tabulate the mean and different quantiles of external-asset exposure across different households in each month. In Panel (b), we first divide households into groups by their external-asset exposure by using a series of 5% intervals between 0 and 100%. Then we average the frequency and asset shares of each group across the sample period. The highlighted bars on the left indicate the average frequency and asset shares accounted for by households with external-asset exposure of zero. We use the statistical weight provided by Ipsos Reid Canada to calculate the statistics in each month. In both panels, the black dashed lines indicate the level of average external exposure.

average external exposure is 21%, which is the empirical target we use to calibrate the portfolio share of external securities for the financially integrated households in our model. Figure B.3 summarizes how the characteristics of financially integrated households vary with the choice of cutoff for external-asset exposure. The fraction of financially integrated households closely follows the fraction of their assets within the total assets, which supports the choice in our baseline calibration whereby financially integrated and nonintegrated households have the same level of net wealth in the steady state. As summarized in Table B.4, under our choice of categorization, the average total assets of integrated and nonintegrated households are very close to each other. What's more, as shown in Table B.2, integrated and nonintegrated households also share very similar demographic characteristics.

To calibrate the transition probabilities across states of financial integration, we use information from the CFM for households that have been surveyed in two consecutive years.[22] In each

[22]Even though the CFM does not have a fixed pool of respondents, 54% of surveyed households between October 2014 and December 2018 were surveyed in more than one wave. The time gap between each pair of these consecutive appearances ranges from 1 month to 46 months, but 31.7% locate at 12 months.

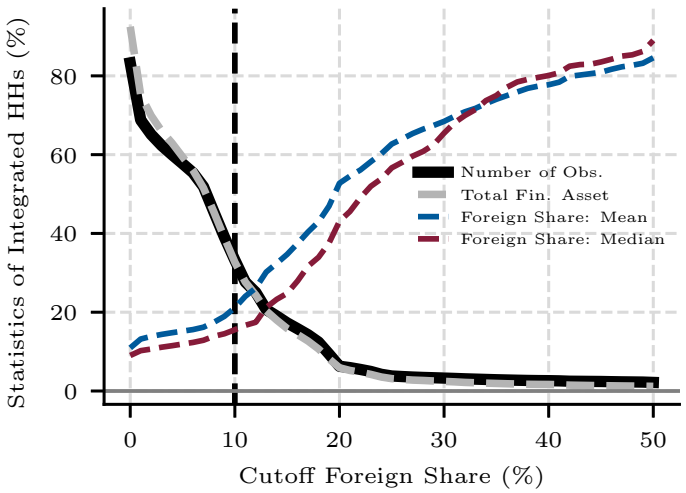
Table B.3: Distribution of Financially Integrated Households

Statistic	Value
Relevance within the full sample of households (%)	
Fraction of observations	33.2
Fraction of assets	32.7
Distribution of external-asset exposure (%)	
Mean	21.1
Median	15.6

Notes: This table summarizes the statistics of financially integrated households under the cutoff of 10%. We categorize households with external exposure above this cutoff as integrated households. Then we calculate (1) the fraction of integrated households; (2) the fraction of their assets within the total assets; and (3) the means and medians of their external-asset exposure in each month. Then we take the average of these statistics across the sample period and collect them in this figure. We use the statistical weight provided by Ipsos Reid Canada when calculating these cross-sectional statistics in each month.

period, we calculate the fraction of integrated households that are also categorized as integrated households in the following 12 months. On average, 74% of integrated households are again categorized as integrated households in the following 12 months, which indicates a high persistence in households' financial integration status. We target this moment to calibrate the transition probabilities between integrated and nonintegrated households. In Figure B.4, we compute the distribution of the changes in foreign asset shares when households switch their integration status. On average, more than 60% of households decrease their foreign shares by more than 10% when they switch from integrated to nonintegrated, and more than 40% of households increase their foreign asset shares by more than 10% when they switch from nonintegrated to integrated. Both facts indicate a relatively significant change in asset composition when households change their financial integration status.

Figure B.3: Distribution of Financially Integrated Households at Different Cutoffs



Notes: This figure summarizes the statistics of financially integrated households under different cutoffs of external-asset exposure. At each cutoff level, we categorize households with external exposure above the cutoff as integrated households. Then we calculate (1) the fraction of integrated households; (2) the fraction of their assets within the total assets; and (3) the means and medians of their external-asset exposure in each month. Then we take the average of these statistics across the sample periods and collect them in this figure. We use the statistical weight provided by Ipsos Reid Canada when calculating these cross-sectional statistics in each month.

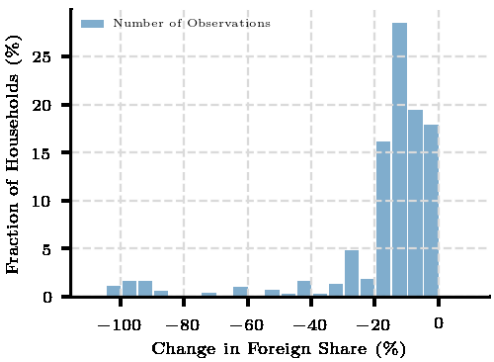
Table B.4: Distribution of Total Assets by Households' Financial Integration Status

	Full sample	Nonintegrated	Integrated
Mean (weighted)	160	160	159
Mean (non-weighted)	174	174	173
25% percentile	6	7	6
Median	58	66	47
75% percentile	234	236	224

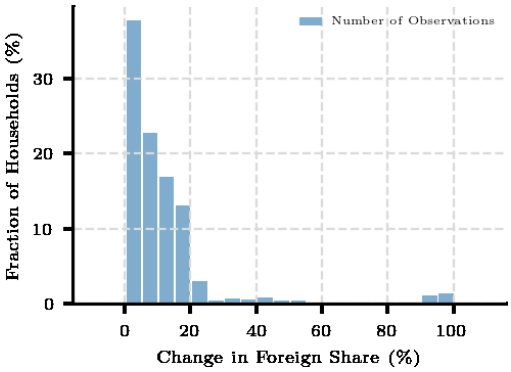
Notes: This table summarizes the statistics of households' total assets conditional on their financial integration status under the cutoff of 10%. In each period, we categorize as financially integrated those households with foreign asset shares above 10% and we compute the summary statistics of the total assets within each subgroup of households by using the statistical weights provided in the CFM. Then we take the average of these statistics across the sample period. All of the numbers in this table are reported in units of thousands of 2016 CAD.

Figure B.4: Change of Foreign Asset Shares when Switching Integration Status

(a) Integrated to nonintegrated



(b) Nonintegrated to integrated



Note: This figure summarizes the distribution of the change in foreign asset shares when a household is observed with a different integration status in a year. In each period, we calculate the change in the foreign asset shares of households whose integration status changes after 12 months and we tabulate the frequency in 5% intervals from -100% to 100%. Then we take the average of the frequencies across the sample periods. Panel (a) depicts the distribution of foreign asset share changes when households' status changes from integrated to nonintegrated, and Panel (b) depicts the distribution when households' status changes from nonintegrated to integrated.

