The Domestic and International Effects of Financial Deregulation

Fabio Ghironi* — *Boston College, EABCN, and NBER*

Viktors Stebunovs† — *Boston College*

July 20, 2007

Preliminary

Comments Welcome

Abstract

This paper studies the domestic and international effects of financial deregulation in a dynamic, stochastic, general equilibrium model with endogenous producer entry. We model deregulation as a decrease in the monopoly power of financial intermediaries. We show that the economy that deregulates experiences an increase in size, real exchange rate appreciation, and a persistent current account deficit. The rest of the world experiences higher consumption and an expansion in the number of domestic producers. Less monopoly power in financial intermediation results in less volatile business creation, reduced markup countercyclicality, and weaker substitution effects in labor supply in response to productivity shocks. Financial deregulation thus contributes to a moderation of firm-level and aggregate output volatility. In turn, trade and financial ties between the two countries allow the foreign economy to enjoy lower volatility as well. The results of the model are consistent with features of U.S. and international data following the U.S. banking deregulation started in 1977.

1 Introduction

The 1980s and late 1990s were characterized by real appreciation of the U.S. dollar and persistent U.S. current account deficits. The decades after the early 1980s were also marked by a reduction of macroeco-

*Department of Economics, Boston College, 140 Commonwealth Avenue, Chestnut Hill, MA 02467-3859, U.S.A. or Fabio.Ghironi@bc.edu. URL: http://www2.bc.edu/~ghironi.

†Department of Economics, Boston College, 140 Commonwealth Avenue, Chestnut Hill, MA 02467-3859, U.S.A. or stebunov@bc.edu. URL: http://www2.bc.edu/~stebunov.

nomic volatility around the world. This paper develops a model of the domestic and international effects of financial deregulation to study the contribution to these phenomena of the U.S. banking deregulation started in 1977 and finalized in 1994.

Our model builds on Ghironi and Melitz (2005), Bilbiie et al (2005), and Stebunovs (2006) by incorporating endogenous producer entry subject to sunk costs, deviations from purchasing power parity (PPP), and a role for financial intermediation. Investment in the model takes the form of the creation of new production lines (for convenience, identified with firms). Sunk costs and a time-to-build lag induce the number of firms (producers, production lines) to respond slowly to shocks, consistent with the notion that the number of productive units is fixed in the short run.[1] Following Stebunovs (2006), we assume that new entrants must obtain funds from financial intermediaries (henceforth, banks) to cover entry costs. Banks with market power erect a financial barrier to firm entry to protect the profitability of existing borrowers, reducing average entry relative to the competitive benchmark of Bilbiie et al (2005).[2] We take bank concentration as exogenous to the business cycle, and we interpret financial deregulation as an exogenous decrease in bank monopoly power.

We show that the economy that deregulates experiences an increase in size, real exchange rate appreciation, and a persistent current account deficit. Bank deregulation makes the domestic economy a relatively more attractive environment for potential entrants in the presence of trade costs. As in Ghironi and Melitz (2005), entry in the domestic economy pushes relative labor costs upward, inducing real appreciation when the economy features a non-traded sector or home bias in preferences. When economies are allowed to borrow and lend, financial deregulation induces the home economy to run persistent current account deficits to finance increased firm entry. The rest of the world experiences higher consumption and an expansion in the number of domestic producers. In addition, less monopoly power in financial intermediation results in less volatile business creation, reduced markup countercyclicality, and weaker substitution effects in labor supply in response to productivity shocks – the source of business cycles in our model. Financial deregulation thus contributes to a moderation of firm-level and aggregate output volatility. In turn, trade and financial ties between the two countries allow the foreign economy to enjoy lower volatility as well. Interpreting the economy that deregulates its financial sector as the U.S., the predictions of our model are thus consistent with features of the empirical evidence following the U.S.

[1] This is in contrast to other recent contributions, such as Comin and Gertler (2006) and Jaimovich (2006), whose entry mechanisms allow instantaneous variation in the number of producing firms.

[2] The model thus incorporates Cestone and White's (2003) insight that entry deterrence takes place through financial rather than product markets, and it explains the empirical evidence in Cetorelli and Strahan (2006).

banking deregulation started at the end of the 1970s.[3]

Our paper contributes to several literatures that address observed dynamics of international relative prices, external imbalances, and the moderation of business cycle volatility observed since the mid 1980s. The conventional explanation for the contemporaneous occurrence of exchange rate appreciation and external borrowing in the U.S. in the 1980s relied on the traditional Mundell-Fleming analysis of the consequences of expansion in government spending. But the tight association between federal budget and external balance has been challenged by recent literature. For instance, Erceg et al (2005) find that a fiscal deficit has a relatively small effect on the U.S. trade balance, irrespective of whether the source is a spending increase or tax cut. With respect to U.S. trade balance and real exchange rate dynamics in the second half of the 1990s, Hunt and Rebucci (2005) conclude that accelerating productivity growth in the U.S. contributed only partly to the appreciation and the trade balance deterioration. They find that a portfolio preference shift in favour of U.S. assets and some uncertainty and learning about the persistence of both shocks are needed for their model to explain the data. Rather than emphasizing the demand-side effect of preference shifts, Caballero et al (2006) provide a model that rationalizes persistent imbalances as the outcome of potential growth differentials among different regions of the world and heterogeneity in these regions' capacity to generate financial assets.[4] Mendoza et al (2007) argue that imbalances can be the outcome of international financial integration when countries differ in financial market deepness (interpreted as the enforcement of financial contracts) and show that countries with more advanced financial markets accumulate foreign liabilities in a gradual, long-lasting process. Finally, Fogli and Perri (2006) argue that global imbalances are a natural consequence of business cycle moderation in the U.S. In their model, if a country experiences a fall in volatility greater than that of its partners, its relative incentives to accumulate precautionary savings weaken, and this results in an equilibrium permanent deterioration of its external balance.[5]

Our model provides an alternative, potentially complementary explanation of observed phenomena, based on the effects of deregulation that made the U.S. banking system more competitive than that of the rest of the world. De Bandt and Davis (2000) provide evidence that the behavior of large banks in Europe was not as competitive as that of U.S. counterparts over the period 1992-1996. Regarding small banks, the level of competition in Europe was even lower. In our model, a differential in the competitiveness of the

[3] Our model also implies that deregulation is welfare improving in both countries as households enjoy higher utility from consumption despite an increase in labor supply.

[4] See also Caballero (2006).

[5] Other explanations emphasize demographics, a 'global saving glut,' and valuation effects.

banking system induces real appreciation of the dollar and U.S. external borrowing by making the U.S. a more attractive environment for business creation. As in the above mentioned papers, persistent external imbalances arise as an equilibrium phenomenon. However, while Caballero et al (2006) do not link business cycle moderation with global imbalances, and Fogli and Perri (2006) take moderation as exogenous, we provide a unified explanation of imbalances and moderation for given stochastic productivity process without requiring long-run productivity differentials. An element of similarity between our approach and those of Caballero et al (2006) and Mendoza et al (2007) is that imbalances arise as a consequence of capital mobility across asymmetric financial systems: In Caballero et al, there is asymmetric ability to generate financial assets; in Mendoza et al, there is asymmetric enforcement of financial contracts; in our model, there is asymmetric banking competition.[6]

The remainder of the paper is organized as follows. Section 2 presents the benchmark model with balanced trade to highlight the mechanism for real exchange rate appreciation as the result of financial deregulation. Section 3 extends the model to allow for international capital flows to show the emergence of external borrowing in response to deregulation. Section 4 incorporates countercyclical firm markups and elastic labor supply to highlight the mechanism for the moderation of business cycle volatility. Finally, Section 5 concludes. Technical details are in the Appendix.

2 Benchmark model

We begin by developing a version of our model under financial autarky.

The world consists of two countries, home (the US) and foreign (the rest of the world). We denote foreign variables by an asterisk. Each country is populated by a unit mass of atomistic households, a number of banks and a varying mass (number) of firms. There are several exogenously given locations with a number of banks and a mass (number) of firms at each of them in each country.[7] Each firm is monopolistic, produces one consumption variety, competes in a domestic market and exports, has

[6] By focusing on the role of financial intermediaries, our paper also contributes to a recent, fast growing literature on the consequences of endogenous producer entry in macroeconomic models. In addition to the works mentioned above, see Bergin and Corsetti (2005), Bilbiie et al (2008), Corsetti, Martin, and Pesenti (2007a,b), Elkhoury and Mancini Griffoli (2006), Ghironi and Melitz (2007), Méjean (2007), and Lewis (2006). Our setup preserves the key international relative price and external balance implications of entry in the Ghironi-Melitz model while removing firm heterogeneity and fixed export costs as a source of endogenous non-tradedness and introducing an exogenous non-traded sector (as in Méjean, 2007) or home bias in preferences. For simplicity, we do not allow for foreign bank ownership and foreign bank lending to domestic entrants. Intuitively, allowing for international financial integration along these dimensions will reinforce our results as it will further undermine bank monopoly power in each country.

[7] In the model the boundaries of product markets and lending markets coincide. However, in reality some larger firms may span multiple banking markets. In such cases, a bank could still have an impact on entry within its area of influence.

no collateral to pledge except a stream of future profits, and its entry is subject to a sunk entry cost. Unspecified financial frictions force a prospective entrant to borrow the amount necessary to cover the sunk entry cost from a local bank rather than to raise funds directly in an equity market. Borrowing at a different location is prohibited altogether. Firm entry reduces the stream of future profits of both incumbents and entrants and thus the amount pledgeable for entry loan repayments.

Each bank, being a local monopolist, is able to extract all the future profits from a prospective entrant, holds a portfolio of firms and decides on the number of loans to be issued (that is, on the number of entrants).[8] Each bank trades the increase in revenue from expanding its firm portfolio (portfolio expansion effect) against the decrease in revenue from all firms in its portfolio due to stronger firm competition (profit destruction effect). The profit destruction effect gives rise to credit rationing on the extensive margin as not all of the prospective entrants will be funded. Thus, there is an intrinsic inefficiency built into the model due to the presence of monopolistic banks.[9] Each bank supplies one-period deposits to domestic households in a perfectly competitive market. The bank then uses the deposits to fund firm entry. Thus, the cost that each bank faces is the deposit interest rate.

We now focus on the home economy. Since the completion of financial deregulation in the US in 1994, it becomes increasingly less plausible to view banking markets as local. Banks' ability to expand across local markets and new technologies, that allow banks to lend to distant borrowers, limited incumbent banks' local monopoly power.[10] Consequently, we model bank deregulation as lifting the restriction on borrowing from a bank at a different location. The number of banks in the economy might stay the same or decrease. However, the number of banks represented locally increases, hence reducing monopoly power.

We assume that the rest of world does not deregulate, hence monopoly power of its banks stays the same.

For expositional simplicity, we present each economy with one location only.

All contracts and prices in the world economy are written in nominal terms. Prices are flexible. Thus,

[8] Banks compete in the number of entrants in Cournot fashion as in the static partial equilibrium model of Gonzalez-Maestre and Granero (2003).

[9] If one interprets the number of firms as the number of production lines in the economy, then a bank might be thought as of a multi-production line company that produces a set of goods that compete within this set and also with goods produced by other multi-production line companies. Then each multi-production line company internalizes only its own "product cannibalization."

[10] Black and Strahan (2002) argue that after deregulation, the effects of concentration ought to have been mitigated by the threat of entry. That is, banking concentration no longer signals market power when barriers to entry from regulations have been eliminated. And, in fact, they find that the effect of concentration on the rate of creation of new incorporations does fall significantly with deregulation.

we only solve for the real variables in the model. However, as the composition of consumption baskets in the two countries changes over time (affecting the definitions of the consumption-based price indexes), we introduce money as a convenient unit of account for contracts. Money plays no other role in the economy. For this reason, we do not model the demand for cash currency, and resort to a cashless economy as in Woodford (2003).

2.1 Households

The representative home household supplies l units of labor inelastically in each period at the nominal wage rate W_t, denominated in units of home currency. The household maximizes expected intertemporal utility from consumption (C), $E_t \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_s^{1-\gamma}}{1-\gamma}$, where $\beta \in (0,1)$ is the subjective discount factor and $\gamma > 0$ is the inverse of the intertemporal elasticity of substitution, subject to a budget constraint. At time t, the household consumes the basket of goods C_t. We consider two definitions of the basket of goods C_t, both such that the purchasing power parity does not hold.

The first definition of the consumption basket distinguishes between tradeable and non-tradeable goods. We define the basket over a set of tradeable home and foreign goods and non-tradeable good as $C_t = (C_{T,t}/\alpha)^{\alpha} (C_{N,t}/1-\alpha)^{1-\alpha}$, where $C_{T,t}$ is the basket of tradeable goods, $C_{N,t}$ is the amount of non-tradeable good, and $\alpha \in (0,1)$ is the weight of tradeable goods in the basket. The consumption-based price index for the home economy is then $P_t = (P_{T,t})^{\alpha} (P_{N,t})^{1-\alpha}$, where $P_{T,t}$ is the price index of the basket of tradeable goods and $P_{N,t}$ is the price of non-tradeable good. At any given time t, only a subset of goods $\Omega_t \subset \Omega$ is available at home and abroad. Hence, we define the basket of tradeable goods as $C_{T,t} = \left(\int_{\omega \in \Omega_t} (c_t(\omega))^{(\theta-1)/\theta} \right)^{\theta/(\theta-1)}$, where $\theta > 1$ is the symmetric elasticity of substitution across goods. Let $p_t(\omega)$ denote the home currency price of tradeable good ω, $\omega \subset \Omega_t$, then $P_{T,t} = \left(\int_{\omega \in \Omega_t} (p_t(\omega))^{1-\theta} d\omega \right)^{1/(1-\theta)}$. The household's demand for each individual tradeable good ω is $c_t = \alpha \left(p_t(\omega) / P_{T,t} \right)^{-\theta} P_t / P_{T,t} C_t$. The household's demand for the single non-tradeable good is $C_{N,t} = (1-\alpha) P_t / P_{N,t} C_t$.

The second definition of the consumption basket does not distinguish between tradeable and non-tradeable goods, instead it introduces home bias in consumption. We define the basket over a set of home and foreign goods as $C_t = \left(\alpha^{1/\theta} (c_{D,t})^{(\theta-1)/\theta} + (1-\alpha)^{1/\theta} (c_{X,t})^{(\theta-1)/\theta} \right)^{\theta/(\theta-1)}$, where $c_{D,t}$ is the basket of goods produced at home goods and $c_{X,t}$ is the basket of goods produced abroad, and $\alpha > 0.5$ is the weight of home goods in the basket, it captures home bias in consumption. Hence, even though the law of one price holds in the absence of trade costs, the purchasing power parity will not. The baskets of home and foreign goods are defined as $c_{D,t} = \left(\int_{\omega\in\Omega} c_{D,t}(\omega)^{(\theta-1)/\theta} d\omega\right)^{\theta/(\theta-1)}$ and $c_{X,t} = \left(\int_{\omega^*\in\Omega} c_{X,t}(\omega^*)^{(\theta-1)/\theta} d\omega^*\right)^{\theta/(\theta-1)}$, where $\theta > 1$ is the symmetric elasticity of substitution across goods. At any given time t, only a subset of goods $\Omega_t \subset \Omega$ is available. Let $P_{D,t}$ and $P^*_{X,t}$ denote the home currency price indices of home and foreign baskets. We assume that export prices are denominated in the currency of the export market. The consumption-based price index for the home economy is then $P_t = \left(\alpha \left(P_{D,t}\right)^{\theta-1} + (1-\alpha)\left(P^*_{X,t}\right)^{\theta-1}\right)^{1/(1-\theta)}$. Let $p_{D,t}(\omega)$ and $p^*_{X,t}(\omega^*)$ denote the home currency price of home and foreign goods respectively, $\omega \subset \Omega_t$ and $\omega^* \subset \Omega_t$, then $P_{D,t} = \left(\int_{\omega\in\Omega_t} p_{D,t}(\omega)^{1-\theta} d\omega\right)^{1/(1-\theta)}$ and $P^*_{X,t} = \left(\int_{\omega^*\in\Omega_t} p^*_{X,t}(\omega^*)^{1-\theta} d\omega^*\right)^{1/(1-\theta)}$. The household's demand for each individual home good ω is $c_{D,t}(\omega) = \alpha \left(p_{D,t}(\omega)/P_t\right)^{-\theta} C_t$ and for each individual foreign good ω^* is $c_{X,t}(\omega^*) = (1-\alpha)\left(p^*_{X,t}(\omega^*)/P_t\right)^{-\theta} C_t$.

