

The Domestic and International Effects of Financial Deregulation*

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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 producer entry, real exchange rate appreciation, and a current account deficit. The rest of the world experiences a long-run increase in GDP and consumption. 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 also the foreign economy to enjoy lower volatility. The results of the model are consistent with features of U.S. and international data following the U.S. banking deregulation started in 1977.

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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 macroeconomic 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, Ghironi, and Melitz (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, Ghironi, and Melitz (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 current account deficit. Bank deregulation makes the domestic economy a relatively more attractive environment for potential entrants in the presence of trade costs. This expansion in producer entry following banking deregulation is consistent with the findings of the empirical finance literature. Cetorelli and Strahan (2006) and Black and Strahan (2002) document the association of the U.S. banking deregulation with a decrease in local monopoly power of commercial banks, an increase in the number of operating non-financial establishments, and a decrease in their average size – all facts that our model reproduces.

As in Ghironi and Melitz (2005), entry in the economy that deregulates pushes relative labor costs upward, inducing real appreciation when the economy features a non-traded sector or home

¹This is in contrast to other recent contributions, such as Comin and Gertler (2006) and Jaimovich (2004), whose entry mechanisms allow instantaneous variation in the number of producing firms.

²The model thus incorporates Cestone and White's (2003) insight that entry deterrence takes place through financial rather than product markets, and it explains empirical evidence in Bertrand, Schoar, and Thesmar (2007), Cetorelli and Strahan (2006), and Kerr and Nanda (2007).

bias in preferences. When economies are allowed to borrow and lend, financial deregulation induces the home economy to run a current account deficit to finance increased firm entry. The rest of the world experiences higher GDP and consumption in the long run. 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.³ In turn, trade and financial ties between the two countries allow also the foreign economy to enjoy lower volatility. 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. banking deregulation started at the end of the 1970s.⁴

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, Guerrieri, and Gust (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 a 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 appreciation and 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, Farhi, and Gourinchas (2007) 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.⁵ Mendoza, Quadrini, and Ríos-Rull (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

³The reduction in firm-level volatility is consistent with evidence in Correa and Suarez (2007), who find a causal link between banking deregulation and lower firm-level volatility in the U.S.

⁴Our model also implies that deregulation is welfare improving in both countries as households enjoy higher utility from consumption despite an increase in labor supply.

⁵See also Caballero (2006).

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.⁶

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 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, current account deficit and the accumulation of a persistent (although not permanent) net foreign debt position arise as an equilibrium phenomenon. However, while Caballero, Fahri, and Gourinchas (2007) do not link business cycle moderation with global imbalances, and Fogli and Perri (2006) take moderation as exogenous, we provide a unified explanation of external borrowing during the post-deregulation transition and eventual business cycle moderation for given stochastic productivity process without requiring long-run productivity differentials. An element of similarity between our approach and those of Caballero, Fahri, and Gourinchas (2007) and Mendoza, Quadrini, and Ríos-Rull (2007) is that net foreign asset imbalances arise as a consequence of capital mobility across asymmetric financial systems: In Caballero, Fahri, and Gourinchas, there is asymmetric ability to generate financial assets; in Mendoza, Quadrini, and Ríos-Rull, there is asymmetric enforcement of financial contracts; in our model, there is asymmetric banking competition.⁷

The remainder of the paper is organized as follows. Section 2 presents the benchmark model with balanced trade. Section 3 discusses real exchange rate determination in our model and the

⁶Other explanations emphasize demographics, a ‘global saving glut,’ and valuation effects.

⁷By 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, Ghironi, and Melitz (2007), 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.

mechanism for appreciation following financial deregulation. Section 4 presents impulse responses to a permanent, unilateral banking deregulation that substantiate the results and intuitions presented in Section 3. Section 5 extends the model to allow for international capital flows to show the emergence of external borrowing in response to deregulation. Section 6 incorporates countercyclical firm markups and elastic labor supply to highlight the mechanism for the moderation of business cycle volatility. Finally, Section 7 concludes. Technical details are in the Appendix.