C. Decomposition of Channels and Comparison with Benchmark Models

C.1. Decomposition of Transmission Channels

To further analyze the heterogeneity in the consumption responses in our model for different types of households, Table C.1 decomposes the effects of monetary policy and external shocks, using a decomposition in the spirit of Auclert (2019) and Kaplan et al. (2018). In particular, we decompose consumption responses into a *real interest rate channel*, which measures the effect on consumption of changes in the nominal rates in the local currency and in inflation; a *labor-income channel*, which measures the effect on consumption of households' labor income changes in response to shocks; and *other channels*, which measure the effect of consumption on the rest of the general equilibrium responses to shocks, including profits, government taxes and transfers, and changes in the wealth distribution.[23]

Panel 1 of Table C.1 decomposes the effects of monetary policy shocks, showing that indirect effects play a major role in explaining aggregate and cross-sectional responses. In particular, changes in labor income induced by changes in monetary policy and its effect on aggregate demand account for 51% of aggregate responses. Additionally, this channel accounts for an important part of the differential consumption responses by net wealth. It is worth mentioning that the direct channel of the interest rate does not play a major role in explaining the heterogeneous responses because of the home bias in the financial portfolios of financially integrated households. To illustrate this, Appendix A.2 presents a version of the model in which integrated households only hold foreign securities and the model shows that this channel is relevant in accounting for heterogeneity in consumption responses.

[23]We focus on decomposing the peak consumption responses. To decompose the consumption responses, we first solve the equilibrium paths of the aggregate prices and quantities. For a specific variable, we fit its equilibrium path into the decision problem of households and keep all other relevant variables constant at their steady-state levels. The fraction between the solved consumption response and their full-equilibrium response is our measure of the contribution from the variation in this specific variable.

Table C.1: Decomposition of Consumption Responses by Transmission Channel (%)

	Aggregate	By real integration		By fin. integration		By net wealth	
		Nonint.	Int.	Nonint.	Int.	Low	High
Panel 1. Domestic monetary shock							
Response w.r.t. the aggregate	1.00	1.02	0.97	1.02	0.96	1.24	0.87
Decomposition by different channels							
Real interest rate	0.38	0.38	0.38	0.40	0.34	0.23	0.48
Nominal rate in dom. currency	0.05	0.05	0.05	0.07	0.01	0.02	0.07
Inflation	0.33	0.33	0.33	0.33	0.33	0.22	0.41
Labor income	0.51	0.53	0.48	0.51	0.51	0.81	0.33
Others	0.11	0.11	0.12	0.11	0.12	0.20	0.06
Panel 2. Foreign demand shock							
Response w.r.t. the aggregate	1.00	0.26	2.26	1.10	0.80	1.22	0.86
Decomposition by different channels							
Real interest rate	0.42	0.42	0.43	0.52	0.23	0.18	0.57
Nominal rate in dom. currency	0.30	0.30	0.30	0.40	0.10	0.16	0.38
Inflation	0.13	0.13	0.13	0.13	0.13	0.01	0.19
Labor income	0.47	-0.27	1.74	0.47	0.47	0.93	0.20
Others	0.10	0.10	0.10	0.10	0.10	0.12	0.09
Panel 3. Foreign monetary shock							
Response w.r.t. the aggregate	1.00	1.95	-0.62	-0.26	3.56	-0.56	1.94
Decomposition by different channels							
Real interest rate	1.73	1.73	1.73	0.47	4.29	0.91	2.21
Nominal rate in dom. currency	1.24	1.24	1.24	-0.03	3.80	0.69	1.57
Inflation	0.49	0.49	0.49	0.49	0.49	0.22	0.65
Labor income	-0.61	0.34	-2.23	-0.61	-0.61	-1.31	-0.18
Others	-0.12	-0.12	-0.12	-0.12	-0.12	-0.16	-0.10

Notes: This table decomposes the consumption responses of different groups of households. The consumption responses correspond to the period in which the aggregate consumption response reaches its peak and are normalized by the size of the peak aggregate consumption responses. Within each panel, the first row reports the total consumption response. The remaining rows report the consumption responses that are explained by the dynamics of different variables.

C.2. Comparison with an Open-economy RANK

We construct a benchmark open-economy representative-agent New Keynesian (RANK) model by removing households' heterogeneity in idiosyncratic labor productivity and international integration. For the latter, we assume no segmentation in labor markets (i.e., intermediate-good producers in the home and nontradable sectors hire workers from the same labor market) and that there are no frictions to international financial integration (all households have access to external financial securities and the UIP holds).

We calibrate the open-economy RANK version of the model with the same parameters as the baseline model. Table C.2 compares the aggregate response and decomposition of the transmission channels of the consumption response to a domestic monetary policy shock in the open-economy RANK (last column) with that of the open-economy baseline model (first column).[24] Consistent with the findings of Kaplan et al. (2018) for closed-economy models, the main difference between the RANK and HANK models is in the decomposition of the channels of the monetary transmission, with direct channels driving the transmission in the open-economy RANK and indirect channels driving that of the open-economy HANK. The presence of a stronger indirect channel explains why the open-economy HANK features a stronger response of aggregate consumption to monetary policy shocks than the representative-agent counterpart.

[24]For further analysis of the mechanisms that drive the aggregate responses of open-economy RANK and HANK models, see Auclert et al. (2020). See also Bianchi and Coulibaly (2021) for decomposition of the channels in a representative-agent open-economy model.

Table C.2: Aggregate Responses to Domestic Monetary Policy Shocks in Alternative Types of Models

	with idiosyncratic income shock			w/o idiosyncratic income shock			
	Both int. hete. (Baseline)	W/o real integration heterogeneity	W/o financial integration heterogeneity	Both integration heterogeneity	W/o real integration heterogeneity	W/o financial integration heterogeneity	No int. hete. (Rep. agent)
Panel 1. Aggregate Effects (%)							
Inflation	0.88	0.88	0.92	0.83	0.83	0.91	0.91
Exchange rate	0.28	0.28	0.33	0.24	0.25	0.47	0.45
Consumption	0.54	0.55	0.51	0.55	0.55	0.25	0.23
Panel 2. Decomposition of Aggregate Consumption Response (%)							
Real interest rate	32	32	30	87	87	76	75
Labor income	30	30	31	9	10	17	17
Other	38	38	39	3	3	7	8