The foreign household supplies l^* units of labor inelastically in each period in the foreign labor market at the nominal wage rate W^*, denominated in units of foreign currency. It maximizes a similar utility function, with identical parameters and similarly defined consumption baskets. The subset of goods available for consumption in the foreign economy during period t is $\Omega^*_t \subset \Omega$ and is identical to the subset of goods that are available in the home economy.

Households in each country hold two types of assets: shares in a mutual fund of H domestic banks and one-period deposits supplied by domestic banks. We assume that deposits pay risk-free, consumption-based real returns. We now focus on the home economy. Let s_t be the share in the mutual fund of home banks held by the representative home household entering period t. The mutual fund pays a total profit in each period (in units of currency) equal to the total profit of all home banks, $P_t \sum_{i\in H} \pi_t(i)$, where $\pi_t(i)$ denotes the profit of home bank i. During period t, the household buys s_{t+1} shares in the mutual fund. The date t price in units of currency of a claim to the future profit stream of the mutual fund is equal to the nominal price of claims to future profits of home banks, $P_t \sum_{i\in H} v_t(i)$, where $v_t(i)$ is the price of claims to future profits of bank i. The household enters period t with deposits B_{t-1} in units of consumption and mutual fund share holdings s_t. It receives gross interest income on deposits, dividend income on mutual fund share holdings and the value of selling its initial share position, and labor income. The household allocates these resources between purchases of deposits and shares to be carried into next period and consumption. The period budget constraint (in units of consumption) is

$$B_t + s_t \sum_{i \in H} v_t(i) + C_t = (1 + r_{t-1}) B_{t-1} + s_{t-1} \sum_{i \in H} (\pi_t(i) + v_t(i)) + w_t l, \tag{1}$$

where r_{t-1} is the consumption-based interest rate on holdings of deposits between $t-1$ and t (known with certainty as of $t-1$), and $w_t = W_t/P_t$ is the real wage. We assume that nominal returns are indexed to inflation in the home economy, so that the deposits provide a risk-free, real return in units of home's consumption basket. The home household maximizes its expected intertemporal utility subject to (1).

The Euler equations for deposits and share holdings are: $1 = \beta(1 + r_t) E_t \left[(C_{t+1}/C_t)^{-\gamma} \right]$, and $v_t = \beta E_t \left[(C_{t+1}/C_t)^{-\gamma} (\pi_{t+1} + v_{t+1}) \right]$, where $v_t = \sum_{i \in H} v_t(i)$ and $\pi_{t+1} = \sum_{i \in H} \pi_{t+1}(i)$. Forward iteration of the Euler equation for shares holdings and absence of speculative bubbles yield the value of the mutual fund, v_t, in terms of a stream of bank profits, $\{\pi_t\}_t^{\infty}$.

2.2 Firms

The following applies to both the economy with tradeable and non-tradeable goods and the economy with tradeable goods only and home bias in consumption. There is a continuum of firms in each country, each producing a different tradeable variety $\omega \in \Omega$. Aggregate labor productivity is indexed by Z_t (Z_t^*), which represents the effectiveness of one unit of home (foreign) labor. Production requires only one factor, labor: $y_t(\omega) = Z_t l_t(\omega)$. Firms are homogeneous as they produce with the same technology, hence identical production cost. This cost, measured in units of the consumption good C_t, is w_t/Z_t. Similarly, for foreign firms the unit cost (measured in units of the foreign consumption good) is w_t^*/Z_t^*, where $w_t^* = W_t^*/P_t^*$ is the real wage of foreign workers. Home and foreign firms serve both their domestic market as well as the export market. Exporting is costly, and involves a melting-iceberg trade cost $\tau > 1$ ($\tau^* > 1$), so that for every unit of home (foreign) good shipped abroad, a fraction $\tau - 1$ ($\tau^* - 1$) does not arrive at the foreign (home) shore.

We now consider the home firms in the economy with both tradeable and non-tradeable goods. All firms producing tradeable goods face a residual demand curve with constant elasticity θ in both markets, and they set flexible prices that reflect the same proportional markup $\mu = \theta/(\theta - 1)$ over marginal cost. Let $p_{D,t}(\omega)$ and $p_{X,t}(\omega)$ denote the nominal domestic and export prices of a home firm. Prices, in real terms relative to the price index in the destination market, are then given by $\rho_{D,t}\rho_{T,t} = p_{D,t}(\omega)/P_{T,t}P_{T,t}/P_t = \mu w_t/Z_t$ and $\rho_{X,t}\rho_{T,t}^* = p_{X,t}(\omega)/P_{T,t}^*P_{T,t}^*/P_t^* = \tau Q_t^{-1} \mu w_t/Z_t$, where $Q_t = \varepsilon_t P_t^*/P_t$ is the consumption-based real exchange rate (units of home consumption per unit of foreign consumption; ε_t is the nominal exchange rate, units of home currency per unit of foreign). A firm decomposes its total profit into two portions earned from domestic sales $d_{D,t}(\omega)$ ($d^*_{D,t}(\omega)$) and from export sales $d_{X,t}(\omega)$ ($d^*_{X,t}(\omega)$). All these profit levels are expressed in real terms in units of the consumption basket in the firm's location. In the case of a home firm, total profits in period t are given by $d_t(\omega) = d_{D,t}(\omega) + d_{X,t}(\omega)$, where $d_{D,t}(\omega) = \alpha/\theta \left(\rho_{D,t}\right)^{1-\theta} C_t$ and $d_{X,t}(\omega) = \alpha/\theta Q_t \left(\rho_{X,t}\right)^{1-\theta} C^*_t$. Since all firms are identical in equilibrium, one may drop indexing by ω. There is also a (fixed) mass of firms in each country producing the identical non-tradeable good. These firms are perfectly competitive and possess the same technology as the firms producing tradeable goods. Hence, the price of the non-tradeable good, in real terms relative to the domestic price index, is given by $\rho_{N,t} = P_{N,t}/P_t = w_t/Z_t$. Foreign firms behave in a similar way.[11]

We now consider the home firms in the economy with tradeable goods only and home bias in consumption. All firms face a residual demand curve with constant elasticity θ in both markets, and they set flexible prices that reflect the same proportional markup $\mu = \theta/(\theta-1)$ over marginal cost. Prices, in real terms relative to the price index in the destination market, are then given by $\rho_{D,t} = p_{D,t}(\omega)/P_t = \mu w_t/Z_t$ and $\rho_{X,t} = p_{X,t}(\omega)/P^*_t = \tau Q_t^{-1}\mu w_t/Z_t$. A firm decomposes its total profit into two portions earned from domestic sales $d_{D,t}(\omega)$ ($d^*_{D,t}(\omega)$) and from export sales $d_{X,t}(\omega)$ ($d^*_{X,t}(\omega)$). In the case of a home firm, total profits in period t are given by $d_t(\omega) = d_{D,t}(\omega) + d_{X,t}(\omega)$, where $d_{D,t}(\omega) = \alpha/\theta \left(\rho_{D,t}\right)^{1-\theta} C_t$ and $d_{X,t}(\omega) = (1-\alpha)/\theta Q_t \left(\rho_{X,t}\right)^{1-\theta} C^*_t$. Since all firms are identical in equilibrium, one may drop indexing by ω. Foreign firms behave in a similar way.[12]

2.3 Banks and firm entry

In every period there is an unbounded number of prospective entrants in both countries. Prior to entry, firms face a sunk entry cost of one effective labor units, equal to w_t/Z_t (w^*_t/Z^*_t) units of the home (foreign) consumption good. Since there are no fixed production costs, all firms produce in every period, until they are hit with a "death" shock, which occurs with probability $\delta \in (0,1)$ in every period. This exit-inducing shock is independent of the firm's vintage or state and the state of the economy. The entrants (as well as banks) are forward looking, and correctly anticipate their future expected profits d_t (d^*_t) in every period

[11] Note though that the pricing equations of tradeable goods in foreign are $\rho^*_{X/T,t}\rho_{T,t} = p^*_{X,t}(\omega)/P_{T,t}P_{T,t}/P^*_t = \tau Q_t \mu w^*_t/Z^*_t$ and a foreign firm earns export profits $d^*_{X,t}(\omega) = \alpha/\theta Q_t^{-1}\left(\rho^*_{X/T,t}\right)^{1-\theta} C_t$.

[12] Note though that a foreign firm earns export profits $d^*_{X,t}(\omega) = (1-\alpha)/\theta Q_t^{-1}\left(\rho^*_{X,t}\right)^{1-\theta} C_t$.

as well as the probability δ (in every period) of incurring the exit-inducing shock. Unspecified financial frictions force entrants to borrow the amount necessary to cover the sunk entry cost from a bank in firm's domestic market. Since the bank has all the bargaining power, it sets each period the entry loan repayment at d_t (d_t^*) to extract all the firm profit.[13]

We now focus on the home economy. There is a fixed number of banks, H, that compete in Cournot fashion.[14] Each bank acts on the expectation that its own decision will not affect decisions of its rivals. Bank i has $K_t(i)$ producing firms in its portfolio and decides simultaneously with other banks on the number of entrants to fund, $k_t(i)$, taking into account the post entry firm profit maximization as each firm sets optimal prices for its variety.

We assume that entrants at time t only start producing at time $t+1$, which introduces a one-period time-to-build lag in the model. The exogenous exit shock occurs at the very end of the time period (after production and entry). A proportion of new entrants will therefore never produce. The bank does not know which firms will be hit by the exogenous exit shock δ at the very end of period t. The timing of entry and production we have assumed implies that number of firms in bank i's portfolio during period t is given by $K_t(i) = (1-\delta)\left(K_{t-1}(i) + k_{t-1}(i)\right)$. Then the number of producing home firms in period t, is $N_t = (1-\delta)(N_{t-1} + n_{t-1})$, where $N_t = \sum_{i \in H} K_t(i)$ and the number of home entrants is $n_t = \sum_{i \in H} k_t(i)$.[15] Hence, the number of producing firms in period t is an endogenous state variable that behaves like physical capital in standard real business cycle models.

Bank i takes the aggregate variables such as home consumption, C_t, foreign consumption, C_t^*, home wages, w_t, home deposit interest rate, r_t, etc as given. The Euler equation for share holdings implies the objective function for bank i, $E_t \sum_{s=t}^{\infty} \beta^{s-t} \left(C_s/C_t\right)^{-\gamma} \pi_s(i)$, which the bank maximizes with respect to $\{K_{s+1}(i)\}_{s=t}^{\infty}$ and $\{k_s(i)\}_{s=t}^{\infty}$. Bank i's profit is $\pi_t(i) = K_t(i)d_t + B_t(i) - w_t/Z_t k_t(i) - (1+r_{t-1})\, B_{t-1}(i)$. Note that $d_t K_t(i)$ is the revenue from bank i's portfolio of $K_t(i)$ firms, $B_t(i)$ is the amount of household deposits in period t into bank's i, $w_t/Z_t k_t(i)$ is the amount lent to $k(i)$ entrants, and finally, $(1+r_{t-1})\, B_{t-1}(i)$ is the principal and interest on the $t-1$ period's deposits. We assume that banks accrue revenues after firm entry has been funded and then rebates its profits to the mutual fund. Hence,

[13] This modelling strategy precludes interpreting the financial contract as debt, as the entry loan repayments are not firm state dependent. Although the assumption that banks have bargaining power and are able to extract all the profit may be unrealistic, it simplifies the model solution substantially. It is not necessary to keep track of outstanding loan amounts for each firm cohort, hence firms of different vintages can be treated equally. The strategy also allows the model to reproduce the apparent absence of pure profits in U.S. industries despite the presence of market power (even in the short run).

[14] As will become clear later, this is not exactly the Cournot model as not only the value of entrants, but also the value of incumbents depends on the number of entrants.

[15] Similarly, the number of foreign firms during period t is given by $N_t^* = (1-\delta)\left(N_{t-1}^* + n_{t-1}^*\right)$.

bank i's balance sheet constraint is $B_t(i) = w_t/Z_t k_t(i)$.

The first order condition with respect to $K_{t+1}(i)$ gives the Euler equation for firm value to bank i, $q_t(i)$, and involves a term capturing the internalization of the profit destruction externality (PDE):[16]

$$q_t(i) = \beta E_t \left[\left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \left(d_{t+1} + \underbrace{K_{t+1}(i) \left(\frac{\partial d_{t+1}}{\partial N_{t+1}} \frac{\partial N_{t+1}}{\partial K_{t+1}(i)} \right)}_{\text{internalization of PDE}} + (1-\delta) q_{t+1}(i) \right) \right].$$

The bank internalizes the effect of entry on firm profits through the effect of entry on the nominal domestic price, $p_{D,t}$, and the effect on the nominal export price, $p_{X,t}$. Firm entry reduces incumbents' and entrants' size and profits, and hence decreases the repayments to the bank. The bank bank internalizes only the effects of the competition it funded, thus $K_{t+1}(i)$ multiplies the profit destruction externality, $\partial d_{t+1}/\partial N_{t+1} \partial N_{t+1}/\partial K_{t+1}(i)$.

The first order condition with respect to $k_t(i)$ defines a firm entry condition, which holds as long as the number of entrants, $k_t(i)$, is positive. We assume that macroeconomic shocks are small enough for this condition to hold in every period. Entry occurs until ex ante firm value, $q_t(i)$, is equalized with the expected, discounted entry cost, which is given by the deposit principal and the interest to be paid back next period, $t+1$, $q_t(i) = \beta/(1-\delta)(1+r_t)w_t/Z_t E_t \left[(C_{t+1}/C_t)^{-\gamma} \right]$. The cost of creating a firm to be repaid at $t+1$ is known with certainty as of period t. As there is no difference between marginal and average $q_t(i)$, firm entry drives down not only the value of entering firms, but also the value of incumbents until all firms' value is equalized with the sunk entry cost.

Since all banks are identical and there are no idiosyncratic shocks, we impose symmetry on the first order conditions to obtain the Nash equilibrium. The equation for firm value, q_t, becomes:[17]

$$q_t = \beta E_t \left[\left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \left(\left(1 - \frac{1}{H} \right) d_{t+1} + (1-\delta) q_{t+1} \right) \right]. \tag{2}$$

The parameter H plays in bank market the same role that θ plays in goods market. At one extreme, $H = 1$ or absolute bank monopoly, equation (2) says that there is no entry as the marginal (and average) return from funding an entrant is zero: the portfolio expansion effect is totally offset by profit destruction

[16] Bilbiie et al (2006) work with post entry value of firm, in their notation v_t, whereas here q_t is ex ante entry value of firms. Assuming the profit destruction externality away, the firm values are related by $q_t = v_t/(1-\delta)$.

[17] Recall that $q_t(i)$ is ex ante entry value of firm, hence the entry entry loan repayment, $d_t(i)$, is not multiplied by $(1-\delta)$.

effect.[18] The economy is starved of firm entry and of any activity as well. The model displays a gradual reduction in market power as the measure of the elasticity of substitution across banks, H, increases. At the other extreme, $H = \infty$, the equation simplifies to the usual asset pricing equation. Similar equations hold aboard.

2.4 Aggregate accounting, balanced trade, bank markup, and data consistent variables

We now focus on the home economy (similar equations hold abroad). Aggregating the budget constraint (1) across (symmetric) home households and imposing the equilibrium conditions ($s_{t+1} = s_t = 1$, $L = \int_j l(j)dj$, and $B_t = w_t/Z_t n_t$) yields the aggregate accounting equation $C_t + B_t = d_t N_t + w_t L$.[19] Consumption in each period must equal labor income plus investment income net of the cost of investing in new firms. Since this cost $B_t = w_t/Z_t n_t$ is the value of home investment in new firms, aggregate accounting also states the familiar equality of spending (consumption plus investment) and income (labor plus dividend) that must hold.