2 The Benchmark Model

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

The world consists of two countries, home and foreign. We denote foreign variables with an asterisk. Each country is populated by a unit mass of atomistic, identical households, a discrete number of banks, and a continuum of firms. In each country, there are several exogenously given locations with a discrete number of banks and a local continuum of firms in each of them. Monopolistically competitive firms must borrow from banks to finance sunk entry costs, and they have no collateral to pledge except a stream of future profits.⁸ Each firm then produces a firm-specific consumption good for sale in the domestic and export markets. Firm entry reduces the stream of future profits of both incumbents and entrants – and thus the amount pledgeable for entry loan repayments – by reducing the share of aggregate demand allocated to each firm.

Before deregulation, firms are restricted to borrow from local banks. These use their monopoly power on the loans they issue to extract all the future profits from the prospective entrants they finance. Each bank holds a portfolio of firms and decides on the number of loans to be issued (that is, on the number of entrants).⁹ 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 reduced market share per firm (profit destruction effect). The profit destruction effect induces credit rationing at the extensive margin: Less prospective entrants receive funding than with perfectly competitive financial markets. Each bank supplies one-period deposits to domestic households in a perfectly competitive deposit market. The bank then uses the deposits to fund firm entry. Thus, the cost that each bank faces is the deposit interest rate. Bank deregulation lifts the restriction on borrowing from banks at a different location. The number of banks to which a

⁸Financial frictions that we leave unspecified force prospective entrants to borrow the amount necessary to cover sunk entry costs from banks rather than to raise funds directly in equity markets.

⁹Banks compete in the number of entrants in Cournot fashion as in the static partial equilibrium model of González-Maestre and Granero (2003).

borrower has access increases, hence reducing bank monopoly power.¹⁰

For expositional simplicity, we present the model economy below normalizing the number of banking locations to one. We denote the number of banks represented at this location with $H \geq 1$. If the number of locations were $M > 1$, following deregulation, the product HM would replace H in the equations where this appears: Before deregulation, prospective entrants can borrow only from the H banks represented at their location; after deregulation, they can borrow from HM banks. Having normalized the number of locations to one, this is isomorphic to an increase in the number H of banks represented at this location.¹¹

All contracts and prices in the world economy are written in nominal terms. Prices are flexible. Thus, 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 we resort to a cashless economy as in Woodford (2003).

Households

We focus on the home economy. 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 the budget constraint specified below. At time t , the household consumes the basket of goods $C_t = (C_{T,t}/\alpha)^\alpha [C_{N,t}/(1-\alpha)]^{1-\alpha}$, where $C_{T,t}$ is a basket of home and foreign tradable goods, $C_{N,t}$ is a non-tradable good, and $\alpha \in (0, 1)$ is the weight of the tradable basket in consumption.¹² The consumption-based price index is then $P_t = (P_{T,t})^\alpha (P_{N,t})^{1-\alpha}$, where $P_{T,t}$ is the price index of the tradable basket, and $P_{N,t}$ is the price of the non-tradable good. The basket of tradable goods is $C_{T,t} = \left(\int_{\omega \in \Omega} c_t(\omega)^{(\theta-1)/\theta} d\omega \right)^{\theta/(\theta-1)}$, where $\theta > 1$ is the

¹⁰Since the completion of financial deregulation in the U.S. in 1994, it is increasingly less plausible to view banking markets as local (Cetorelli and Strahan, 2006). The ability of banks to expand across local markets and new technologies that allow banks to lend to distant borrowers act to limit the incumbent banks' local monopoly power (Petersen and Rajan, 2002).

¹¹We abstract from endogenous entry into banking as function of economic conditions (for given regulatory environment). While there is evidence of cyclical variation in entry in goods markets (see Bilbiie, Ghironi, and Melitz, 2005, and references therein), bank creation is unlikely to move at business cycle frequency.

¹²Differently from Ghironi and Melitz (2005), we do not model the endogenous determination of the set of traded goods, since this is not central to the analysis in this paper. We present in the Appendix an alternative version of the model in which all goods are traded, and home bias in consumption preferences is the source of PPP deviations.

symmetric elasticity of substitution across tradable goods. At any given time t , only a subset of goods $\Omega_t \subset \Omega$ is actually available for consumption. Let $p_t(\omega)$ denote the home currency price of tradable good $\omega \subset \Omega_t$. 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 tradable good ω is $c_t(\omega) = \alpha (p_t(\omega) / P_{T,t})^{-\theta} (P_t / P_{T,t}) C_t$. The household's demand for the non-tradable good is $C_{N,t} = (1 - \alpha) (P_t / P_{N,t}) C_t$.