Notes: Panel 1 reports the effects of a 25 b.p. expansionary monetary shock ($\epsilon_{m,t} = -0.25\%$) in the period when the aggregate consumption response reaches its peak in various models. Panel 2 summarizes the composition of aggregate consumption responses due to the dynamics of different aggregate prices and transfers. *Real interest rate* summarizes the effects of the domestic interest rate, foreign interest rate, the exchange rate and inflation; *labor income* summarizes the effects of wages in the nontradable and home goods sectors; and *other* summarizes the effects of the tax rate and transfers. The models can be divided into two groups: the ones with idiosyncratic income shocks and those without. Within the group with idiosyncratic income shocks, *both int. hete.* refers to the baseline model that features the heterogeneity in both real and financial integration; *w/o real int. hete.* refers to the model where we remove the heterogeneity in real integration from the baseline model; i.e. labor is perfectly substitutable across different sectors and there is wage difference across sectors; *w/o fin. int. hete.* refers to the model where we remove the heterogeneity in financial integration; i.e., all households are financially integrated and they share the same home bias and portfolio adjustment costs as in the baseline model. Within the group without idiosyncratic income shock, the models feature different representative agents with the same setup for their international integration and the transition of their integration status as in the baseline model. *both int. hete.* refers to the model where we keep the heterogeneity in both real and financial integration; *w/o real int. hete.* refers to the model where we remove the heterogeneity in real integration by assuming perfectly substituable labor across sectors; *w/o fin. int. hete.* refers to the model where we assume all agents are financially integrated; *no int. hete.* refers to the model where we remove the heterogeneity in both real and financial integration; i.e., a small open economy New Keynesian model with representative agents.

C.3. The Role of Different Sources of Household Heterogeneity

The intermediate columns of Table C.2 compare the aggregate response and decomposition of the transmission channels of the consumption response to a domestic monetary policy shock in various variants of the model in which we remove each source of household heterogeneity one at a time. The main takeaway from this table is that the main source of heterogeneity that explains the larger relevance of indirect channels of transmission of domestic monetary shocks is the idiosyncratic income shock. In turn, the heterogeneity along international integration is the most-relevant source of heterogeneity in accounting for the dispersion in the consumption responses to external macro shocks, as analyzed in Sections 4.2 and 4.3.

C.4. Comparison with a Closed-economy HANK

We construct a benchmark closed-economy HANK by removing from the model tradable goods and external securities; in this economy, all households save only in domestic bonds and work in the nontradable goods sector.

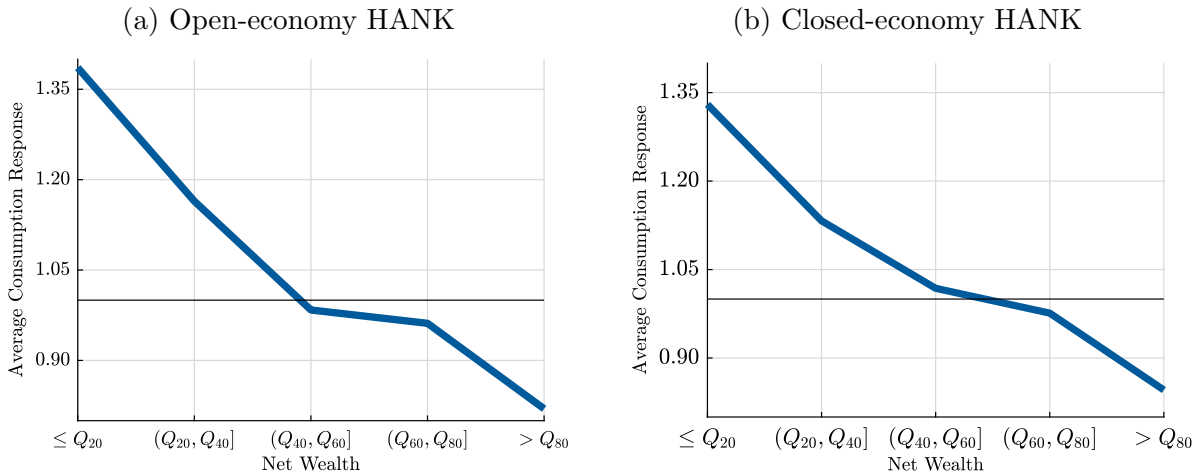
We calibrate the closed-economy HANK to match the same steady-state moments and domestic aggregate responses as in our baseline calibration; Table C.3 reports the parameters obtained in this calibration. Table C.4 shows that the aggregate response, distributional effects, and decomposition of the transmission channels of the consumption response to monetary policy shocks in the open-economy HANK are similar to their closed-economy counterparts. To understand this result, Figure C.1 shows that the distribution of the consumption responses along the wealth distribution, which Section 4.1 shows is the main source of the unequal consumption responses to domestic monetary policy shocks, is similar in both models. This suggests that the main difference introduced by the open-economy aspect of the HANK is linked to the external shocks and the heterogeneity in international integration, which we study in Sections 4.2 and 4.3.

Table C.3: Recalibrated Parameters in the Closed-economy HANK

Parameter	Description	Value
Panel 1. Recalibrated Parameters Governing the Steady State		
B_{ss}	Government debt	0.95
$\underline{b}$	Borrowing constraint	-0.18
ψ	Disutility of labor	3.44
β	Discount factor	0.96
Panel 2. Recalibrated Parameters Governing Aggregate Responses		
ϕ_π	Taylor rule, coefficient of inflation	1.10
ϕ_i	—, coefficient of lagged nominal interest rate	0.90
ρ_m	Domestic monetary shock, persistence	0.63
σ_m	—, std.	0.25%

Note: The values for B_{ss} and $\underline{b}$ are expressed in units of households' quarterly average labor income in the steady state.

Figure C.1: Heterogeneous Consumption Responses to Monetary Policy Shocks



Notes: This figure summarizes the average consumption responses of households from different net wealth groups to a 25 b.p. expansionary monetary shock (i.e. $\epsilon_{m,t} = -0.0025$) in the period when aggregate consumption responses reach their peak. The *open-economy HANK* model refers to the baseline model, as specified in Section 2, and the *closed-economy HANK* model refers to the model specified in Appendix C.4.