To close the model, observe that financial autarky implies balanced trade: the value of home exports must equal the value of foreign exports. Hence, $Q_t N_t \left(\rho_{X,t}\right)^{1-\theta} C_t^* = N_t^* \left(\rho_{X,t}^*\right)^{1-\theta} C_t$. As in Ghironi and Melitz (2005) balanced trade under financial autarky implies labor market clearing.

The model does not feature an explicit bank markup, however one may define a measure of ex post markup as $\mu_{B,t} = d_t N_t / q_t N_{t+1} - r_t$. Taking into account the time-to-build lag, one can think of the ratio $d_t N_t / q_t N_{t+1}$ as measuring the relative return from funding a marginal (and average) firm. The measure of ex post markup as $\mu_{B,t}$ turns out to be countercyclical.

Under C.E.S. product differentiation, it is well-known that the price index can be decomposed into components reflecting average prices and product variety.

[18] Under $H = 1$, equation (2) becomes $q_t = \beta(1-\delta)E_t\left[(C_{t+1}/C_t)^{-\gamma} q_{t+1}\right]$, which is a contraction mapping because of discounting, and by forward iteration under the assumption $\lim_{T\to\infty}(\beta(1-\delta))^T E_t q_{t+T} = 0$ (there is a zero value of firms when reaching the terminal period), the only stable solution for firm value is $q_t = 0$, which implies $N_t = 0$. An alternative would be to assume that the monopolist bank takes into account its influence on the aggregate consumption demand, C_t. This channel is reminiscent of "Ford effect" described in D'Aspremont et al (1996) where a firm-monopolist, owned by households, internalizes the effects of dividend pay outs, that boost households income, on demand for its output. In an alternative multi-location setup, where firms compete in a national market rather than in local markets, there is firm entry under $H = 1$ at each location as long as there is more than one location in the economy.

[19] Labor market equilibrium requires that the total amount of labor employed in the production of goods and in creation of new firms must be equal to the aggregate labor supply. In the economy with tradeable and non-tradeable goods the condition is $L = (\theta - 1)/w_t d_t N_t + n_t/Z_t + (1-\alpha)/Z_t C_t/\rho_{N,t}$ and in the economy with tradeable goods only and home bias in consumption - $L = (\theta-1)/w_t d_t N_t + n_t/Z_t$. As in Ghironi and Melitz (2005) and Bilbiie et al (2006), there are labor market dynamics, as labor reallocates between the two sectors of the economy in response to shocks.

In the economy with tradeable and non-tradeable goods, the price index of tradeable goods can be decomposed as $P_{T,t} = (N_t + N_t^*)^{1/(1-\theta)} \widetilde{P}_{T,t}$ $(P_{T,t}^* = (N_t + N_t^*)^{1/(1-\theta)} \widetilde{P}_{T,t}^*)$, where the sum $N_t + N_t^*$ reflects product variety at home (and foreign) and $\widetilde{P}_{T,t}$ $(\widetilde{P}_{T,t}^*)$ is an average nominal price for all varieties sold in home (foreign). The consumption-based price index then can be decomposed as $P_t = \widetilde{P}_t (N_t + N_t^*)^{\alpha/(1-\theta)}$ $(P_t^* = \widetilde{P}_t^* (N_t + N_t^*)^{\alpha/(1-\theta)})$, where $\widetilde{P}_t$ $(\widetilde{P}_t^*)$ is an average nominal price in home (foreign).

In the economy with tradeable goods only and home bias in consumption, the consumption-based price index then can be decomposed as $P_t = (\alpha N_t + (1-\alpha) N_t^*)^{1/(1-\theta)} \widetilde{P}_t$ $(P_t^* = (\alpha N_t^* + (1-\alpha) N_t)^{1/(1-\theta)} \widetilde{P}_t^*)$, where $\widetilde{P}_t$ $(\widetilde{P}_t^*)$ is an average nominal price for all varieties sold in home (foreign).

The average prices $(\widetilde{P}_t, \widetilde{P}_t^*)$ correspond much more closely to empirical measures such as the CPI then the welfare based indexes. Hence, when investigating the properties of the model in relation to the data, any variable in units of the consumption basket should be deflated by the data consistent price index $\widetilde{P}_t$ $(\widetilde{P}_t^*)$. Data consistent variables can be defined as $\widetilde{X}_t = X_t P_t / \widetilde{P}_t$, where X_t is any variable in units of the consumption basket. For example, the aggregate output is $Y_t = C_t + B_t$ (i.e. consumption plus investment in new firms), hence, the data consistent measure of GDP in the model is $\widetilde{Y}_t = Y_t P_t / \widetilde{P}_t$, which removes the role of variety as an endogenous productivity shifter.[20]

Up to now, we have used a definition of the real exchange rate, $Q_t = \varepsilon_t P_t^* / P_t$, computed using welfare-based price indexes (P_t and P_t^*). Thus, we define $\widetilde{Q}_t = \varepsilon_t \widetilde{P}_t^* / \widetilde{P}_t$ as the theoretical counterpart to the empirical real exchange rate - since the latter relates CPI levels best represented by $\widetilde{P}_t$ and $\widetilde{P}_t^*$. In the economy with tradeable and non-tradeable goods, the real exchange rate based on welfare-based prices, Q_t, and the real exchange rate based on average prices, $\widetilde{Q}_t$, coincide. However, it is not the case in the economy with tradeable goods only and home bias in consumption. Although the product varieties available at home and in foreign are identical, the real exchange rate based on average prices deviates from the welfare-based measure Q_t due to the presence of home bias, $Q_t = (\alpha N_t + (1-\alpha) N_t^*)^{\frac{1}{\theta-1}} / (\alpha N_t^* + (1-\alpha) N_t)^{\frac{1}{\theta-1}} \widetilde{Q}_t$, and these real exchange rates need not move in the same direction.

For expositional simplicity, we define the "terms of labor" as $TOL_t = \varepsilon_t (W_t^*/Z_t^*) / (W_t/Z_t)$, it measures the relative cost of effective units of labor across countries. A decrease in TOL_t indicates an appreciation of home effective labor relative to foreign: if $TOL_t < 1$, a firm could produce any amount

[20] See Bilbiie et al (2006).

of output at lower cost in the foreign country than in home.

2.5 Summary

Table 1 summarizes the main equilibrium conditions of the model with tradeable and non-tradeable sectors (only the equations pertaining to the home variables and the balanced trade shown). The equations in the table constitute a system of 29 equations in 29 endogenous variables: $r,\ w,\ d,\ \pi,\ q,\ n,\ v,\ \rho_D,\ \rho_X,\ \rho_T,\ \rho_N,\ N,\ B,\ C,\ r^*,\ w^*,\ d^*,\ \pi^*,\ q^*,\ n^*,\ v^*,\ \rho_D^*,\ \rho_X^*,\ \rho_T^*,\ \rho_D^*,\ N^*,\ B^*,\ C^*,\ Q$. Of these endogenous variables, six are predetermined as of time t: the total numbers of firms at home and abroad, N_t and N_t^*, the risk-free interest rates, r_{t-1} and r_{t-1}^*, and the deposits, B_{t-1} and B_{t-1}^*. Additionally, the model features three exogenous variables: the aggregate productivity Z_t and Z_t^*, the measure of the elasticity of substitution among banks in the home economy, H_t. We interpret changes in H_t as capturing banking deregulation the in home economy. We omit the transversality conditions for deposits and satisfied to ensure optimality. The foreign household maximizes subject to a similar budget constraint, resulting in analogous and transversality conditions.

Table 1: Model summary, tradeable and non-tradeable sectors, financial autarky

General price index	$1 = \left(\rho_{T,t}\right)^{\alpha} \left(\rho_{N,t}\right)^{1-\alpha}$
Tradeable price index	$N_t \left(\rho_{D,t}\right)^{1-\theta} + N_t^* \left(\rho_{X,t}^*\right)^{1-\theta} = 1$
Goods pricing, home market	$\rho_{D,t}\rho_{T,t} = \mu \frac{w_t}{Z_t}$
Goods pricing, foreign market	$\rho_{X,t}\rho_{T,t}^* = \tau Q_t^{-1} \mu \frac{w_t}{Z_t}$
Goods pricing, non-tradeable	$\rho_{N,t} = \frac{w_t}{Z_t}$
Firm profit	$d_t = \frac{\alpha}{\theta} \left(\rho_{D,t}\right)^{1-\theta} C_t + \frac{\alpha}{\theta} Q_t \left(\rho_{X,t}\right)^{1-\theta} C_t^*$
Bank profit	$\pi_t = d_t N_t - (1 + r_{t-1}) B_{t-1}$
Firm entry condition	$q_t = \beta \left(\frac{1+r_t}{1-\delta} \frac{w_t}{Z_t}\right) E_t \left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\right]$
Euler equation (q equation)	$q_t = \beta E_t \left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} \left(\left(1 - \frac{1}{H_t}\right) d_{t+1} + (1-\delta) q_{t+1}\right)\right]$
Number of firms	$N_{t+1} = (1-\delta)(N_t + n_t)$
Euler equation (deposits)	$1 = \beta \left(1 + r_t\right) E_t \left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\right]$
Euler equation (shares)	$v_t = \beta E_t \left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} (v_{t+1} + \pi_{t+1})\right]$
Deposit market clearing	$B_t = \frac{w_t}{Z_t} n_t$
Aggregate accounting	$C_t + B_t = d_t N_t + w_t L$
Balanced trade	$Q_t N_t \left(\rho_{X,t}\right)^{1-\theta} C_t^* = N_t^* \left(\rho_{X,t}^*\right)^{1-\theta} C_t$

The model with tradeable goods only and home bias in consumption can be summarized by deleting the general price index equation and replacing the tradeable price index, the goods pricing equations, and the firm profit equation with the equations given in Table 2 (again only the equations pertaining to the home variables shown). The complete model constitutes a system of 25 equations in 25 endogenous variables: r, w, d, π, q, n, v, ρ_D, ρ_X, N, B, C, r^*, w^*, d^*, π^*, q^*, n^*, v^*, ρ_D^*, ρ_X^*, N^*, B^*, C^*, Q.

Table 2: Model summary, tradeable goods and home bias in consumption, financial autarky

General price index	$\alpha N_t \left(\rho_{D,t}\right)^{1-\theta} + (1-\alpha) N_t^* \left(\rho_{X,t}^*\right)^{1-\theta} = 1$
Goods pricing, home market	$\rho_{D,t} = \mu \frac{w_t}{Z_t}$
Goods pricing, foreign market	$\rho_{X,t} = \tau Q_t^{-1} \mu \frac{w_t}{Z_t}$
Firm profit	$d_t = \frac{\alpha}{\theta} \left(\rho_{D,t}\right)^{1-\theta} C_t + \frac{1-\alpha}{\theta} Q_t \left(\rho_{X,t}\right)^{1-\theta} C_t^*$

2.6 Calibration

We calibrate parameters as follows. We interpret periods as quarters and set $\beta = 0.99$ and $\gamma = 1$, both standard choices for quarterly business cycle models. We set the size of the exogenous firm exit shock $\delta = 0.025$ to match the U. S. empirical level of 10 percent job destruction per year.[21] Using as a guideline the fraction of firm closures and bankruptcies over the total number of firms, reported by the U.S. Small Business Administration, consistently around 10% per year over the recent years, gives the same calibration.[22] We use the value of θ from Bernard et al (2003) and set $\theta = 3.8$, which was calibrated to fit U. S. plant and macro trade data.[23] We postulate that $\tau = \tau^* = 1.33$, which is in line with Obstfeld and Rogoff (2001). Trade costs include (among other things), tariffs, non-tariff barriers, and transport costs and as Obstfeld and Rogoff note it is likely that simple estimates of average transport costs grossly understate average τ across all goods in the economy (due to substitution effects). In fact, Anderson and Van Wincoop (2004) estimate international trade costs in the range of 40% to 70%.

As trade costs, the presence of non-tradeable goods and home bias in preferences skew the consumption expenditures towards domestic goods. For the US, the openness to trade over GDP is 24% (in 2004), the steady-state import share is around 12%. We treat the share of tradeable goods in consumption, α, in

[21] Empirically, job destruction is induced by both firm exit and contraction. In the model the exogenous exit shock induces firm exit.

[22] There are other calibration approaches that might suggest an upward revision of the δ calibration, see Stebunovs (2006).

[23] It may be argued that the value of results in a steady-state markup that is too high relative to the evidence. A standard choice in the macro literature is 6 to deliver a 20 percent. The model, void of period by period fixed cost, delivers equal marginal and average cost. Therefore the firm markup is a measure of both markup over marginal and average cost. Thus, our parameterization delivers reasonable markups over average costs.

the economy with tradeable and non-tradeable goods, and the weight of home goods in the consumption basket, α, in the economy with tradable goods only and home bias in consumption as free parameters to match the observed steady-state import share in the US given the trade cost $\tau = \tau^* = 1.33$.[24] The values of α's vary among the models to be considered, but in general the share of tradeable goods in consumption, α, is around 0.39 and the weight of home goods in the consumption basket, α, is around 0.75.

We set steady-state aggregate productivity, Z, and aggregate labor endowment, L, equal to one without loss of generality. These parameters determine the size of economy, but leave the model dynamics unaffected. We set steady-state H (H^*), the measure of the elasticity of substitution among banks in the home (foreign) economy), such that it implies a bank markup of about 10 percentage points. Then to determine the size of a permanent deregulation shock, we calculate the change in H that induces a 30% increase in the number of firms in home country (the US). Note that according to Davis et al (2006) the number of firms (both total and privately held) increased by around 34% between 1980 and 2000, hence we attribute most of the increase to deregulation effects. We pursue the same calibration strategy of H for computation of the second moments in the international business cycle.

Table 3 shows the calibrated parameter values.

Table 3: Quarterly calibration

Discount factor	β	0.99
Elast. of goods substitution	θ	3.8
Risk aversion	γ	1
Prob. of exogenous exit	δ	0.025
Trade costs	τ	1.33
Agg. productivity in steady state	Z	1
Aggregate labor	L	1
Tradeable and non-tradeable goods model		
Share of tradeable goods	α	0.39
Tradeable goods and home bias model		
Weight on home goods	α	0.75

[24] The steady-state import share in the economy with tradeable and non-tradeable goods is $\alpha N^* \left(\rho_X^*\right)^{1-\theta} C/(C+B)$ and in the economy with tradeable goods only and home bias in consumption - $(1-\alpha) N^* \left(\rho_X^*\right)^{1-\theta} C/(C+B)$.

2.7 Deregulation and macroeconomic dynamics

We now analyze the response path of the real exchange rate and other key variables in response to permanent deregulation in the home economy. (We assume that the foreign economy does not deregulate.) To do so, we log-linearize the system of equilibrium conditions in Table 1 (and in Table 2) around the symmetric steady state. (All endogenous variables are constant in steady state. All exogenous variables, including aggregate productivity, are constant in steady state.)

Figures 1 shows the responses (percent deviations from steady state) to a permanent home deregulation shock in the economy with tradeable and non-tradeable goods.[25] The number of quarters after the shock is on the horizontal axis. Consider first the long-run effects in the new steady state. With the fall in bank monopoly power, the home market becomes a relatively more attractive business environment, drawing a permanently higher number of entrants, which translates into a permanently higher number of producers, hence generates the increase in home labor demand and puts upward pressure on wages. This induces the new steady state for TOL_t below 1, leads to a long-run increase in the prices at home, this effect induces a long-run appreciation of both the welfare-based real exchange rate Q_t (and the average prices-based real exchange rate $\widetilde{Q}_t$). Given the existence of a non-tradeable sector, changes in the relative cost of labor (TOL_t) lead to relative price differences for non-tradeable goods across countries, hence to the Harrod-Balassa-Samuelson effect (i.e. less regulated economy exhibits higher average prices relative to its trading partner).

We now describe the transitional changes in response to the permanent deregulation (summarized by the impulse responses in Figure 1). Absent sunk entry costs, and the associated time-to-build lag before production starts, the number of producing firms in home would immediately adjust to its new steady-state level. Sunk costs and time-to-build transform N_t into a state variable that behaves very much like a capital stock: the number of entrants n_t represents the home consumers' investment, which translates into increases in the stock N_t over time. Deregulation does not increase the available supply of effective labor units for production in the home market. Thus, there is no short-run excess supply of home effective labor units, and TOL_t steadily appreciates over time with the increase in home labor demand generated by entry. Home consumption decreases in the short run, in order to finance the entry of new firms (this requires a much greater reallocation of effective labor units away from production as the supply of these labor units is unaffected by deregulation). The increase in investment in new firms is not

[25] Given $\tau = 1.33$, we se the weight of tradeable goods in the consumption basket, α, to 0.397.