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 basket. The subset of tradable goods available for consumption in the foreign economy during period t is $\Omega_t^* \subset \Omega$ and is identical to the subset of tradable goods that are available in the home economy ($\Omega_t^* = \Omega_t$).

Households in each country hold two types of assets: shares in a mutual fund of domestic banks and one-period deposits supplied by domestic banks. We assume that deposits pay risk-free, consumption-based real returns.¹³ Let x_t be the share in the mutual fund of H 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, $P_t \sum_{h \in H} \pi_t(h)$, where $\pi_t(h)$ denotes the profit of home bank h . During period t , the household buys x_{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, $P_t \sum_{h \in H} v_t(h)$, where $v_t(h)$ is the price of claims to future profits of bank h . In addition to mutual fund share holdings x_t , the household enters period t with deposits B_t in units of consumption. 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 consumption and purchases of deposits and shares to be carried into next period. The period budget constraint (in units of consumption) is

$$B_{t+1} + x_{t+1} \sum_{h \in H} v_t(h) + C_t = (1 + r_t)B_t + x_t \sum_{h \in H} (\pi_t(h) + v_t(h)) + w_t L, \quad (1)$$

where r_t is the consumption-based interest rate on holdings of deposits between $t - 1$ and t (known with certainty at $t - 1$), and $w_t = W_t / P_t$ is the real wage. The home household maximizes its expected intertemporal utility subject to (1).

The Euler equations for deposits and share holdings are: $1 = \beta(1 + r_{t+1})E_t [(C_{t+1}/C_t)^{-\gamma}]$, and

¹³We assume that nominal returns are indexed to consumer price inflation, so that deposits provide a risk-free, real return in units of the consumption basket.

$v_t = \beta E_t [(C_{t+1}/C_t)^{-\gamma} (\pi_{t+1} + v_{t+1})]$, where $v_t = \sum_{h \in H} v_t(h)$ and $\pi_{t+1} = \sum_{h \in H} \pi_{t+1}(h)$. Forward iteration of the Euler equation for share holdings and absence of speculative bubbles yield the value of the mutual fund, v_t , as expected present discounted value of the stream of bank profits, $\{\pi_s\}_{s=t+1}^\infty$.¹⁴

Firms

Tradable Goods Producers

There is a continuum of firms in each country, each producing a different tradable 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: The output of firm ω is $y_t(\omega) = Z_t l_t(\omega)$, where $l_t(\omega)$ is the amount of labor employed by the firm. The unit production cost, measured in units of the consumption basket C_t , is w_t/Z_t . Similarly, the unit cost for foreign firms (measured in units of the foreign consumption basket) is w_t^*/Z_t^* , where $w_t^* = W_t^*/P_t^*$ is the foreign real wage.¹⁵ Home and foreign tradable producers serve both their domestic and export markets. Exporting is costly, and it involves a melting-iceberg trade cost $\tau > 1$ ($\tau^* > 1$).

All tradable goods producers face a residual demand curve with constant elasticity θ in both markets, and they set flexible prices that reflect the same proportional markup $\mu \equiv \theta/(\theta - 1)$ over marginal cost. Let $p_{D,t}(\omega)$ and $p_{X,t}(\omega)$ denote the nominal domestic and export prices of a home firm (in the currency of the destination market). Define the relative prices $\rho_{D,t}(\omega) \equiv p_{D,t}(\omega)/P_{T,t}$, $\rho_{T,t} \equiv P_{T,t}/P_t$, $\rho_{X,t}(\omega) \equiv p_{X,t}(\omega)/P_{T,t}^*$, and $\rho_{T,t}^* \equiv P_{T,t}^*/P_t^*$. Then, $\rho_{D,t}(\omega) = (\rho_{T,t})^{-1} \mu w_t/Z_t$ and $\rho_{X,t}(\omega) = (\rho_{T,t}^*)^{-1} \tau Q_t^{-1} \mu w_t^*/Z_t^*$, 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), and ε_t is the nominal exchange rate (units of home currency per unit of foreign). Total profits of firm ω in period t are given by $d_t(\omega) = d_{D,t}(\omega) + d_{X,t}(\omega)$, where $d_{D,t}(\omega) = \alpha (\rho_{D,t}(\omega))^{1-\theta} C_t/\theta$ denotes profits from domestic sales and $d_{X,t}(\omega) = \alpha Q_t (\rho_{X,t}(\omega))^{1-\theta} C_t^*/\theta$ denotes profits from exports. Since all firms behave identically in equilibrium, we drop the index ω below.¹⁶