Table C.4: Consumption Responses to Domestic Monetary Shocks in HANK Models

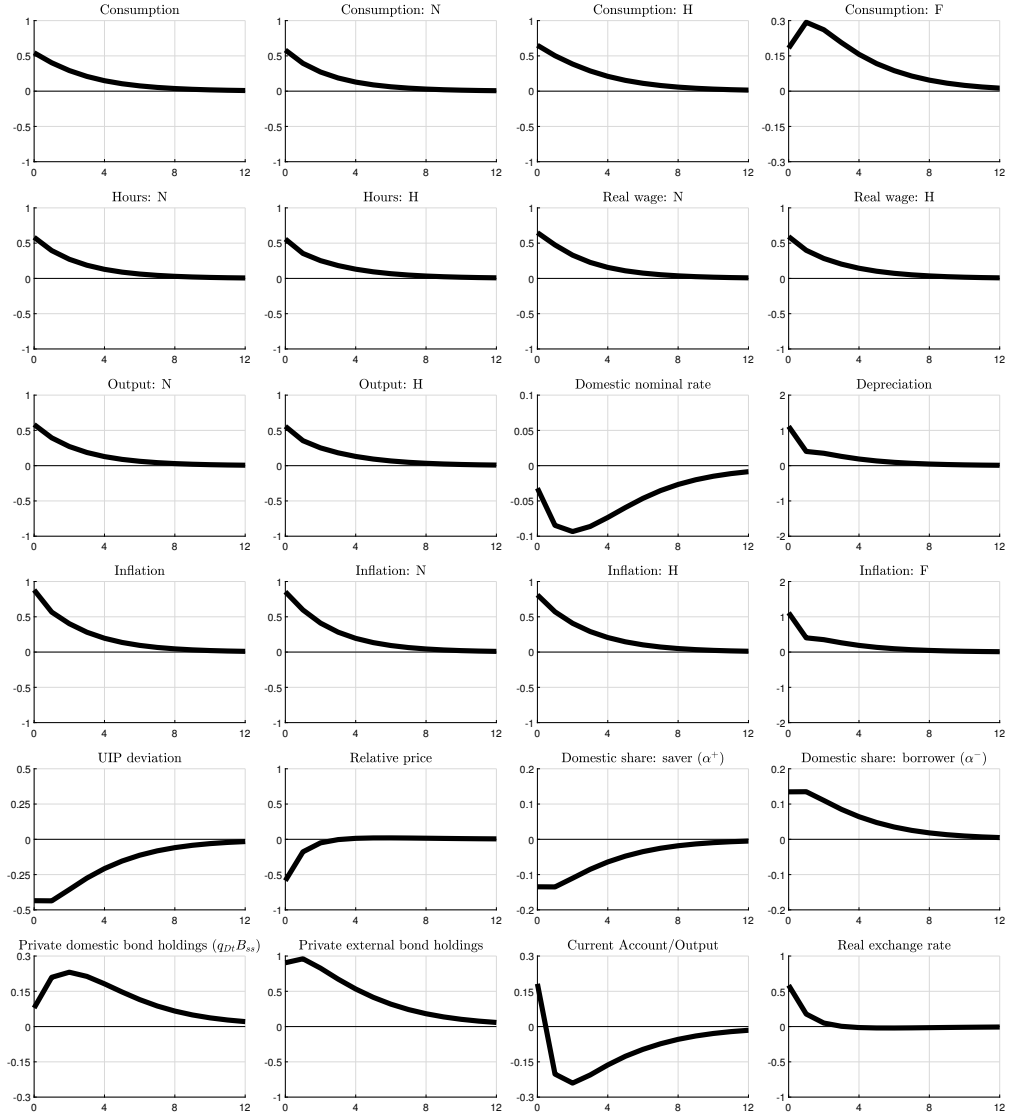
	Open Economy	Closed Economy
Panel 1. Aggregate Effects (%)		
Inflation	0.88	0.77
Exchange rate	0.28	-
Consumption	0.54	0.58
Panel 2. Distributional Effects on Consumption		
Std.	0.25	0.23
Gap by Net Wealth	0.36	0.29
Panel 3. Decomposition of Aggregate Consumption Response (%)		
Real Interest Rate	32	37
Labor Income	30	48
Other	38	15

Notes: This table summarizes the effects of a 25 b.p. expansionary monetary policy shock ($\epsilon_{m,t} = -0.25\%$) in the period when the aggregate consumption response reaches its peak in the baseline model (*Open Economy*) and a comparable model with a closed-economy setup (*Closed Economy*). Panel 1 reports the responses of various aggregate variables. Panel 2 reports the dispersion of individual consumption responses normalized by the size of the peak aggregate consumption response. Panel 3 reports the composition of the aggregate consumption response due the dynamics of different groups of aggregate prices and transfers. *Real interest rate* summarizes the effects of the domestic interest rate, foreign interest rate, exchange rate and inflation; *labor income* summarizes the effects of wages in the nontradable goods and home goods sectors; and *other* summarizes the effects of the tax rate and transfers.