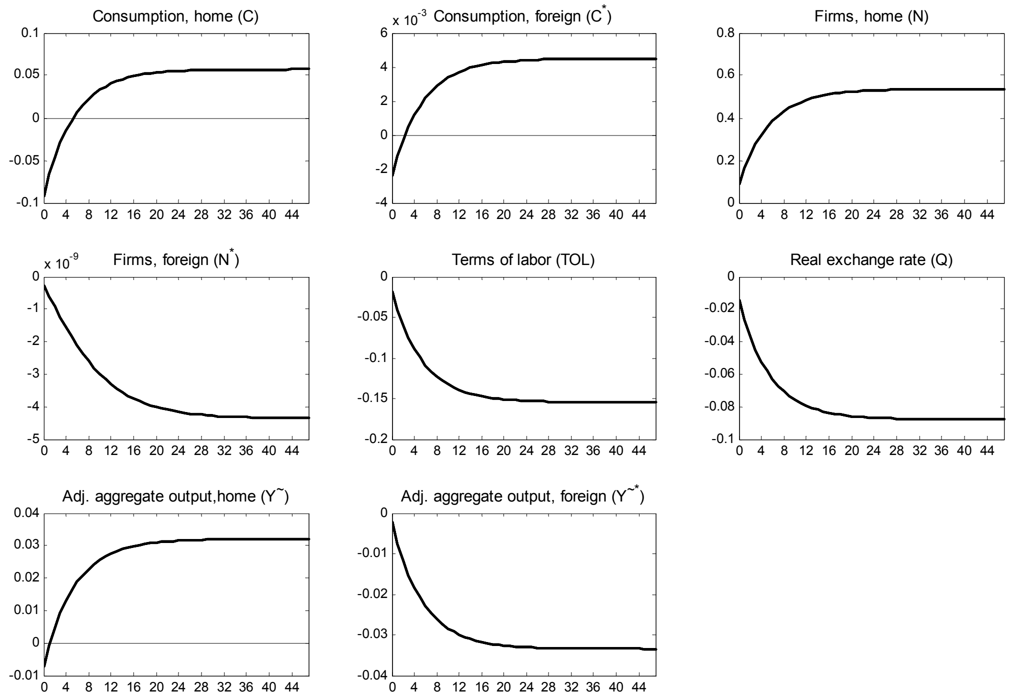

Figure 1: Response to permanent deregulation shock in the economy with tradeable and non-tradeable goods (financial autarky).

sufficient to offset the decrease in consumption in the early stages of the transition, hence the aggregate output falls initially. We note that the real exchange rate appreciation is slow to unfold. About half of the long-run appreciation occurs after the first year and a half of the permanent deregulation shock, and reaching the long-run level takes over 7 years.

The notable externality of deregulation in home is the significant decline of the aggregate output in foreign evaluated at the average prices, $\widetilde{Y}_t^*$.

Figures 2 shows the responses (percent deviations from steady state) to a permanent home deregulation shock in the economy with tradeable goods only and home bias in consumption.[26] The number of quarters after the shock is on the horizontal axis. Consider first the long-run effects in the new steady state. With the fall in bank monopoly power, the home market becomes a relatively more attractive business environment, drawing a permanently higher number of entrants, which translates into a permanently

[26] Given $\tau = 1.33$, we se the weight of home goods in the consumption basket, α, to 0.755.

higher number of producers. This induces the new steady state for TOL_t below 1. This appreciation of home labor costs leads to a long-run increase in the average prices at home (due the presence of home bias in consumption), this effect induces a long-run appreciation of the real exchange rate $\widetilde{Q}_t$. Our simulations suggest that the increase in product variety for home consumers dominates the average price appreciation, leading to a depreciation of the welfare-based index Q_t. Consumers in both countries would rather spend a given nominal expenditure in the home market, even though average prices there are relatively higher.

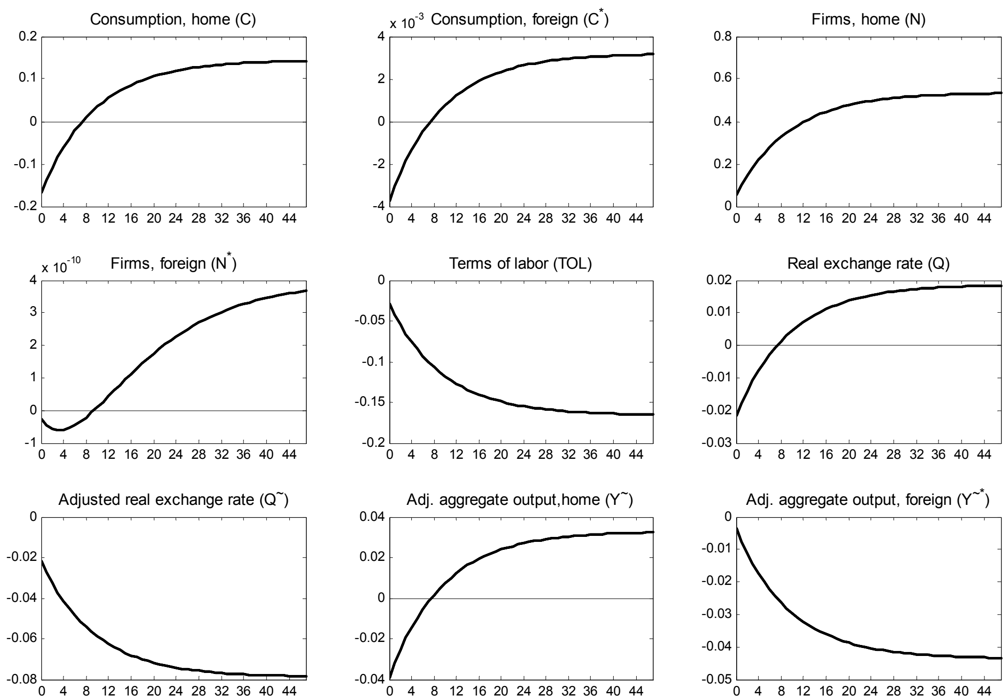

Figure 2: Response to permanent deregulation shock in the economy with tradeable goods only and home bias in consumption (financial autarky).

We now describe the transitional changes in response to the permanent deregulation (summarized by the impulse responses in Figure 2). The number of producing firms in home gradually adjusts to its new steady-state level. There is no short-run excess supply of home effective labor units, and TOL_t steadily appreciates over time with the increase in home labor demand generated by entry. Home consumption decreases in the short run, in order to finance the entry of new firms (this requires a much greater reallocation of effective labor units away from production as the supply of these labor units is unaffected by deregulation). The increase in investment in new firms is not sufficient to offset the decrease in consumption in the early stages of the transition, hence the aggregate output falls initially. We note that the real exchange rate appreciation is slow to unfold. About half of the long-run appreciation occurs after the first two years of the permanent deregulation shock, and reaching the long-run level takes about 10 years.

The notable externality of deregulation in home is the significant decline of the aggregate output in foreign evaluated at the average prices, $\widetilde{Y}_t^*$.

3 International deposits

We now extend the model of previous section to allow for international trade in deposits. We study how international deposit trading affects the results we have previously described and how our new microeconomic dynamics affect the current account. Since the extension to international deposits does not involve especially innovative features relative to the financial autarky setup, we herein limit ourselves to describing its main ingredients in words and present the relevant model equations in Table 6 in the Appendix.

We assume that banks can supply deposits domestically and internationally. Home deposits, issued to home and foreign households, are denominated in home currency. Foreign deposits, issued to home and foreign households, are denominated in foreign currency. We maintain the assumption that nominal returns are indexed to inflation in each country, so that deposits issued by each country provide a risk-free, real return in units of that country's consumption basket. International asset markets are incomplete, as only risk-free deposits are traded across countries. In the absence of any other change to our model, this would imply indeterminacy of steady-state net foreign assets and nonstationarity. To resolve these issues, we assume that agents must pay fees to domestic banks when adjusting their deposits. We assume that these fees are a quadratic function of the stock of deposits. This convenient specification is sufficient to uniquely pin down the steady state and deliver stationary model dynamics in response to temporary shocks. Realistic choices of parameter values imply that the cost of adjusting deposit holdings has a very small impact on model dynamics, other than pinning down the steady state and ensuring mean reversion in the long run when shocks are transitory. We set the scale parameter for the deposit adjustment cost, η, to 0.0025 - sufficient to generate stationarity in response to transitory shocks but small enough to avoid overstating the role of this friction in determining the international business cycle dynamics of our model. However, in simulations of a permanent deregulation shock, which we do not interpreted as a business cycle frequency shock, we set the scale parameter for the deposit adjustment cost, η, close to zero.

We assume that banks rebate the revenues from deposit adjustment fees to domestic households. In equilibrium, the markets for home and foreign deposits clear, and each country's net foreign assets entering period $t+1$ depend on interest income from asset holdings entering period t, labor income, net investment income, and consumption during period t. The change in asset holdings between t and $t+1$ is the country's current account. Home and foreign current accounts add to zero when expressed in units of the same consumption basket. There are now three Euler equations in each country: the Euler equation for share holdings, which is unchanged, and Euler equations for holdings of domestic and foreign deposits. The fees for adjusting deposits imply that the Euler equations for deposits feature a term that depends on the stock of deposits - a key ingredient delivering determinacy of the steady state and model stationarity. Euler equations for deposits in each country imply a no-arbitrage condition between deposits. In the log-linear model, this no-arbitrage condition relates (in a standard fashion) the real interest rate differential across countries to expected depreciation of the consumption-based real exchange rate. The balanced trade condition closed the model under financial autarky. Since trade is no longer balanced under international deposit trading, we must explicitly impose labor market clearing conditions in both countries. These conditions state that the amount of labor used in production and to cover entry costs in each country must equal labor supply in that country in each period.

The costs of adjusting deposits do not imply zero holdings of foreign deposits by home and vice versa in the symmetric steady state. Thus, the extended model with international deposit trading does not feature the same steady state as the model under financial autarky. We now consider the home economy. The deposit interest rate depends on the investment into new firms, $1+r=\frac{1}{\beta}\left(1+\eta\frac{1}{2}\frac{w}{Z}n\right)$, and home and foreign deposits each cover half of the investment, $B=B^{*}=\frac{1}{2}\frac{w}{Z}n$. Similar equations hold abroad.

As before, we analyze the response path of the real exchange rate and other key variables in response to the same permanent deregulation. To do so, we log-linearize the system of equilibrium conditions in Table 6 around the symmetric steady state.

3.1 Deregulation and macroeconomic dynamics

We consider the deregulation shocks as under financial autarky (however, the shock size have to be recalibrated). The response of several key variables to the shock is qualitatively similar to that under financial autarky.

Figure 3 shows impulse responses to deregulation of the home market. The permanent nature of the shock implies that home households do not have an incentive to adjust their net foreign asset position to smooth the effect of a transitory fluctuation in income. The path of C_t is therefore very similar to that in Figure 1. The home economy runs a current account deficit in response to the shock and accumulates

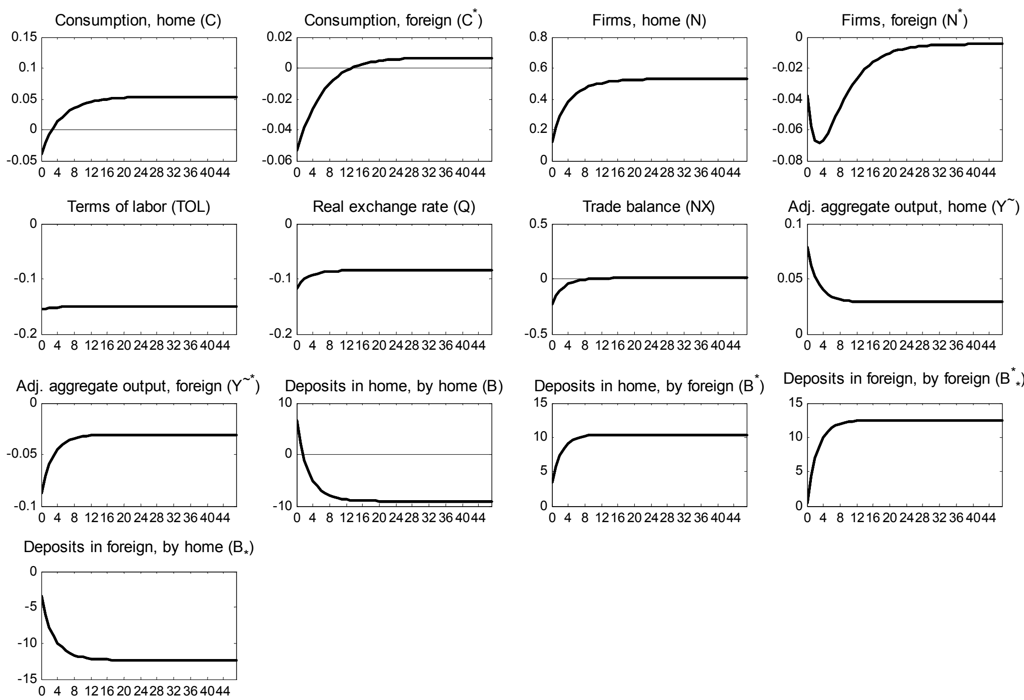

Figure 3: Response to permanent deregulation in the economy with tradeable and non-tradeable goods (international deposits).

net foreign debt. Home households borrow from abroad to finance higher initial investment (relative to autarky) in new home firms. This is apparent in the different responses of N_t in the initial years after the shock (Figure 3 relative to Figure 1). The home household's incentive to front-load entry of more productive firms is mirrored by the foreign household's desire to invest savings in the more attractive economy. Home consumption initially declines and is permanently higher in the long run. Foreign consumption moves by more than in Figure 1 as foreign households initially save in the form of foreign lending and then receive income from their positive asset position. Although foreign households cannot hold shares in the mutual fund of home banks (since only international deposits can be traded across countries), the return on deposit holdings is tied to the return on holdings of shares in home banks by no-arbitrage between bonds and shares within the home economy. Therefore, foreign households share the benefits of expansion in the home economy via international deposit holdings. As in the case of financial autarky, TOL_t must decrease in the long run (home effective labor must relatively appreciate); otherwise, all new entrants would choose to locate in the home economy. The accelerated entry of new home firms induces an immediate relative increase in home labor demand and TOL_t immediately appreciates (as opposed to a gradual appreciation under financial autarky). Thus, the real exchange rate Q_t (and $\widetilde{Q}_t$) also immediately appreciates. The opening of the economy to international deposit trading does not qualitatively change the functioning of the HBS mechanism in our model. The notable long-run externalities of deregulation in home are a significant decline of the aggregate output in foreign evaluated at the average prices, $\widetilde{Y}_t^*$, and lower number of foreign firms.

Figure 4 shows impulse responses to deregulation of the home market in the economy with tradeable goods only and home bias in consumption. The comparison with the case of financial autarky in Figure 2 on the one hand and with the economy with tradeable and non-tradeable goods in Figure 3 reveals similarities.

The key difference between the economy with tradeable goods only and home bias in consumption and the economy with tradeable and non-tradeable goods is the paths of the real exchange rates. As in the case of financial autarky, the appreciation of home labor costs leads to a long-run increase in the average prices at home (due the presence of home bias in consumption), this effect induces a long-run appreciation of the real exchange rate $\widetilde{Q}_t$. However, the welfare-based real exchange Q_t depreciates in the long run due to the dominating effect of increased product variety at home (relative to foreign). This implies that the consumer derives higher utility from spending the same amount in the home market with higher prices. This is the case as product variety in the home market N_t is sufficiently above that in the foreign market N_t^*. As before, the notable long-run externality of deregulation in home is a significant decline of the aggregate output in foreign evaluated at the average prices, $\widetilde{Y}_t^*$.