¹⁴We omit the transversality conditions for deposits and shares. Similar Euler equations, transversality conditions, and expression for v_t^* hold abroad.

¹⁵Since we assume that tradable producers are symmetric within each country to keep the model simple, our framework does not capture the reallocation effects of banking deregulation across firms highlighted by Bertrand, Schoar, and Thesmar (2007) and Kerr and Nanda (2007) – although it captures the favorable effect of deregulation on firm entry that they document and that is central to our results.

¹⁶The pricing equations for foreign tradable goods are $\rho_{D,t}^* = p_{D,t}^*/P_{T,t}^* = (\rho_{T,t}^*)^{-1} \mu w_t^*/Z_t^*$ and $\rho_{X,t}^* = p_{X,t}^*/P_{T,t}^* = (\rho_{T,t}^*)^{-1} \tau^* Q_t^* \mu w_t^*/Z_t^*$, and foreign profits from domestic and export sales are $d_{D,t}^* = \alpha (\rho_{D,t}^*)^{1-\theta} C_t^*/\theta$ and $d_{X,t}^* = \alpha Q_t^* (\rho_{X,t}^*)^{1-\theta} C_t^*/\theta$, respectively.

Non-Tradable Good Producers

There is a constant mass of firms in each country producing the homogeneous non-tradable good. These firms are perfectly competitive and possess the same technology as the firms producing tradable goods.¹⁷ Labor is perfectly mobile across sectors in each country. Hence, the price of the non-tradable 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 non-tradable producers behave in a similar way.

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 basket. Since there are no fixed production costs, all firms produce in every period, until they are hit with an exogenous exit shock, which occurs with probability $\delta \in (0, 1)$ in every period. Entrants are forward looking, and correctly anticipate their future expected profits d_t (d_t^*) in every period 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 local bank in the firm's domestic market. Since the bank has all the bargaining power, it sets the entry loan repayment in each period at d_t (d_t^*) to extract all the firm profit.¹⁸

There is a number H of forward looking banks in the home country, which compete in Cournot fashion over the number of loans issued. Each bank takes the decisions of its competitors as given. Bank h has $N_t(h)$ producing firms in its portfolio and decides simultaneously with other banks on the number of entrants to fund, $N_{E,t}(h)$, taking into account the post entry firm profit maximization as each firm sets optimal prices for its product.^{19,20}

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

¹⁷For simplicity, we assume identical labor productivity across tradable and non-tradable sectors (and across production of existing goods and creation of new product lines in the tradable sector – see below).

¹⁸The assumption that banks have all the bargaining power and are able to extract all the profit simplifies the model solution substantially. Relative to a debt contract, it is not necessary to keep track of outstanding loan amounts for each cohort of firms, making it possible to treat firms of different vintages equally. To the extent that a debt contract (or other contracts between banks and firms) do not alter the fact that financial deregulation facilitates firm access to finance, the key mechanisms of our model would still operate, and the main results would not be affected.

¹⁹As will become clear later, this is not exactly the static Cournot model as not only the value of entrants, but also the value of incumbents depends on the number of entrants.

²⁰If we interpret the number of firms as the number of production lines in the economy, we can think of a bank as a financial company that controls the producers of a set of goods. These producers compete among themselves and also with producers controlled by other financial companies.