D. Additional Figures and Tables

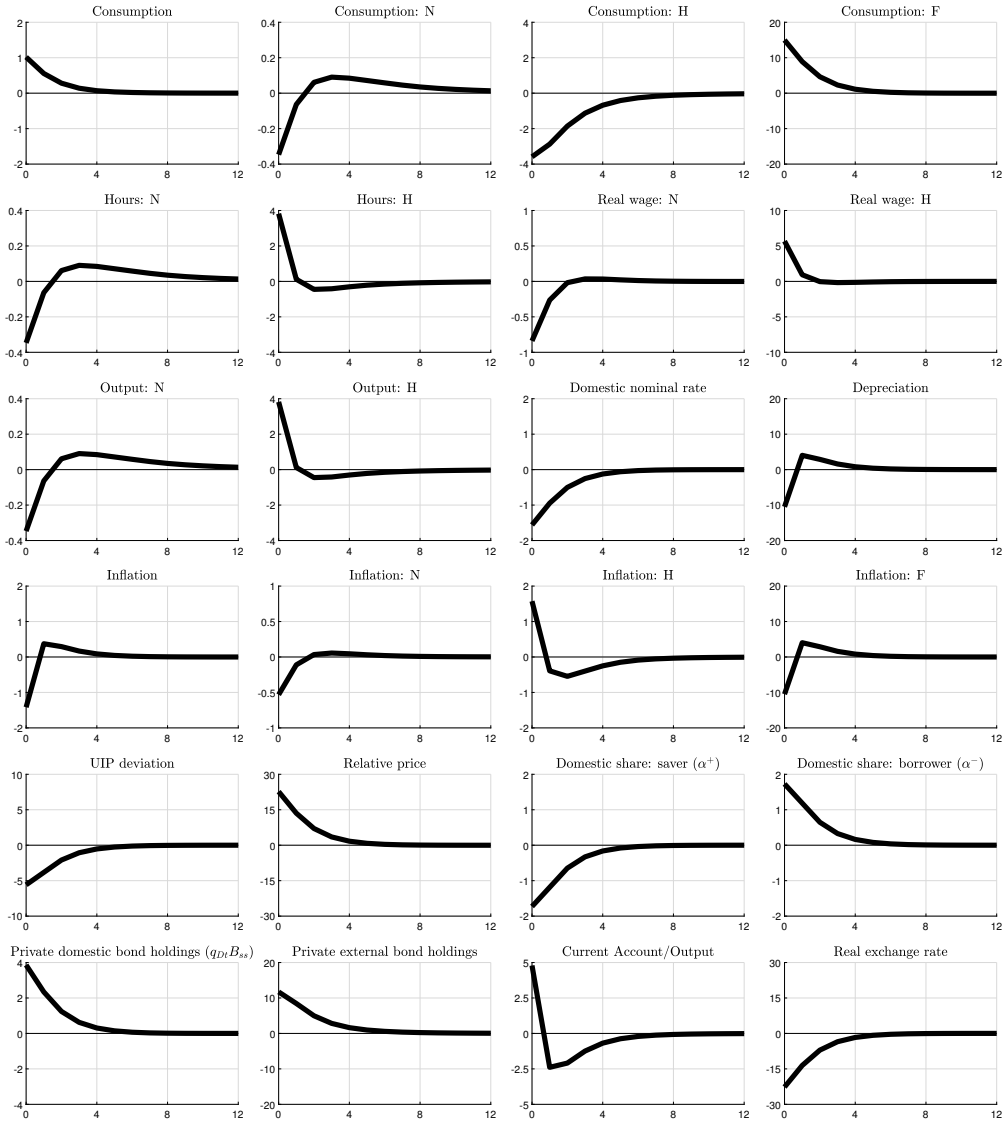
D.1. Impulse Responses to Macro Shocks

Figure D.1: Impulse Responses to Domestic Monetary Shocks



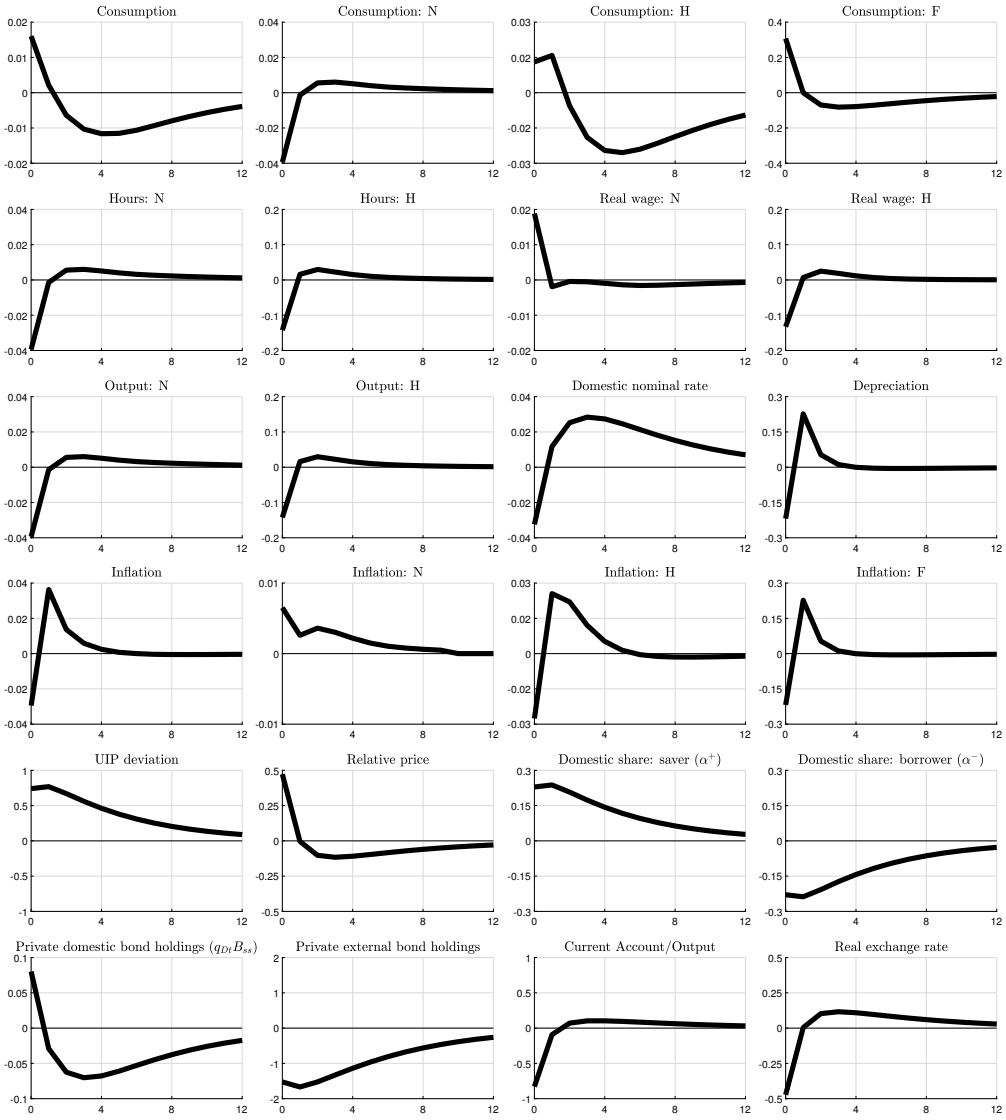
Notes: This figure reports the deviation of different variables from their steady-state levels (%) following a 25 b.p. expansionary monetary policy shock (i.e., $\epsilon_{m,t} = -0.0025$) at quarterly frequencies. The domestic nominal rate, depreciation, the different types of inflation, and the UIP deviation are all converted to annual rates. "N," "H," and "F" refer to the nontradable, home tradable, and foreign tradable goods sectors.

Figure D.2: Impulse Responses to Foreign Demand Shocks



Note: This figure reports the deviation of different variables from their steady-state levels (%) following a 15% expansionary external demand shock (i.e., $\epsilon_{y^*,t} = 0.15$) at quarterly frequencies. The domestic nominal rate, depreciation, the different types of inflation, and the UIP deviation are all converted to annual rates. "N," "H," and "F" refer to the nontradable, home tradable, and foreign tradable goods sectors.