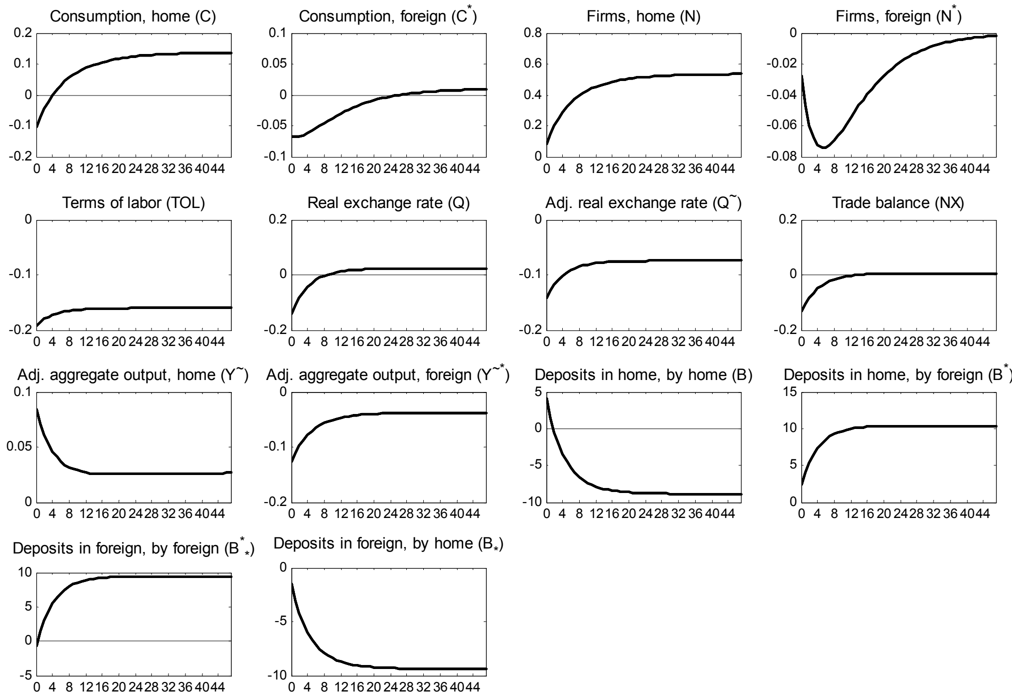

Figure 4: Response to permanent deregulation in the economy with tradeable goods only and home bias in consumption (international deposits).

4 Countercyclical firm markups, elastic labor supply, and international deposits

We now extend the model with international deposits to countercyclical firm markups and elastic labor supply to highlight the mechanism behind volatility moderation over the international business cycle, driven by productivity shocks. This extension exploits the implications of endogenous variety. The model separates taste for variety and firm monopoly power, hence allowing for varying demand elasticity and countercyclical firm markups.

The representative home household supplies l_t units of labor elastically in each period at the nominal wage rate W_t, denominated in units of home currency. The household maximizes expected intertemporal utility from consumption and labor: $E_t \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_s^{1-\gamma}}{1-\gamma} - \chi \frac{l_s^{1+1/\varphi}}{1+1/\varphi}$, where $\beta \in (0,1)$ is the subjective discount factor and $\gamma > 0$ is the inverse of the intertemporal elasticity of substitution, $\chi > 0$ is the the weight of disutility of labor effort and $\varphi > 0$ is the Frisch elasticity of labor supply to wages, subject to the same budget constraint as in the previous section. The household's intertemporal optimality conditions remain the same, the only additional intratemporal condition is the optimality condition for labor supply. Elastic labor supply implies that households have an extra margin of adjustment to aggregate productivity shocks, as in Bilbiie et al (2006). This enhances the propagation mechanism of the model by amplifying the responses of endogenous variables with respect to the benchmark model. As before we consider two definitions of the basket of goods C_t. However, now we define the basket goods over discrete varieties. Given that the number of firms is endogenous, one cannot assume that the number is sufficiently large for the weight of each producer to be negligible.

First, we consider the economy with tradeable and non-tradeable goods. The basket of tradeable goods now is $C_{T,t} = \left(\sum_{\omega\in\Omega} c_t(\omega)^{(\theta-1)/\theta} d\omega\right)^{\theta/(\theta-1)}$, hence $P_{T,t} = \left(\sum_{\omega\in\Omega_t} (p_t(\omega))^{1-\theta} d\omega\right)^{1/(1-\theta)}$. Each producer no longer ignores the effects of its nominal domestic price, $p_{D,t}(\omega)$, on the home tradeable price index, $P_{T,t}$, and the effect of its nominal export price, $p_{X,t}(\omega)$, on the foreign tradeable price index, $P^*_{T,t}$.[27] The perceived home demand elasticities is then $\varepsilon_{D,t}(\omega) = \theta\left(1 - (p_{D,t}(\omega)/P_{T,t})^{1-\theta}\right)$ and the foreign demand elasticity is $\varepsilon_{X,t}(\omega) = \theta\left(1 - \left(p_{X,t}(\omega)/P^*_{T,t}\right)^{1-\theta}\right)$. Note that taking into account this indirect price effect decreases the elasticities perceived by firm ω, $\varepsilon_{D,t}(\omega) < \theta$ and $\varepsilon_{X,t}(\omega) < \theta$, hence increases its monopoly power in both markets. The implied firm markup in domestic market is $\mu_{D,t}(\omega) = \varepsilon_{D,t}(\omega)/\left(\varepsilon_{D,t}(\omega) - 1\right)$ and in foreign market $\mu_{X,t}(\omega) = \varepsilon_{X,t}(\omega)/\left(\varepsilon_{X,t}(\omega) - 1\right)$.[28] Firms set flexible prices that reflect the different markups over marginal cost. Prices, in real terms relative to the price index in the destination market, are then given by $\rho_{D,t}(\omega)\rho_{T,t}(\omega) = p_{D,t}(\omega)/P_{T,t}P_{T,t}/P_t = \mu_{D,t}(\omega)w_t/Z_t$ and $\rho_{X,t}(\omega)\rho^*_{T,t}(\omega) = p_{X,t}(\omega)/P^*_{T,t}P^*_{T,t}/P^*_t = Q_t^{-1}\tau\mu_{X,t}(\omega)w_t/Z_t$. A firm decomposes its total profit into two portions earned from domestic sales $d_{D,t}(\omega)$ ($d^*_{D,t}(\omega)$) and from export sales $d_{X,t}(\omega)$ ($d^*_{X,t}(\omega)$). In the case of a home firm, the portions of total profits are $d_{D,t}(\omega) = \alpha/\varepsilon_{D,t}\left(\rho_{D,t}\right)^{1-\theta} C_t$ and $d_{X,t} = \alpha/\varepsilon_{X,t}Q_t\left(\rho_{X,t}\right)^{1-\theta} C^*_t$.[29] Since all firms are identical in equilibrium, one may drop indexing by ω. In this economy the bank internalizes the effect of entry on firm profits through the effect of entry on the nominal domestic price, $p_{D,t}$, and then on the home tradeable goods price index, $P_{T,t}$, and the effect

[27] See Yang and Heijdra (1993) for the treatment of Dixit-Stiglitz model of monopolistic competition with discrete number of producers.

[28] As it turns out firm entry is procyclical, hence firm markups are countercyclical and work to amplify, rather than stabilize, movements in firm output.

[29] Similar price equations hold for foreign firms, though note that $\rho^*_{X,t}(\omega)\rho_{T,t}(\omega) = p^*_{X,t}(\omega)/P_{T,t}P_{T,t}/P_t = Q_t\tau^*\mu^*_{X,t}(\omega)w^*_t/Z^*_t$, and hence a foreign firm earns export profits $d^*_{X,t} = \alpha/\varepsilon^*_{X,t}Q_t^{-1}\left(\rho^*_{X,t}\right)^{1-\theta} C_t$.

of entry on the nominal export price, $p_{X,t}$, and then on the foreign tradeable goods price index, $P^*_{T,t}$.

Second, we consider the economy with tradeable goods only and home bias in consumption. The baskets of home and foreign goods now are defined as $c_{D,t} = \left(\sum_{\omega\in\Omega} c_{D,t}(\omega)^{(\theta-1)/\theta} d\omega\right)^{\theta/(\theta-1)}$ and $c_{X,t} = \left(\sum_{\omega^*\in\Omega} c_{X,t}(\omega^*)^{(\theta-1)/\theta} d\omega^*\right)^{\theta/(\theta-1)}$ and the corresponding price indices for home and foreign baskets are $p_{D,t} = \left(\sum_{\omega\in\Omega_t} p_{D,t}(\omega)^{1-\theta} d\omega\right)^{1/(1-\theta)}$ and $p^*_{X,t} = \left(\sum_{\omega^*\in\Omega_t} p^*_{X,t}(\omega^*)^{1-\theta} d\omega^*\right)^{1/(1-\theta)}$. As above each producer no longer ignores the effects of its nominal domestic price, $p_{D,t}(\omega)$, on the home general price index, P_t, and the effect of its nominal export price, $p_{X,t}(\omega)$, on the foreign general price index, P^*_t. The perceived home demand elasticities is then $\varepsilon_{D,t}(\omega) = \theta\left(1-(p_{D,t}(\omega)/P_t)^{1-\theta}\right)$ and the foreign demand elasticity is $\varepsilon_{X,t}(\omega) = \theta\left(1-(p_{X,t}(\omega)/P^*_t)^{1-\theta}\right)$. The implied firm markup in domestic market is $\mu_{D,t}(\omega) = \varepsilon_{D,t}(\omega)/\left(\varepsilon_{D,t}(\omega)-1\right)$ and in foreign market $\mu_{X,t}(\omega) = \varepsilon_{X,t}(\omega)/\left(\varepsilon_{X,t}(\omega)-1\right)$. Prices, in real terms relative to the price index in the destination market, are then given by $\rho_{D,t}(\omega) = p_{D,t}(\omega)/P_t = \mu_{D,t}(\omega)w_t/Z_t$ and $\rho_{X,t}(\omega) = p_{X,t}(\omega)/P^*_t = Q_t^{-1}\tau\mu_{X,t}(\omega)w_t/Z_t$. Similar price equations hold for foreign firms. A firm decomposes its total profit into two portions earned from domestic sales $d_{D,t}(\omega)$ $(d^*_{D,t}(\omega))$ and from export sales $d_{X,t}(\omega)$ $(d^*_{X,t}(\omega))$. In the case of a home firm, the portions of total profits are $d_{D,t}(\omega) = \alpha/\varepsilon_{D,t}\left(\rho_{D,t}\right)^{1-\theta} C_t$ and $d_{X,t} = (1-\alpha)/\varepsilon_{X,t}Q_t\left(\rho_{X,t}\right)^{1-\theta} C^*_t$. Foreign firms behave in a similar way. Since all firms are identical in equilibrium, one may drop indexing by ω. In this economy, the bank internalizes the effect of entry on firm profits through the effect of entry on the nominal domestic price, $p_{D,t}$, and then on the home general price index, P_t, and the effect of entry on the nominal export price, $p_{X,t}$, and then on the foreign general price index, P^*_t.

In both the economy with tradeable and non-tradeable goods and the economy with tradeable goods only and home bias in consumption, the new equation for firm value, q_t, becomes:

$$q_t = \beta E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\left(\left(1-\frac{1}{H}\frac{\theta}{\varepsilon_{D,t+1}}\right)d_{D,t+1} + \left(1-\frac{1}{H}\frac{\theta}{\varepsilon_{X,t+1}}\right)d_{X,t+1} + (1-\delta)q_{t+1}\right)\right]. \tag{3}$$

(The derivation details are given in Appendix. A similar equation holds aboard.) The parameter H plays in bank market the same role that θ plays in goods market. At one extreme, $H = 1$ or absolute bank monopoly, equation (2) says that there is no entry as the marginal (and average) return from funding an entrant is negative: the portfolio expansion effect is dominated by profit destruction effect. The model displays a gradual reduction in market power as the measure of the elasticity of substitution across banks, H, increases. At the other extreme, $H = \infty$, the equation simplifies to the usual asset pricing equation.

Over the business cycle, as the number of firms increases, the perceived demand elasticities $\varepsilon_{D,t}$ and $\varepsilon_{X,t}$ increase, hence markups fall. On the one hand, the fall in firm markups reduces the bank's incentive to invest in new firms. (Note that the ratios $\theta/\varepsilon_{D,t+1}$ and $\theta/\varepsilon_{X,t+1}$are larger than one.) But on the other hand, since the aggregate firm profit is procyclical and the bank has claims on it, the importance of profit destruction externality, $\theta/\varepsilon_{D,t+1}$ and $\theta/\varepsilon_{X,t+1}$, falls, thus increasing the bank's incentive to invest.

Table 1 summarizes the main equilibrium conditions of the model with tradeable and non-tradeable sectors (only the equations pertaining to the home variables and the balanced trade shown). The model with tradeable goods only and home bias in consumption can be summarized by deleting the general price index equation and replacing the tradeable price index, the goods pricing equations, the firm profit equation, and the labor clearing equation with the equations given in Table 2 (again only the equations pertaining to the home variables shown).

We examine the model predictions under Frisch elasticity, φ, of ten.[30] We set the weight of disutility of labor, χ, to one. The household preference, exogenous exit parameters remain the same as in the benchmark model (see Table 3).[31] The calibration strategy of a's and H are the same as before. We pick a's that match the 12% imports over GDP ratio observed for the US given $\tau = \tau^* = 1.33$. We then pick the value of H before deregulation that implies a bank markup of 10 percentage points. Then a 30% increase in the number of domestic firms pins down the value of H after deregulation. We use the two values of H to determine the size of a permanent deregulation shock, and then for computation of the second moments in the international business cycle. We keep the steady-state aggregate productivity, Z, set to one. Note though that it is no longer just a scale parameter. It not only determines the number of firms (the size of the economy) in steady state and hence the steady-state firm markups, but also the cyclical properties of markups. The lower the steady-state aggregate productivity is, the lower is the number of firms and the higher are firm markups in steady state and the more countercyclical markups are over the business cycle. In fact, by adjusting the steady-state aggregate productivity we can affect the interplay of wealth and substitution effects in labor supply decisions. As lower steady-state aggregate productivity leads to more countercyclical markups, and hence more procyclical wages, it helps to generate stronger substitution effects and weaker wealth effect (on temporary domestic productivity shock impact) in labor supply decisions. The representative household then is willing to take advantage of

[30] The case in which $\varphi \to \infty$ corresponds to linear disutility of effort and is often studied in the business cycle literature.

[31] King et al (1988) show that under separable preferences, log utility of consumption ensures that income and substitution effects or real wage variation on effort cancel out in steady state. This guarantees constant steady state effort and is necessary for balanced growth under trend productivity growth.

the temporary high productivity by supplying more labor to increase substantially the available number of varieties, lower firm monopoly power, and experience much higher consumption in the future. Two things are crucial for the strength of this mechanism. First, the elasticity of intertemporal substitution (and little or no habit formation in consumption) should be relative high, so that the representative household is not overly engaged in consumption smoothing. Second, as usual, the persistence of a productivity shock increases the strength of wealth effect, as when the representative household does not expect to change consumption much in the future, the household thus simply takes this opportunity to increase consumption of leisure.

4.1 Deregulation and macroeconomic dynamics

We consider the deregulation shocks as international deposits, inelastic labor supply, and constant firm markups (however, the shock size have to be recalibrated). The response of several key variables to the shock is qualitatively similar to that under financial autarky.

In this and the following sections, the share of tradeable goods in consumption basket, α, in the economy with tradeable and non-tradeable goods is set to 0.5, while the iceberg cost, τ, is kept at 1.33.[32] This choice of α is dictated by computational difficulties in finding the model's steady state, and it implies the steady-state import share of about 18%. In the economy with tradeable goods only and home bias in consumption, given $\tau = 1.33$, we set the weight of home goods in the consumption basket, α, to 0.797, which gives the steady-state import share of about 12%.