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 implies that the number of firms in bank h 's portfolio during period t is given by $N_t(h) = (1 - \delta)(N_{t-1}(h) + N_{E,t-1}(h))$. Then the number of producing home firms in period t , is $N_t = (1 - \delta)(N_{t-1} + N_{E,t-1})$, where $N_t = \sum_{h \in H} N_t(h)$ and the number of home entrants is $N_{E,t} = \sum_{h \in H} N_{E,t}(h)$.²¹ As in Bilbiie, Ghironi, and Melitz (2005) and Stebunovs (2006), the number of producing firms in period t is an endogenous state variable that behaves like physical capital in standard real business cycle models.

The Euler equation for household holdings of shares in the bank fund implies that the objective function for bank h is $E_t \sum_{s=t}^{\infty} \beta^{s-t} (C_s/C_t)^{-\gamma} \pi_s(h)$, which the bank maximizes with respect to $\{N_{s+1}(h)\}_{s=t}^{\infty}$ and $\{N_{E,s}(h)\}_{s=t}^{\infty}$. Bank h 's profit is $\pi_t(h) = N_t(h)d_t + B_{t+1}(h) - (w_t/Z_t)N_{E,t}(h) - (1 + r_t)B_t(h)$, where $d_t N_t(h)$ is the revenue from bank h 's portfolio of $N_t(h)$ firms, $B_{t+1}(h)$ denotes household deposits into bank h entering period $t+1$ (so that $B_{t+1} = \sum_{h \in H} B_{t+1}(h)$), $(w_t/Z_t)N_{E,t}(h)$ is the amount lent to $N_{E,t}(h)$ entrants, and $(1 + r_t)B_t(h)$ is the principal and interest on the previous period's deposits. We assume that banks accrue revenues after firm entry has been funded and then rebate profits to the mutual fund. Hence, bank h 's balance sheet constraint is $B_{t+1}(h) = (w_t/Z_t)N_{E,t}(h)$. In solving its optimization problem, bank h takes aggregate consumption, wages, and the interest rate as given.

The first-order condition with respect to $N_{t+1}(h)$ yields the Euler equation for the value of a firm to bank h , $q_t(h)$, which involves a term capturing the bank's internalization of the profit destruction externality (PDE) generated by firm entry:²²

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

The bank internalizes the effect of entry on firm profits through the effect of entry on the domestic and export relative prices $\rho_{D,t}$ and $\rho_{X,t}$. Firm entry reduces firm size and profits, and hence

²¹Similarly, the number of foreign firms during period t is given by $N_t^* = (1 - \delta)(N_{t-1}^* + N_{E,t-1}^*)$.

²²In Bilbiie, Ghironi, and Melitz (2005), firm entry is determined by the stock market value of a firm at time t , which reflects the probability $1 - \delta$ that the firm will generate profit and be priced in the next period. Here, $q_t(h)$ is the value to the bank of an additional firm *producing* at $t+1$ (recall that the first-order condition is taken with respect to $N_{t+1}(h)$, which is the number of firms in the bank's portfolio that produce at $t+1$). Thus, $q_t(h)$ is computed under the assumption that the firm does produce at $t+1$, and the entry loan repayment, d_{t+1} , is not multiplied by $1 - \delta$. On the other hand, $q_{t+1}(h)$ is multiplied by $1 - \delta$ because the firm may be hit by the exit inducing shock at the end of period $t+1$.

decreases the repayments to the bank. The bank internalizes only the effects of the entry it funds. Hence, $N_{t+1}(h)$ multiplies the profit destruction externality, $(\partial d_{t+1}/\partial N_{t+1})(\partial N_{t+1}/\partial N_{t+1}(h))$.²³

The first-order condition with respect to $N_{E,t}(h)$ defines a firm entry condition, which holds as long as the number of entrants, $N_{E,t}(h)$, is positive. We assume that macroeconomic shocks are small enough for this condition to hold in every period. Entry occurs until the value of an additional producer to the bank, $q_t(h)$, is equalized with the expected, discounted entry cost, given by the deposit principal and the interest to be paid back at $t + 1$,

$$q_t(h) = \frac{\beta}{1-\delta}(1+r_{t+1})\frac{w_t}{Z_t}E_t\left(\frac{C_{t+1}}{C_t}\right)^{-\gamma} = \frac{1}{1-\delta}\frac{w_t}{Z_t},$$

where the second equality follows from the household's Euler equation for deposits. 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 $q_t(h)$ (the bank's valuation of a marginal new entrant coincides with its valuation of an incumbent), firm entry reduces not only the value of entering firms, but also the value of incumbents until the value of all firm is equalized with the sunk entry cost (adjusted by a premium for the risk of firm death).²⁴