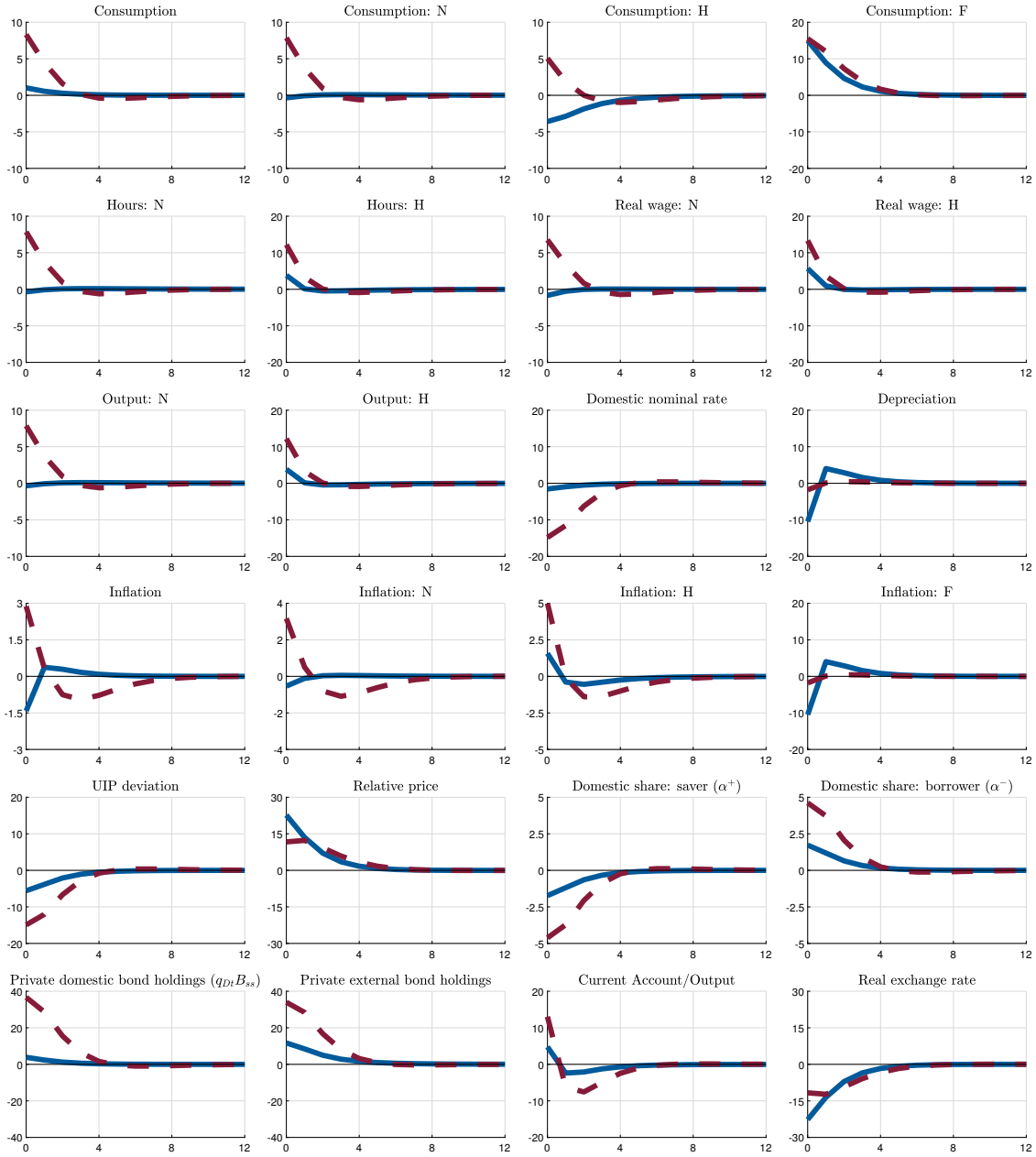
Figure D.3: Impulse Responses to Foreign Monetary Shocks



Note: This figure reports the deviation of different variables from their steady-state levels (%) following a 25 b.p. expansionary foreign monetary policy shock (i.e., $\epsilon_{m^*,t} = -0.0025$) at quarterly frequencies. The domestic nominal rate, depreciation, the different types of inflation, and the UIP deviation are all converted to annual rates. "N," "H," and "F" refer to the nontradable, home tradable, and foreign tradable goods sectors.

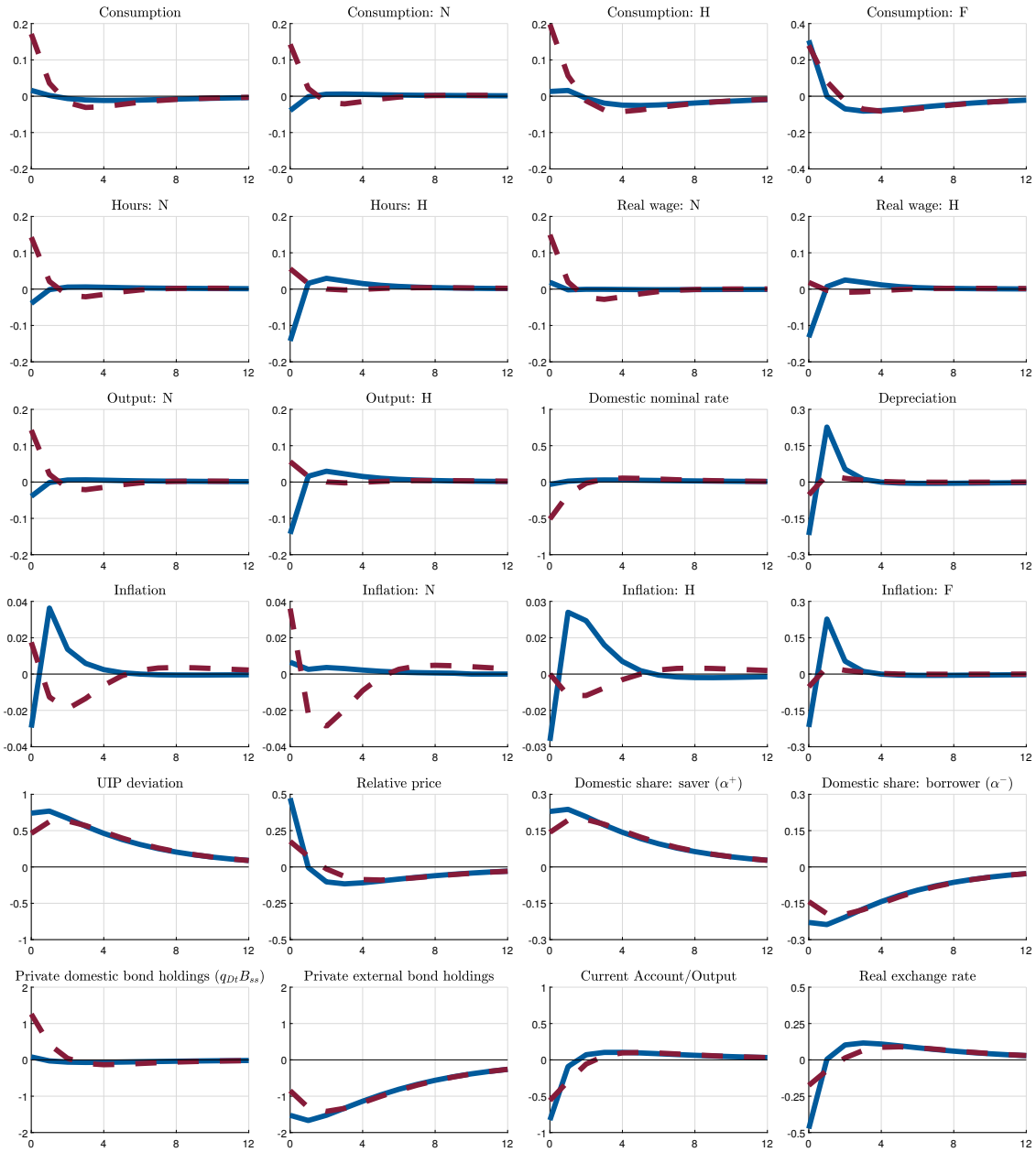
D.2. Responses to External Shocks under Alternative Exchange-rate Regimes

Figure D.4: Impulse Responses to Foreign Demand Shocks



Notes: This figure reports the deviation of different variables from their steady-state levels (%) following a 15% expansionary external demand shock (i.e., $\epsilon_{y^*,t} = 0.15$) under different exchange-rate regimes. *Flexible exchange rate*, represented by the solid line, corresponds to the baseline model (described in Section 2); *Fixed exchange rate*, represented by the dashed line, corresponds to a monetary policy that sets the nominal rate to target $\mathcal{E}_t = 1$ in all periods. The domestic nominal rate, depreciation, the different types of inflation, and the UIP deviation are all converted to annual rates. "N," "H," and "F" refer to the nontradable, home tradable, and foreign tradable goods sectors.