Figure 5 shows impulse responses to deregulation of the home market in the economy with tradeable and non-tradeable goods. The response of several key variables to the shock is qualitatively similar to that under international deposits, inelastic labor supply, and constant firm markups, but there are several new features as well. The home economy runs a current account deficit in response to the shock and accumulates net foreign debt. Home households borrow from abroad to finance higher initial investment (relative to the international deposit model in the previous section) in new home firms. This is apparent in the different responses of N_t in the initial years after the shock. The home household's incentive to front-load entry of more productive firms is mirrored by the foreign household's desire to invest savings in the more attractive economy. Notably, home consumption does not initially decline and, as before, is permanently higher in the long run. Foreign consumption moves by more than in Figure 3 as foreign

[32] The lowest steady-state import share given $\tau = 1.33$ we were able to obtain was 16% under α approaching 0.35.

households initially save in the form of foreign lending (and investing in new foreign firms) and then receive income from their positive asset position. The accelerated entry of new home firms induces an immediate relative increase in home labor demand and TOL_t immediately appreciates (and remains appreciated in the long run). Thus, the real exchange rate Q_t (and $\widetilde{Q}_t$) immediately appreciates. Both the number of home and foreign firms remains permanently above steady-state level. However, it does not prevent the aggregate output in foreign evaluated at the average prices, $\widetilde{Y}_t^*$, from declining in the long run. Note that responses of endogenous variables are amplified with respect to the benchmark model with international deposits due to a combination of varying firm markups and elastic labor supply. In fact, the home labor supply is permanently higher and the foreign labor supply remains above its steady-state level for over one year. The most striking new feature is the dynamics of home and foreign deposits: home deposits at home and abroad B_t and $B_{*,t}$ undershoot and foreign deposits in foreign and home $B_{*,t}^*$ and B_t^* overshoot the long-run (positive) levels. Due to the scale parameter for the deposit adjustment cost, η, set close to zero the transition of deposits to the steady state levels takes well over 12 years. We study the responses of key variables under the scale parameter for the deposit adjustment cost, η, set to 0.0025 in Appendix. The presence of more sizeable adjustment cost reduces the transition time, but preserve the complicated dynamics.

Figure 6 shows impulse responses to deregulation of the home market in the economy with tradeable goods only and home bias in consumption. The response of several key variables to the shock is qualitatively similar to that under international deposits, inelastic labor supply, and constant firm markups, there are several new features though. The home economy runs a current account deficit in response to the shock and accumulates net foreign debt. Home households borrow from abroad to finance higher initial investment (relative to the international deposit model in the previous section) in new home firms. This is apparent in the different responses of N_t in the initial years after the shock. The home household's incentive to front-load entry of more productive firms is mirrored by the foreign household's desire to invest savings in the more attractive economy. Home consumption does not initially decline though and is permanently higher in the long run. Foreign consumption moves by more than in Figure 3 as foreign households initially save in the form of foreign lending (and investing in new foreign firms) and then receive income from their positive asset position. The accelerated entry of new home firms induces an immediate relative increase in home labor demand and TOL_t immediately appreciates (and remains appreciated in the long run). As before, the appreciation of home labor costs leads to a long-run increase

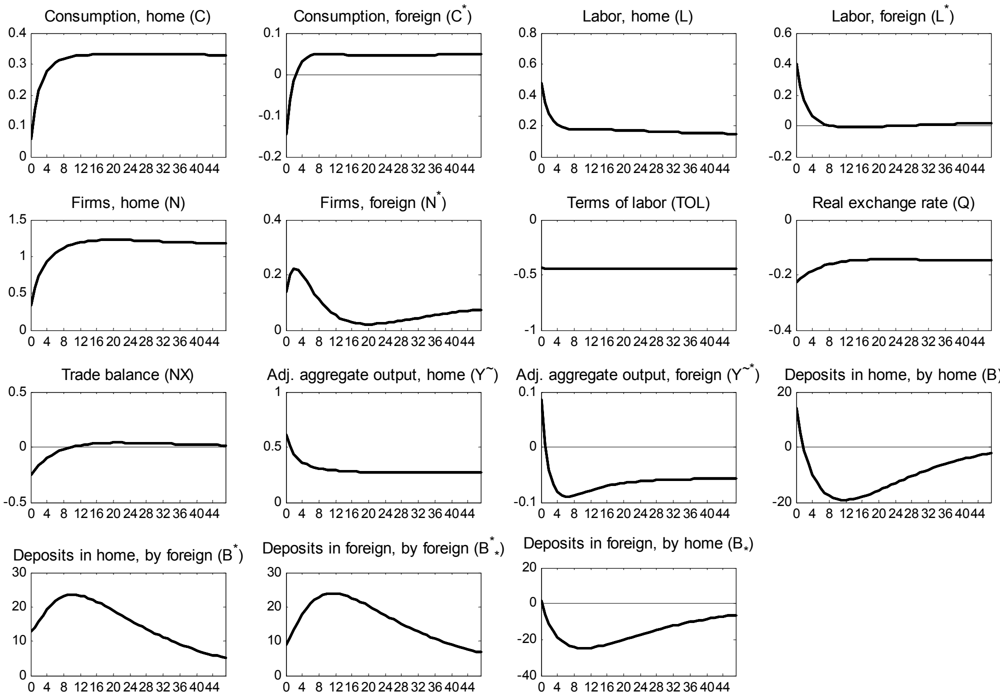

Figure 5: Response to permanent deregulation in the economy with tradeable and non-tradeable goods (international deposits, elastic labor supply, countercyclical firm markups).

in the average prices at home, this effect induces a long-run appreciation of the real exchange rate $\widetilde{Q}_t$. However, the welfare-based real exchange Q_t depreciates in the long run due to the dominating effect of increased product variety at home (relative to foreign). Note though, the number of foreign firms remains above its steady-state level for over 6 years. However, it does not prevent the aggregate output in foreign evaluated at the average prices, $\widetilde{Y}_t^*$, from declining slightly even in the short run. Note that responses of endogenous variables are amplified with respect to the benchmark model with international deposits due to a combination of varying firm markups and elastic labor supply. In fact, the home labor supply is permanently higher and the foreign labor supply remains above its steady-state level for over 4 years.

4.2 Transitory productivity shock and macroeconomic dynamics

We illustrate now the endogenous persistence and amplification properties of our model by showing the impulse responses to a transitory increase in home productivity. These responses are illustrated in Figure

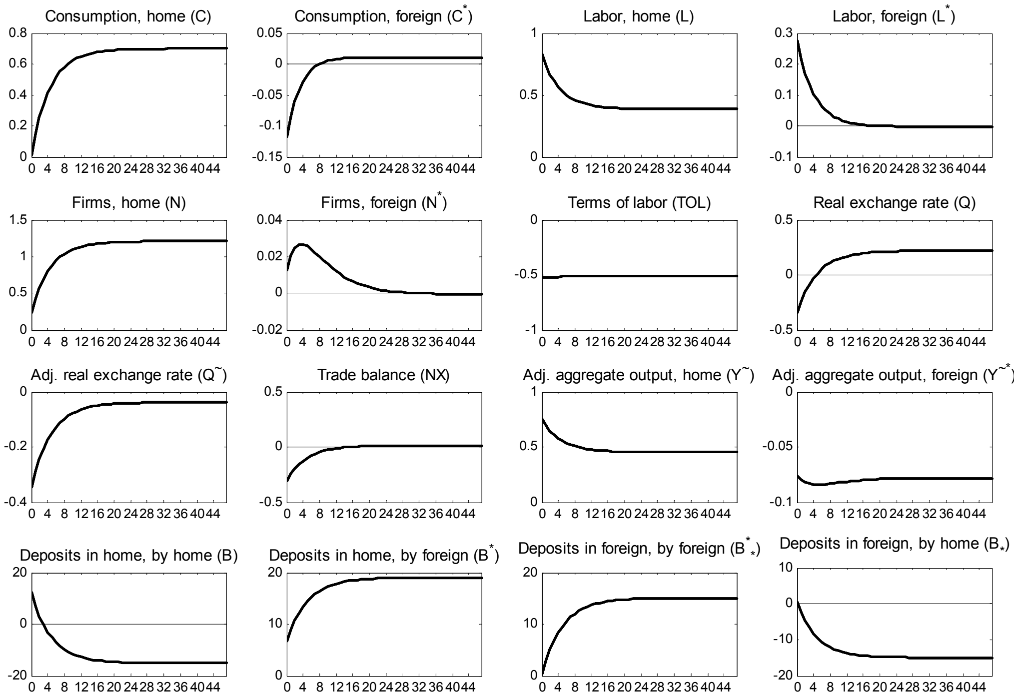

Figure 6: Response to permanent deregulation in the economy with tradeable goods only and home bias in consumption (international deposits, elastic labor supply, countercyclical firm markups).

7 for the economy with tradeable and non-tradeable goods and Figure 8 for the economy with tradeable goods only and home bias in consumption, where in deviations from steady state $Z_t = 0.9Z_{t-1} + \xi_t^Z$, and the size of shock is 1%. The response paths are quite similar, the strength of shock amplification is quite similar as well. As the responses clearly show, the shock has no permanent effect since all endogenous variables are stationary in response to stationary exogenous shocks. However, the responses also clearly highlight the substantial persistence of key endogenous variables - well beyond the exogenous persistence of the productivity shock. For example, in both economies it takes over 10 years for the real exchange rates to the steady-state level.[33]

Note the initial appreciation of the terms of labor, again motivated by faster entry of new firms into the home economy. Home households borrow initially to finance faster entry. However, borrowing is quickly reversed, and home runs current account surpluses for approximately 4 years after the initial

[33] Dynamics in response to a productivity shock with the same persistence are qualitatively similar to those under financial autarky; thus, we omit the figures.

response. The path of the current account is such that home's net foreign assets are actually above the steady state throughout the transition, except in the initial few quarters. When the shock is not permanent, lending abroad to smooth the consequences of a temporary, favorable shock on consumption becomes the main determinant of net foreign asset dynamics.

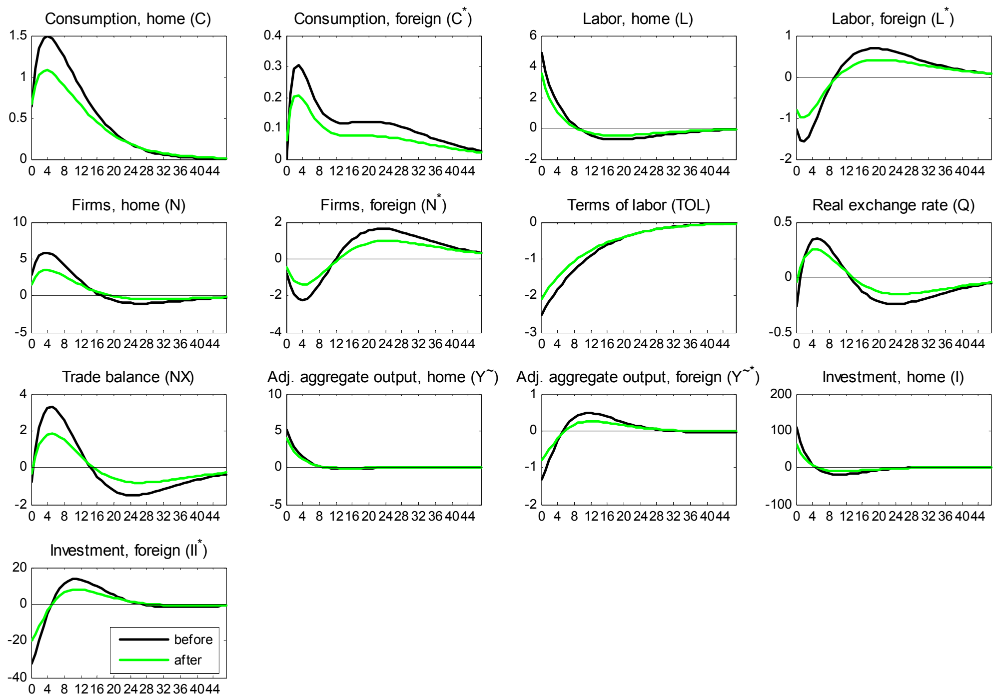

Figure 7: Response to transitory Z shock in the economy with tradeable and non-tradeable goods (international deposits, elastic labor supply, countercyclical firm markups).

As the responses illustrate, over the business cycle, weaker banking competition implies more vigorous firm entry, more countercyclical firm markups, and stronger substitution effects in labor supply decision. As a consequence of deregulation, i.e. reduction of bank monopoly power, the responses of firm entry, labor supply, consumption, investment, and aggregate output are less amplified in the home economy. Given the trade and financial ties with the US, the lower amplification in the economy allows the rest of the world to enjoy lower amplification as well.

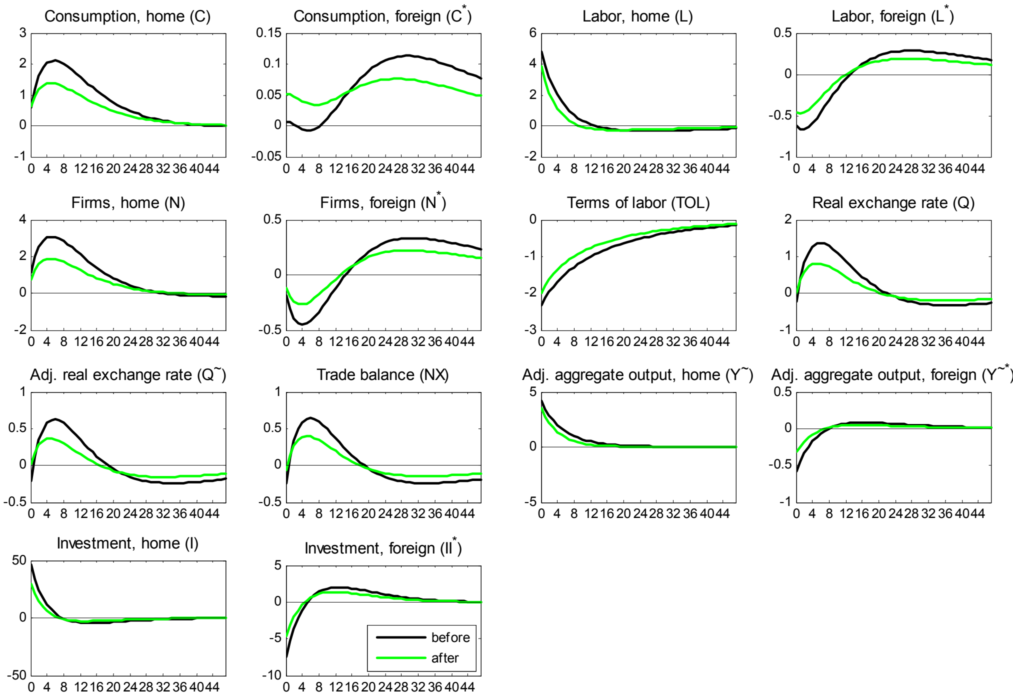

Figure 8: Response to transitory Z shock in the economy with tradeable and non-tradeable goods (international deposits, elastic labor supply, countercyclical firm markups).

4.3 International business cycle

The model includes only one source of fluctuations at business cycle frequency, the shocks to aggregate productivity Z_t and Z_t^*. As such, we do not attempt to replicate exactly data moments, just the magnitude of changes in the second moments. We assume that the percentage deviations of Z_t and Z_t^* from the steady state follow the bivariate process:

$$\begin{bmatrix} Z_t \\ Z_t^* \end{bmatrix} = \begin{bmatrix} \phi_Z & \phi_{ZZ^*} \\ \phi_{Z^*Z} & \phi_{Z^*} \end{bmatrix} \begin{bmatrix} Z_{t-1} \\ Z_{t-1}^* \end{bmatrix} + \begin{bmatrix} \xi_t^Z \\ \xi_t^{Z^*} \end{bmatrix}$$

where the persistence parameters ϕ_Z and ϕ_{Z^*} are in the unit interval, the spillover parameters ϕ_{ZZ^*} and ϕ_{Z^*Z} are nonnegative, and ξ_t^Z and $\xi_t^{Z^*}$ are normally distributed, zero-mean innovations. We use the symmetrized estimate of the bivariate productivity process for the United States and an aggregate of

European economies in Backus et al (1992) and set

$$\begin{bmatrix} \phi_Z & \phi_{ZZ^*} \\ \phi_{Z^*Z} & \phi_{Z^*} \end{bmatrix} = \begin{bmatrix} 0.906 & 0.088 \\ 0.088 & 0.906 \end{bmatrix}.$$

This matrix implies a small, positive productivity spillover across countries, such that, if home productivity rises during period t, foreign productivity will also increase at $t+1$. We set the standard deviation of the productivity innovations to.1% and the correlation to 0.258 (corresponding to a 0.19 percent covariance), the latter as estimated by Backus et al. We calculate the implied second moments of endogenous variables (percent deviations from steady state) using the frequency domain technique. We focus on the high-frequency properties of business cycles in home and foreign, we report second moments of Hodrick-Prescott (HP)-filtered variables.