Figure D.5: Impulse Responses to Foreign Monetary Policy Shocks under Alternative Exchange-rate Regimes



Note: This figure reports the deviation of different variables from their steady-state levels (%) following a 25 b.p. expansionary foreign monetary policy shock (i.e., $\epsilon_{m^*,t} = -0.0025$) under different exchange-rate regimes. *Flexible exchange rate*, represented by the solid line, corresponds to the baseline model (described in Section 2); *Fixed exchange rate*, represented by the dashed line, corresponds to a monetary policy that sets the nominal rate to target $\mathcal{E}_t = 1$ in all periods. The domestic nominal rate, depreciation, the different types of inflation, and the UIP deviation are all converted to annual rates. "N," "H," and "F" refer to the nontradable, home tradable, and foreign tradable goods sectors.

D.3. Empirical Targets

Table D.1: Target 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 are from Bowlus, Gouin-Bonenfant, Liu, Lochner, and Park (2020).

Table D.2: Target Moments for Aggregate Impulse Responses

	Data	Model
Peak response to domestic monetary shocks (%)		
Consumption	$(0.52, 1.78)$	0.54
Nominal interest rate	$(-1.00, -0.76)$	-0.03
UIP deviation	$(-0.53, -0.18)$	-0.44
Relative price	$(-0.78, 0.31)$	-0.06
Peak response to foreign demand shocks (%)		
Consumption	$(0.8, 1.6)$	1.02
Exchange rate	$(-4.0, -2.0)$	-2.62
Export	$(8.0, 12.0)$	11.30

Notes: Empirical responses to a quarterly 25 b.p. domestic monetary shock are based on evidence from local projections using quarterly Canadian data. Following Champagne and Sekkel (2018), the local projection regression is designed as $y_{t+h} - y_{t-1} = \alpha + \beta_h \cdot \epsilon_{m,t} + \Gamma \cdot X_{t-1} + \sum_{l=1}^{4} \epsilon_{m,t-l} + \sum_{l=1}^{8} \Delta y_{t-l} + \varepsilon_{h,t}$ for $h = 0, 1, \ldots, 20$, where ϵ_m is the quarterly monetary shock from Champagne and Sekkel (2018); y denotes the variable of interest; and X is a vector of control variables, including the growth rate of labor income and commodity prices. Empirical responses to a foreign demand shock are from Charnavoki and Dolado (2014). The listed empirical moments are the 68% confidence intervals of the peak impulse responses. Listed moments in the model are the peak impulse responses of the corresponding variables.

D.4. Distributional Effects with or without Normalization

Table D.3: Dispersion of Individual Consumption Responses to Aggregate Shocks: Normalized vs. Non-normalized

	Domestic Monetary Shock	Foreign Demand Shock	Foreign Monetary Shock
Panel 1. Non-normalized (%)			
std	0.14	1.50	0.05
Interquantile range	0.16	1.22	0.03
90-10 percentile range	0.27	4.61	0.17
Panel 2. Normalized by the Peak Aggregate Consumption Response			
std	0.25	1.47	3.21
Interquantile range	0.30	1.20	1.64
90-10 percentile range	0.50	4.54	10.37

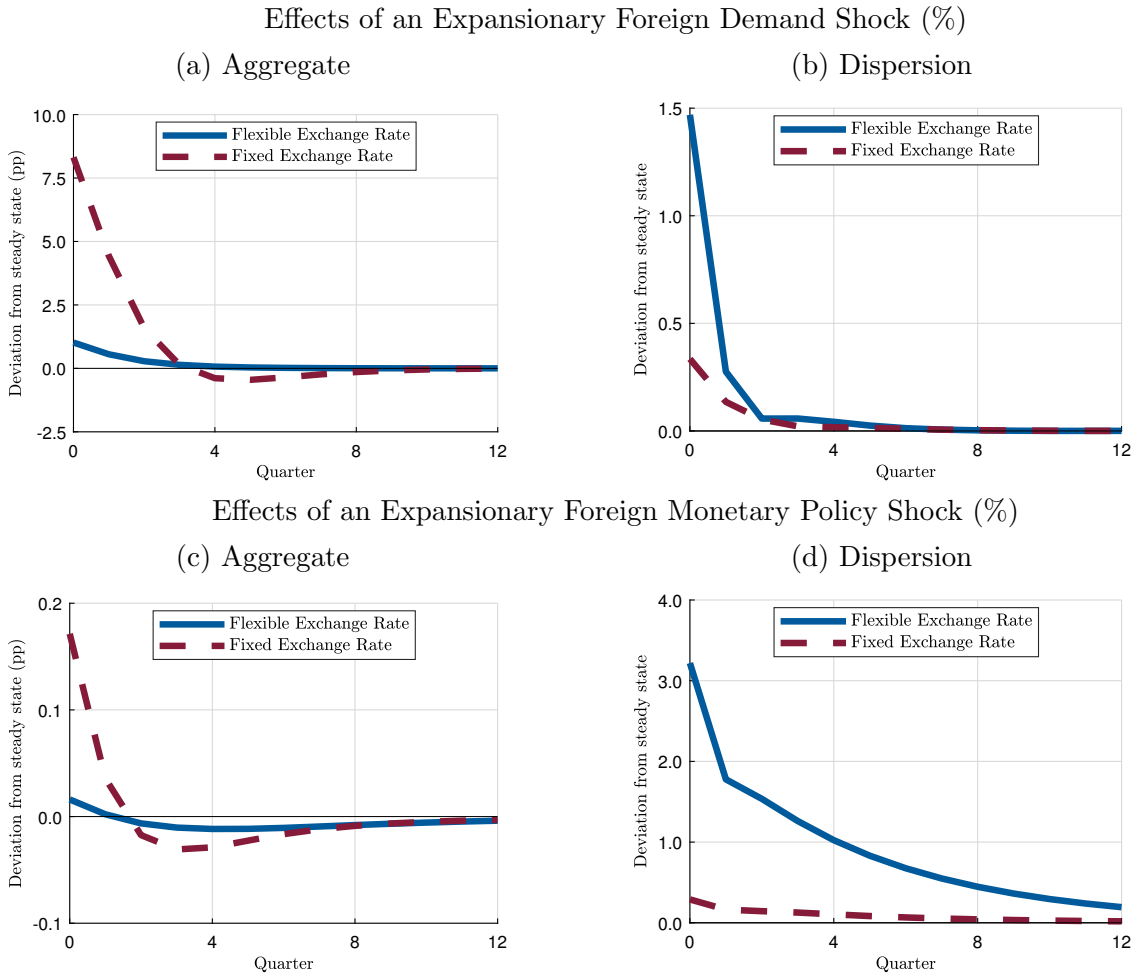
Notes: Panel 1 reports different statistics of the cross-sectional dispersion of individual consumption responses following a 25 b.p. expansionary monetary shock ($\epsilon_{m,t} = -0.25\%$), a 15% expansionary foreign demand shock ($\epsilon_{y^*,t} = 15\%$), and a 25 b.p. expansionary foreign monetary shock ($\epsilon_{m^*,t} = -0.25\%$) in the period when the aggregate consumption response reaches its peak. Panel 2 reports the same statistics, but these are normalized by the size of the peak consumption responses.

Table D.4: Decomposition of the Distributional Effects under Alternative Monetary Policies

	By real integration				By financial integration			
	Flexible		Fixed		Flexible		Fixed	
	Non--int.	Int.	Non--int.	Int.	Non--int.	Int.	Non--int.	Int.
Panel 1. Foreign demand shock								
Response w.r.t. the aggregate	0.26	2.26	0.91	1.15	1.10	0.80	1.03	0.93
Decomposition of consumption responses by different channels								
Real interest	0.42	0.43	0.44	0.44	0.52	0.23	0.47	0.37
Nominal rate in dom. currency	0.30	0.30	0.47	0.47	0.40	0.10	0.51	0.40
Inflation	0.13	0.13	-0.03	-0.03	0.13	0.13	-0.03	-0.03
Labor income	-0.27	1.74	0.28	0.51	0.47	0.47	0.37	0.37
Other	0.10	0.10	0.19	0.19	0.10	0.10	0.19	0.19
Panel 2. Foreign monetary shock								
Response w.r.t. the aggregate	1.95	-0.62	1.08	0.86	-0.26	3.56	0.90	1.19
Decomposition of consumption responses by different channels								
Real interest	1.73	1.73	0.59	0.59	0.47	4.29	0.49	0.78
Nominal rate in dom. currency	1.24	1.24	0.62	0.62	-0.03	3.80	0.53	0.82
Inflation	0.49	0.49	-0.03	-0.03	0.49	0.49	-0.03	-0.03
Labor income	0.34	-2.23	0.25	0.02	-0.61	-0.61	0.16	0.16
Other	-0.12	-0.12	0.25	0.25	-0.12	-0.12	0.25	0.25

Notes: This table decomposes the consumption responses of different groups of households. These consumption responses correspond to the period when the aggregate consumption response reaches its peak and are normalized by the size of the peak aggregate consumption responses. Within each panel, the first row reports the total consumption response. The remaining rows report the response of the consumption that is explained by the dynamics of different variables. Panel 1 reports the responses to a one-standard-deviation external demand shock (i.e., $\epsilon_{y^*,t} = 0.15$). Panel 2 reports the responses to a 25 b.p. expansionary foreign monetary policy shock (i.e., $\epsilon_{m^*,t} = -0.0025$). In each panel, we report the consumption responses under two exchange-rate regimes. *Flexible* indicates the flexible-exchange-rate regime, which corresponds to the baseline model (described in Section 2); *Fixed* indicates the fixed-exchange-rate regime, which corresponds to the equilibrium where the monetary policy sets the nominal rate to target $\mathcal{E}_t = 1$ in all periods.

Figure D.6: Consumption Responses to External Shocks under Alternative Exchange-rate Regimes



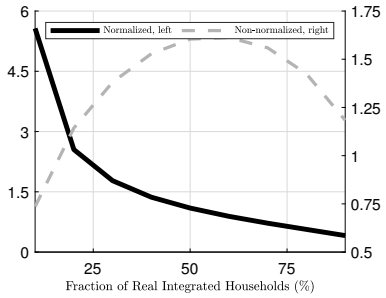
Notes: Panels (a) and (b) summarize the effects of a 15% expansionary foreign demand shock ($\epsilon_{y^*,t} = 15\%$) on consumption, and Panels (c) and (d) summarize the effects of a 25 b.p. expansionary foreign monetary shock ($\epsilon_{m^*,t} = -0.25\%$) on consumption. Panels (a) and (c) depict the responses of aggregate consumption. Panels (b) and (d) depict the cross-sectional standard deviation of individual consumption responses, normalized by the size of the peak aggregate consumption response. *Flexible exchange rate*, represented by the solid line, corresponds to the baseline model (described in Section 2); *Fixed exchange rate*, represented by the dashed line, corresponds to the equilibrium under which the monetary policy sets the nominal rate to target $\mathcal{E}_t = 1$ in all periods.

D.5. Distributional Effects with Different Degrees of International Integration

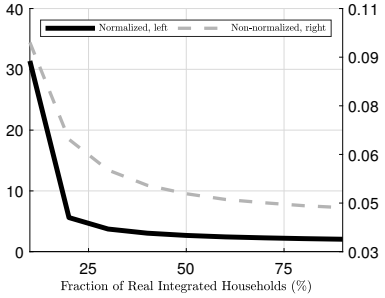
Figure D.7: Distributional Effects under Alternative Degrees of International Integration

Dispersion of Consumption Responses under Alternative Degrees of Real Integration

(a) Foreign Demand Shock

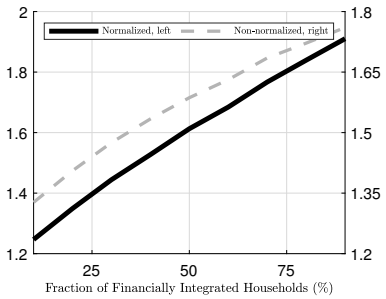


(b) Foreign Monetary Shock

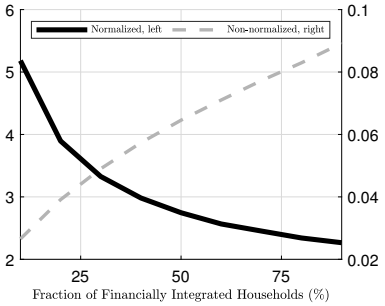


Dispersion of Consumption Responses under Alternative Degrees of Financial Integration

(c) Foreign Demand Shock



(d) Foreign Monetary Shock



Note: Panels (a) and (d) report the effects of a 25 b.p. expansionary monetary policy shock (i.e., $\epsilon_{m,t} = -0.0025$); Panels (b) and (e) report the effects of a 15% expansionary external demand shock ($\epsilon_{y^*,t} = 0.15$); and Panels (c) and (f) report the effects of a 25 b.p. expansionary foreign monetary policy shock ($\epsilon_{m^*,t} = -0.0025$). The *degree of real integration* refers to the fraction of households working in the home tradable goods sector, and the *degree of financial integration* refers to the fraction of households with access to international financial markets. When we vary the degree of international integration, we calibrate the model to have the same wealth distribution across households. In each panel, we report the cross-sectional standard deviations of households' consumption responses when the aggregate consumption responses reach their peaks, and we also report the standard deviations that are normalized by the peak aggregate consumption responses.