We previously noted that empirical price deflators are best represented by the average prices $\widetilde{P}_t$ and $\widetilde{P}_t^*$ in our model (as opposed to the welfare based price indices P_t and P_t^*). Thus, we focus on the second moments of real variables deflated by the average prices $\widetilde{P}_t$ and $\widetilde{P}_t^*$. As we previously discussed, new entrants embody the investment by households, and the stock of firms represents the capital accumulated by such investments. For comparison with the investment and capital variables in standard models, we compute second moments for n_t and n_t^* as well as for investment in new firms deflated by the average price.$\widetilde{I}_t = w_t/Z_t n_t P_t/\widetilde{P}_t$ and $\widetilde{I}_t^* = w_t^*/Z_t^* n_t^* P_t^*/\widetilde{P}_t^*$.

Table 4 reports standard deviations for the economy with tradeable and non-tradeable goods and for the economy with tradeable goods only and home bias in consumption. Both models are successful at generating less volatile consumption than GDP, labor volatile (roughly) as GDP, more volatile investment than GDP. However, both models overpredict the ratio of standard deviations of firm entry (and investment) to aggregate output; in the data this ratio lies between 3 and 4. Both models are also successful at generating significant volatility reduction after deregulation in home country comparable in magnitude with that observed in the data for the US. Over the business cycle, weaker banking competition implies more vigorous firm entry, more countercyclical firm markups, and stronger substitution effects in labor supply decision. As a consequence of deregulation, firm entry, labor supply, consumption, investment, and aggregate output are all less volatile in the US. The trade and financial ties with the US allow the rest of the world to enjoy lower volatility as well.

Table 5 reports variance decomposition for the economy with tradeable and non-tradeable goods

Table 4: Standard deviations (in percent, HP filtered)

	Economy with tradeable and non-tradeable goods		
	Before	After	Change,%
C	1.6296	1.2791	−21.51
C^*	1.6296	1.5906	−2.40
L	6.5460	5.5095	−15.83
L^*	6.5460	5.6558	−13.60
n	140.4298	94.5894	−32.64
n^*	140.4297	121.7101	−13.33
TOL	2.9906	2.5778	−13.80
Q ($\widetilde{Q}$)	1.0705	0.8402	−21.51
NX	8.0399	5.7781	−28.13
$\widetilde{Y}$	6.1438	5.3642	−12.69
$\widetilde{Y}^*$	6.1438	5.5426	−9.79
$\widetilde{I}$	140.4330	94.5795	−32.65
$\widetilde{I}^*$	140.4329	121.6827	−13.3517

	Economy with tradeable goods only and home bias in consumption		
	Before	After	Change,%
C	2.1425	1.5347	−28.37
C^*	2.1425	2.1031	−1.84
L	5.4454	4.4762	−17.80
L^*	5.4454	5.1529	−5.37
n	51.1245	34.6967	−32.13
n^*	51.1245	48.4664	−5.20
TOL	2.7220	2.3122	−15.06
Q	2.6411	2.0594	−22.02
$\widetilde{Q}$	1.3441	1.0328	−23.16
NX	1.4021	1.0797	−23.00
$\widetilde{Y}$	4.5082	3.9459	−12.47
$\widetilde{Y}^*$	4.5082	4.3585	−3.32
$\widetilde{I}$	51.0484	34.6388	−32.1452
$\widetilde{I}^*$	51.0484	48.3826	−5.2220

and for the economy with tradeable goods only and home bias in consumption. Both models predict a (slight) increase in importance of the shocks originated in the rest of the world after deregulation for home aggregate output, investment, and labor supply, but for consumption.

5 Conclusion

We developed a two-country model of the domestic and external effects of financial deregulation that predicts real appreciation, external borrowing, and moderation of domestic and international business cycles as joint equilibrium consequences of increased competition in banking in the country that deregulates. The key channel through which this occurs is an increase in the attractiveness of this country's business environment relative to the rest of the world. The model provides a unified explanation of features of behavior of the U.S. and international economy following the drastic deregulation of U.S. banking started in 1977 and finalized in 1994.

Our paper thus contributes to a growing body of literature on observed dynamics of external balances, business cycles, and international relative prices. It provides a complementary explanation of equilibrium external imbalances that highlights an additional source of cross-country asymmetry in the characteristics of financial sectors relative to those emphasized by Caballero et al (2006) and Mendoza et al (2007). It

Table 5: Variance decomposition (in percent, HP filtered)

	Economy with tradeable and non-tradeable goods					Economy with tradeable goods only and home bias in consumption			
	Before		After			Before		After	
	ξ_t^Z	$\xi_t^{Z^*}$	ξ_t^Z	$\xi_t^{Z^*}$		ξ_t^Z	$\xi_t^{Z^*}$	ξ_t^Z	$\xi_t^{Z^*}$
C	95.65	4.35	95.86	4.14	C	89.53	10.47	94.30	5.70
C^*	13.44	86.56	12.42	87.58	C^*	6.52	93.48	6.84	93.16
L	55.98	44.02	52.48	47.52	L	67.67	32.33	67.53	32.47
L^*	20.22	79.78	21.04	78.96	L^*	11.79	88.21	13.23	86.77
n	56.48	43.52	51.29	48.71	n	66.59	33.41	64.41	35.59
n^*	19.90	80.10	19.86	80.14	n^*	13.15	86.85	12.64	87.36
TOL	93.38	6.62	93.12	6.88	TOL	96.41	3.59	95.77	4.23
Q ($\widetilde{Q}$)	37.10	62.90	41.07	58.93	Q	37.10	62.90	36.38	63.62
$\widetilde{Y}$	63.12	36.88	59.37	40.63	$\widetilde{Q}$	37.10	62.90	41.67	58.33
$\widetilde{Y}^*$	16.39	83.61	14.73	85.27	$\widetilde{Y}$	75.81	24.19	73.85	26.15
$\widetilde{I}$	56.44	43.56	51.23	48.77	$\widetilde{Y}^*$	9.52	90.48	8.64	91.36
$\widetilde{I}^*$	19.93	80.07	19.86	80.14	$\widetilde{I}$	66.57	33.43	64.34	35.66
					$\widetilde{I}^*$	13.16	86.84	12.60	87.40

complements Fogli and Perri's (2006) recent work by connecting imbalances to an endogenous moderation of the cycle, and it contributes to the study of persistent movements in real exchange rates by pointing to a so far unexplored source of differential pressures on labor costs.

Several extensions of this work could be pursued in future work. We took the structure of the banking market in each country as exogenous to economic developments, but there is some indication of endogeneity. For example, in the late 1970s, bank branch creation turned from acyclical to countercyclical. A richer modeling of the financial sector, potentially leading to endogenous differences in financial structures across countries, and a deeper analysis of the financing contract between banks and firms are clearly relevant avenues for further research in this area.

References

Anderson, J. and E. V. Wincoop (2000). Trade costs. *Journal of Economic Literature 42*, 691–751.

Bergin, P. R. and G. Corsetti (2005). Towards a theory of firm entry and stabilization policy. Working Paper 11821, National Bureau of Economic Research.

Bernard, A., J. Eaton, J. B. Jensen, and S. S. Kortum (2003). Plants and productivity in international trade. *American Economic Review 93*(4), 1268–1290.

Bilbiie, F., F. Ghironi, and M. Melitz (2008). Monetary policy and business cycles with endogenous entry and product variety (forthcoming). In D. Acemoglu, K. S. Rogoff, and M. Woodford (Eds.), *NBER Macroeconomics Annual 2007*, Cambridge, MA. MIT Press.

Bilbiie, F., F. Ghironi, and M. J. Melitz (2005). Endogenous entry, product variety, and business cycles. Working paper, Boston College.

Black, S. E. and P. E. Strahan (2002). Entrepreneurship and bank credit availability. *Journal of Finance 57*(6), 2807–2833.

Caballero, R. J. (2006). On the macroeconomics of asset shortages. NBER Working Paper 12753, National Bureau of Economic Research.

Caballero, R. J., E. Farhi, and P.-O. Gourinchas (2006). An equilibrium model of ”global imbalances” and low interest rates. NBER Working Paper 11996, National Bureau of Economic Research.

Cestone, G. and L. White (2003). Anticompetitive financial contracting: The design of financial claims. *Journal of Finance 58*(5), 2109–2142.

Cetorelli, N. and P. E. Strahan (2006). Finance as a barrier to entry: Bank competition and industry structure in local U.S. markets. *Journal of Finance 61*(1), 437–461.

Comin, D. and M. Gertler (2006). Medium term business cycles. *American Economic Review 96*(3), 523–551.

Corsetti, G., P. Martin, and P. Pesenti (2007a). Productivity, terms of trade and the "home market effect". *Journal of International Economics 73*(1), 99–127.

Corsetti, G., P. Martin, and P. Pesenti (2007b). Varieties and the transfer problem: The extensive margin of current account adjustment. Manuscript, European University Institute.

D'Aspremont, C., R. D. S. Ferreira, and L.-A. Gerard-Varet (1996). On the Dixit-Stiglitz model of monopolistic competition. *American Economic Review 86*(3), 623–629.

Davis, S. J., J. C. Haltiwanger, R. Jarmin, and J. Miranda (2006). Volatility and dispersion in business growth rates: Publicly traded versus privately held firms. NBER Working Paper 12354, National Bureau of Economic Research.

DeBandt, O. and E. P. Davis (2000). Competition, contestability and market structure in european banking sectors on the eve of emu. *Journal of Banking and Finance 24*(6), 1045–1066(22).

Elkhoury, M. and T. Mancini-Griffoli (2006). Monetary policy with firm entry. Manuscript, Graduate Institute of International Studies, Geneva.

Erceg, C. J., L. Guerrieri, and C. J. Gust (2005). Expansionary fiscal shocks and the trade deficit. *International Finance 8*(3), 363–397.

Fogli, A. and F. Perri (2006). The "great moderation" and the us external imbalance. NBER Working Paper 12708, National Bureau of Economic Research.

Ghironi, F. and M. Melitz (2007). Trade flow dynamics with heterogeneous firms. *American Economic Review (Papers and Proceedings) 97*(2), 356–361.

Ghironi, F. and M. J. Melitz (2005). International trade and macroeconomic dynamics with heterogeneous firms. *Quarterly Journal of Economics 120*(3), 865–915.

González-Maestre, M. and L. M. Granero (2003). Industrial loans and market structure. *European Economic Review 47*(5), 841–55.

Hunt, B. and A. Rebucci (2005). The us dollar and the trade deficit: What accounts for the late 1990s? *International Finance 8*(3), 399–434.

Jaimovich, N. (2006). Firm dynamics, markup variations and the business cycle. Working paper, Stanford University.

King, R. G., C. I. Plosser, and S. T. Rebelo (1988). Production, growth and business cycles: I. The basic neoclassical model. *Journal of Monetary Economics 21*(2-3), 195–232.

Lewis, V. (2006). Macroeconomic fluctuations and firm entry: Theory and evidence. Working Paper 103, National Bank of Belgium.

Mendoza, E. G., V. Quadrini, and J.-V. Rios-Rull (2007). Financial integration, financial deepness and global imbalances. NBER Working Paper 12909, National Bureau of Economic Research.

Méjean, I. (2007). Can firms' location decisions counteract the balassa-samuelson effect? Manuscript, CEPII, Paris.

Stebunovs, V. (2006). Finance as a barrier to entry: U.S. bank deregulation and volatility. Job market paper, Boston College.

Woodford, M. (2003). *Interest and Prices: Foundations of a Theory of Monetary Policy*. Princeton, NJ: Princeton University Press.

Yang, X. and B. J. Heijdra (1993). Monopolistic competition and optimum product diversity: Comment. *American Economic Review 83*(1), 295–301.

6 Appendix

6.1 International deposits

The budget constraint of the representative home household, in units of the home consumption basket, is now

$$B_t+Q_tB_{*,t}+\frac{\eta}{2}\left[B_t^2+Q_tB_{*,t}^2\right]+v_tx_{t+1}+C_t=(1+r_{t-1})B_{t-1}+Q_t(1+r_{t-1}^*)B_{*,t-1}+(\pi_t+v_t)x_t+T_t^F+w_tl,$$

where B_t denotes holdings of home deposits, $B_{*,t}$ denotes holdings of foreign deposits, $\frac{\eta}{2}B_t^2$ is the cost of adjusting holdings of home deposits, $\frac{\eta}{2}Q_tB_{*,t}^2$ is the cost of adjusting holdings of foreign deposits (in units of foreign consumption), T_t^F is the fee rebate, taken as given by the household, and equal to $\frac{\eta}{2}\left[B_t^2+Q_tB_{*,t}{}^2\right]$ in equilibrium. For simplicity, we assume that the scale parameter $\eta>0$ is identical across costs of adjusting holdings of home and foreign deposits. Also, there is no cost of adjusting equity holdings. Hence, in equilibrium, deposit - adjustment fees capture fees on international transactions, which we assume absent from domestic transactions such as those involving equity to avoid adding unnecessary complication. The representative foreign household faces a similar constraint, in units of foreign consumption.

Home and foreign households maximize the respective intertemporal utility functions subject to the respective constraints. The first-order conditions for the choices of share holdings in mutual portfolios of domestic firms at home and abroad are unchanged relative to the case of financial autarky. The new Euler equations for home and foreign deposit holdings, deposit market clearing condition, bank profit, replace the equations in Table 1. Since trade is no longer balanced under international deposit trading, we must explicitly impose labor market clearing conditions in both countries. To close the model we add the net foreign asset equation. Aggregate accounting implies the law of motion for net foreign assets at home

$$B_t+Q_tB_{*,t}=\left[Q_t(1+r_{t-1}^*)B_{*,t-1}-(1+r_{t-1})B_{t-1}^*\right]+d_tN_t+w_tL-C_t,$$

where holdings of individual deposits across countries are tied by the equilibrium condition $B_t+B_t^*=\frac{w_t}{Z_t}n_t$. Similar equations hold abroad. Given these conditions, multiplying the law of motion for net foreign assets at foreign times Q_t and subtracting the resulting equation from the law of motion for net foreign assets at home yields an expression for the difference of home and foreign net foreign asset accumulation as a function of the cross-country differentials between interest income, labor income, net investment income, and consumption:

$$\begin{aligned}(B_t + Q_t B_{*,t}) - \left(B_t^* + Q_t B_{*,t}^*\right) &= 2\left[Q_t(1+r_{t-1}^*)B_{*,t-1} - (1+r_{t-1})B_{t-1}^*\right] \\ &\quad + (d_t N_t - Q_t d_t^* N_t^*) + (w_t L - Q_t w_t^* L^*) - (C_t - Q_t C_t^*)\,.\end{aligned}$$

The new equations are given in Table 6.

Table 6: Model summary, international deposits

Bank profit	$\pi_t = d_t N_t - (1+r_{t-1})\left(B_{t-1} + B_{t-1}^*\right)$
Euler equations (deposits)[1]	$(1+\eta B_t) = \beta\,(1+r_t)\,E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\right]$
	$(1+\eta B_{*,t}) = \beta\,(1+r_t^*)\,E_t\left[\left(\frac{Q_{t+1}}{Q_t}\right)\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\right]$
Deposit market clearing	$B_t + B_t^* = \frac{w_t}{Z_t} n_t$
Net foreign assets	$(B_t + Q_t B_{*,t}) - \left(B_t^* + Q_t B_{*,t}^*\right)$
	$= 2\left[Q_t(1+r_{t-1}^*)B_{*,t-1} - (1+r_{t-1})B_{t-1}^*\right]$
	$+ \left((d_{D,t} + d_{X,t})\,N_t - Q_t\left(d_{D,t}^* + d_{X,t}^*\right)N_t^*\right)$
	$+ (w_t L - Q_t w_t^* L^*) - (C_t - Q_t C_t^*)$
Tradeable and non-tradeable goods model	
Labor market clearing	$L = \frac{\theta-1}{w_t} d_t N_t + \frac{n_t}{Z_t} + \frac{1-\alpha}{Z_t}\frac{C_t}{\rho_{N,t}}$
Tradeable goods and home bias model	
Labor market clearing	$L = \frac{\theta-1}{w_t} d_t N_t + \frac{n_t}{Z_t}$

[1] in foreign country the corresponding equations are:
$\left(1+\eta B_{*,t}^*\right) = \beta\,(1+r_t^*)\,E_t\left[\left(\frac{C_{t+1}^*}{C_t^*}\right)^{-\gamma}\right]$ and $(1+\eta B_t^*) = \beta\,(1+r_t)\,E_t\left[\left(\frac{Q_t}{Q_{t+1}}\right)\left(\frac{C_{t+1}^*}{C_t^*}\right)^{-\gamma}\right]$

The presence of the terms that depend on the stock of deposits on the left-hand side of these equations is crucial not only for model stationarity, but also for determinacy of the steady state. Note that solving for home (foreign) investment into new firms, $\frac{w}{Z}n$, does not require knowing home (foreign) deposit interest rate and home holdings of home deposits and foreign holdings of home deposits. The four Euler equations for deposits and deposit market clearing conditions at home and foreign constitute a system of six equations in six unknowns in the steady state, see Table 7. By adding the Euler equations featuring B and B^* and using home deposit market clearing we obtain $1+r = \frac{1}{\beta}\left(1+\eta\frac{1}{2}\frac{w}{Z}n\right)$ and $B = B^* = \frac{1}{2}\frac{w}{Z}n$. Similar equations hold abroad.

Table 7: System of six equations in six unknowns

Euler equations (deposits)	$(1+\eta B)=\beta(1+r)$
	$(1+\eta B_*)=\beta(1+r^*)$
	$(1+\eta B^*)=\beta(1+r)$
	$(1+\eta B^*_*)=\beta(1+r^*)$
Deposit market clearing	$B+B^*=\frac{w}{Z}n$
	$B_*+B^*_*=\frac{w^*}{Z^*}n^*.$

6.2 Countercyclical firm markups, elastic labor supply, and international deposits

6.2.1 Internalization of profit destruction externality

The first order condition with respect to $K_{t+1}(i)$ gives the Euler equation for firm value to bank i, $q_t(i)$, and involves a term capturing the internalization of the profit destruction externality:

$$q_t(i)=\beta E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\left(\begin{array}{c} d_{D,t+1}+d_{X,t+1} \\ +K_{t+1}(i)\left(\frac{\partial d_{D,t+1}}{\partial N_{t+1}}\frac{\partial N_{t+1}}{\partial K_{t+1}(i)}+\frac{\partial d_{X,t+1}}{\partial N_{t+1}}\frac{\partial N_{t+1}}{\partial K_{t+1}(i)}\right) \\ +(1-\delta)q_{t+1}(i)\end{array}\right)\right]. \tag{A1}$$

We focus now on the economy with tradeable and non-tradeable goods. Internalization of the effect of entry on firm profits through the effect on the nominal domestic price, $p_{D,t}$, and then on the home tradeable price index $P_{T,t}$ (in case of the economy with tradeable goods only and home bias in consumption - the home general price index, P_t), and the effect of entry on the nominal export price, $p_{X,t}$, and then on the foreign tradeable price index $P^*_{T,t}$ (the foreign general price index, P^*_t), goes as follows. We rearrange the home tradeable price index (the home general price index) as $\left(\rho_{D,t}\right)^{1-\theta}=\left[\frac{1-N^*_t\left(\rho^*_{X,t}\right)^{1-\theta}}{N_t}\right]$, then the elasticity of demand is $\varepsilon_{D,t}=\theta\frac{N_t-\left(1-N^*_t\left(\rho^*_{X,t}\right)^{1-\theta}\right)}{N_t}$, then firm profit in home market is $d_{D,t}=\frac{1}{\theta}\frac{1-N^*_t\left(\rho^*_{X,t}\right)^{1-\theta}}{N_t-\left(1-N^*_t\left(\rho^*_{X,t}\right)^{1-\theta}\right)}C_t$ and under symmetry $(d_{D,t+1}K_{t+1})'=\frac{\partial d_{D,t+1}}{\partial N_{t+1}}\frac{\partial N_{t+1}}{\partial K_{t+1}}K_{t+1}+d_{D,t+1}=\left(1-\frac{1}{H}\frac{N_{t+1}}{\left(N_{t+1}-\left(1-N^*_{t+1}\left(\rho^*_{X,t}\right)^{1-\theta}\right)\right)}\right)d_{D,t+1}=\left(1-\frac{1}{H}\frac{1}{1-\left(\rho_{D,t+1}\right)^{1-\theta}}\right)d_{D,t+1}$ $=\left(1-\frac{1}{H}\frac{\theta}{\varepsilon_{D,t+1}}\right)d_{D,t+1}$. Similarly, $(d_{D,t+1}K_{t+1})'=\left(1-\frac{1}{H}\frac{\theta}{\varepsilon_{X,t+1}}\right)d_{X,t+1}$. Substituting these results into equation (A1) we obtain the Euler equation for firm value to the bank in the main text (and in Table 8).

6.2.2 Model summary

Table 8 summarizes the main equilibrium conditions of the model (only the equations pertaining to the home variables and the balanced trade shown). The equations in the table constitute a system of 39 equations in 39 endogenous variables: $r,\ w,\ d_D,\ d_{X,}\ \pi,\ q,\ n,\ v,\ \rho_D,\ \rho_X,\ \rho_T,\ \rho_N,\ \varepsilon_D,\ \varepsilon_X,\ N,\ B,\ B_*,$ $C,\ L,\ r^*,\ w^*,\ d_D^*,\ d_{X,}^*\ \pi^*,\ q^*,\ n^*,\ v^*,\ \rho_D^*,\ \rho_X^*,\ \rho_T^*,\ \rho_N^*,\ \varepsilon_D^*,\ \varepsilon_X^*,\ N^*,\ B^*,\ B_*^*,\ C^*,\ L^*,\ Q^*$. Of these endogenous variables, eight are predetermined as of time t: the total numbers of firms at home and abroad, N_t and N_t^*, the risk-free interest rates, r_{t-1} and r_{t-1}^*, and the deposits, B_{t-1}, $B_{*,t-1}$, B_{t-1}^*, and $B_{*,t-1}^*$. Additionally, the model features three exogenous variables: the aggregate productivity Z_t and Z_t^*, the measure of the elasticity of substitution among banks in the home economy, H_t. We interpret changes in H_t as capturing banking deregulation the in home economy. We omit the transversality conditions for deposits and satisfied to ensure optimality. The foreign household maximizes subject to a similar budget constraint, resulting in analogous and transversality conditions.

The model with tradeable goods only and home bias in consumption can be summarized by deleting the general price index equation and replacing the tradeable price index, the goods pricing equations, and the firm profit equation, and the labor market clearing equation with the equations given in Table 9 (again only the equations pertaining to the home variables shown). The complete model constitutes a system of 35 equations in 35 endogenous variables: $r,\ w,\ d_D,\ d_{X,}\ \pi,\ q,\ n,\ v,\ \rho_D,\ \rho_X,\ \varepsilon_D,\ \varepsilon_X,\ N,\ B,\ B_*,$ $C,\ L,\ r^*,\ w^*,\ d_D^*,\ d_{X,}^*\ \pi^*,\ q^*,\ n^*,\ v^*,\ \rho_D^*,\ \rho_X^*,\ \varepsilon_D^*,\ \varepsilon_X^*,\ N^*,\ B^*,\ B_*^*,\ C^*,\ L^*,\ Q^*$.

6.3 Deregulation and macroeconomic dynamics

Figures 9 shows the responses (percent deviations from steady state) to a permanent home deregulation shock in the economy with tradeable and non-tradeable goods under the scale parameter for the deposit adjustment cost, η, set to 0.0025. The presence of the adjustment cost reduces the transition time and amplification, but preserves B_t and $B_{*,t}$ undershooting and $B_{*,t}^*$ and B_t^* overshooting the long-run (positive) levels.

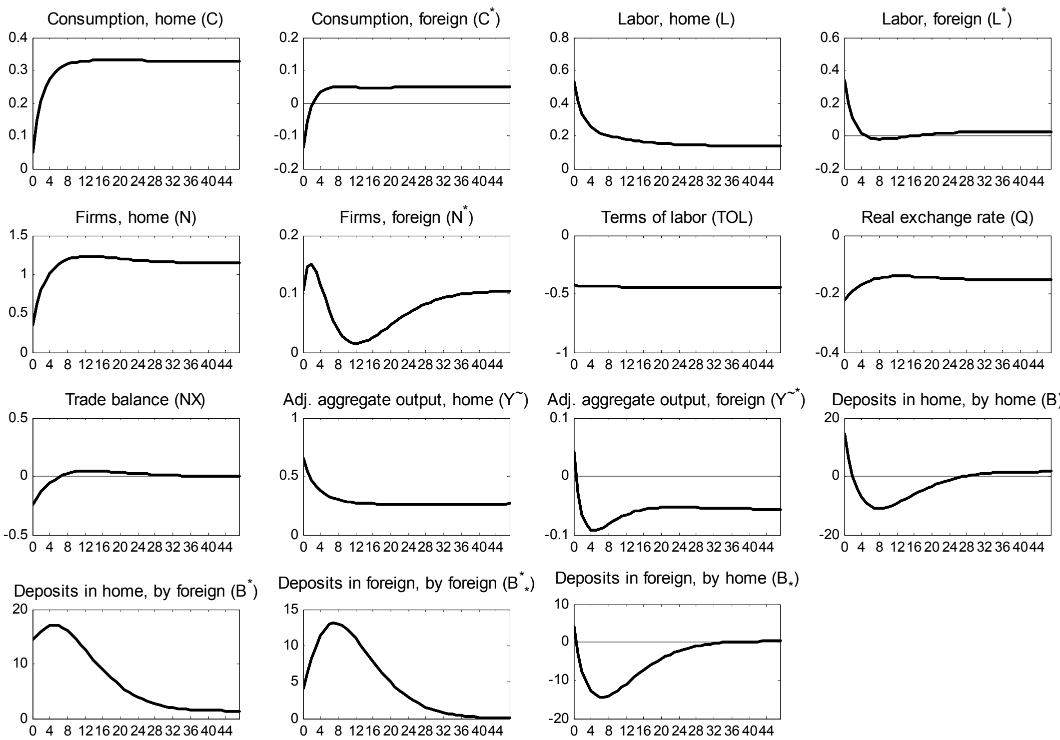

Figure 9: Response to permanent deregulation in the economy with tradeable and non-tradeable goods (international deposits, elastic labor supply, countercyclical firm markups, and $\eta = 0.0025$).

Table 8: Model summary, the economy with tradeable and non-tradeable goods

General price index	$1 = \left(\rho_{T,t}\right)^{\alpha}\left(\rho_{N,t}\right)^{1-\alpha}$
Tradeable price index	$N_t\left(\rho_{D,t}\right)^{1-\theta} + N_t^*\left(\rho_{X,t}^*\right)^{1-\theta} = 1$
Demand elasticity, home market	$\varepsilon_{D,t} = \theta\left(1-\rho_{D,t}^{1-\theta}\right)$
Goods pricing, home market	$\rho_{D,t}\rho_{T,t} = \left(\frac{\varepsilon_{D,t}}{\varepsilon_{D,t}-1}\right)\frac{w_t}{Z_t}$
Demand elasticity, foreign market	$\varepsilon_{X,t} = \theta\left(1-\rho_{X,t}^{1-\theta}\right)$
Goods pricing, foreign market	$\rho_{X,t}\rho_{T,t}^* = \tau Q_t^{-1}\left(\frac{\varepsilon_{X,t}}{\varepsilon_{X,t}-1}\right)\frac{w_t}{Z_t}$
Goods pricing, non-tradeable goods	$\rho_{N,t} = \frac{w_t}{Z_t}$
Firm profit, home market	$d_{D,t} = \frac{\alpha}{\varepsilon_{D,t}}\left(\rho_{D,t}\right)^{1-\theta}C_t$
Firm profit, foreign market	$d_{X,t} = \frac{\alpha}{\varepsilon_{X,t}}Q_t\left(\rho_{X,t}\right)^{1-\theta}C_t^*$
Bank profit	$\pi_t = \left(d_{D,t}+d_{X,t}\right)N_t - \left(1+r_{t-1}\right)\left(B_{t-1}+B_{t-1}^*\right)$
Firm entry condition	$q_t = \beta\left(\frac{1+r_t}{1-\delta}\frac{w_t}{Z_t}\right)E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\right]$
Euler equation (q equation)	$q_t = \beta E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\left(\begin{array}{c}\left(1-\frac{1}{H}\frac{\theta}{\varepsilon_{D,t+1}}\right)d_{D,t+1}\\ +\left(1-\frac{1}{H}\frac{\theta}{\varepsilon_{X,t+1}}\right)d_{X,t+1}\\ +(1-\delta)q_{t+1}\end{array}\right)\right]$
Number of firms	$N_{t+1} = (1-\delta)(N_t+n_t)$
Euler equation (deposits)[1]	$\left(1+\eta B_t\right) = \beta\left(1+r_t\right)E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\right]$
	$\left(1+\eta B_{*,t}\right) = \beta\left(1+r_t^*\right)E_t\left[\left(\frac{Q_{t+1}}{Q_t}\right)\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\right]$
Euler equation (shares)	$v_t = \beta E_t\left[\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma}\left(v_{t+1}+\pi_{t+1}\right)\right]$
Deposit market clearing	$B_t + B_t^* = \frac{w_t}{Z_t}n_t$
Labor supply	$\chi L_t^{1/\varphi} = w_t C_t^{-\gamma}$
Aggregate accounting	$C_t + B_t = \left(d_{D,t}+d_{X,t}\right)N_t + w_t L_t$
Labor market clearing	$L_t = \left(\frac{\varepsilon_{D,t}-1}{w_t}d_{D,t} + \frac{\varepsilon_{X,t}-1}{w_t}d_{X,t}\right)N_t + \frac{n_t}{Z_t} + \frac{1-\alpha}{Z_t}\frac{C_t}{\rho_{N,t}}$
Net foreign assets	$\begin{array}{c}\left(B_t+Q_tB_{*,t}\right) - \left(B_t^*+Q_tB_{*,t}^*\right)\\ = 2\left[Q_t(1+r_{t-1}^*)B_{*,t-1} - (1+r_{t-1})B_{t-1}^*\right]\\ +\left(\left(d_{D,t}+d_{X,t}\right)N_t - Q_t\left(d_{D,t}^*+d_{X,t}^*\right)N_t^*\right)\\ +\left(w_tL_t - Q_tw_t^*L_t^*\right) - \left(C_t - Q_tC_t^*\right)\end{array}$

Table 9: Model summary, the economy with tradeable goods only and home bias in consumption

General price index in home[1]	$\alpha N_t \left(\rho_{D,t}\right)^{1-\theta} + (1-\alpha) N_t^* \left(\rho_{X,t}^*\right)^{1-\theta} = 1$
Goods pricing, home market	$\rho_{D,t} = \left(\frac{\varepsilon_{D,t}}{\varepsilon_{D,t}-1}\right) \frac{w_t}{Z_t}$
Goods pricing, foreign market	$\rho_{X,t} = \tau Q_t^{-1} \left(\frac{\varepsilon_{X,t}}{\varepsilon_{X,t}-1}\right) \frac{w_t}{Z_t}$
Firm profit, home market	$d_{D,t} = \frac{\alpha}{\varepsilon_{D,t}} \left(\rho_{D,t}\right)^{1-\theta} C_t$
Firm profit, foreign market	$d_{X,t} = \frac{1-\alpha}{\varepsilon_{X,t}} Q_t \left(\rho_{X,t}\right)^{1-\theta} C_t^*$
Labor market clearing	$L_t = \left(\frac{\varepsilon_{D,t}-1}{w_t} d_{D,t} + \frac{\varepsilon_{X,t}-1}{w_t} d_{X,t}\right) N_t + \frac{n_t}{Z_t}$

[1] in foreign General price index is:
$\alpha N_t^* \left(\rho_{D,t}^*\right)^{1-\theta} + (1-\alpha) N_t \left(\rho_{X,t}\right)^{1-\theta} = 1$