Since all banks are identical, we impose symmetry to obtain the Nash equilibrium. The equation for firm value, q_t , becomes:

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

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

²³Consider profits from domestic sales: $d_{D,t} = \alpha (\rho_{D,t})^{1-\theta} C_t/\theta$, with $\rho_{D,t} = (\rho_{T,t})^{-1} \mu w_t/Z_t$. The price index for tradables in the home country implies $1 = N_t (\rho_{D,t})^{1-\theta} + N_t^* (\rho_{X,t}^*)^{1-\theta}$, or $\rho_{D,t} = (N_t)^{\frac{1}{\theta-1}} \left[1 - N_t^* (\rho_{X,t}^*)^{1-\theta} \right]^{\frac{1}{1-\theta}}$. An increase in the number of domestic producers thus decreases $d_{D,t}$ by

$$\frac{\partial d_{D,t}}{\partial N_t} \frac{\partial N_t}{\partial N_t(h)} = -\frac{\alpha}{\theta} \frac{1 - N_t^* (\rho_{X,t}^*)^{1-\theta}}{N_t^2} C_t,$$

and it is straightforward to verify that the derivative of $d_{D,t+1}N_{t+1}(h)$ with respect to $N_{t+1}(h)$ is given by $(1 - N_{t+1}(h)/N_t) d_{D,t+1}$. Under symmetry across banks, this reduces to $(1 - 1/H) d_{D,t+1}$ (see below). A similar reasoning applies to export profits.

²⁴The first-order condition with respect to the number of *entrants* in period t recognizes the fact that some of these entrants will be hit by the exit shock and will not produce and repay the loan at $t + 1$. To compensate the bank for the risk of entrant death, the entry condition requires that $q_t(h)$ be higher than the entry cost w_t/Z_t by the factor $1/(1 - \delta)$.

totally offset by profit destruction.²⁵ The economy is starved of firm entry – and thus, eventually, of any activity.²⁶ Bank market power decreases as H increases. At the other extreme, $H = \infty$, equation (2) simplifies to the usual asset pricing equation.

Equation (2) allows us to relate our results on the effects of bank monopoly power on firm creation to Hayashi’s (1982) results on the consequences of firm monopoly power for capital accumulation. Solving (2) forward yields:

$$q_t = \left(1 - \frac{1}{H}\right) E_t \sum_{s=t+1}^{\infty} \beta^{s-t} (1 - \delta)^{s-(t+1)} \left(\frac{C_s}{C_t}\right)^{-\gamma} d_s = \left(1 - \frac{1}{H}\right) q_t^A,$$

where $q_t^A \equiv E_t \sum_{s=t+1}^{\infty} \beta^{s-t} (1 - \delta)^{s-(t+1)} (C_s/C_t)^{-\gamma} d_s$. With an alternative interpretation of the concepts of average and marginal q in our model, q_t^A corresponds to the average q of Hayashi (1982): q_t^A would be the valuation of an additional firm (or unit of capital) producing at time $t+1$ generated by a perfectly competitive financial market (for instance, by a competitive market for shares in firms). As demonstrated by Hayashi, the existence of monopoly power induces a discrepancy between average q and marginal q – the measure of q that determines decisions. In our model, monopoly power in banking results in a proportional mark-down $((H - 1)/H)$ of the value of firms to the bank relative to the competitive valuation (much as monopoly power in production of goods results in a proportional markup $(\theta - 1)/\theta$ relative to competitive pricing). As in Hayashi’s capital accumulation model, the discrepancy between average and marginal q disappears as the economy approaches the competitive benchmark ($H \rightarrow \infty$). Monopoly power causes marginal q to be below average q because additional firm creation (or capital accumulation) conflicts with a monopolist’s incentive to reduce supply relative to the competitive benchmark in order to generate higher profit. The results of our model thus parallel those of traditional theory of capital accumulation.

Although the model does not feature an explicit bank markup, we can define a measure of ex post bank markup as $\mu_{B,t} \equiv d_t N_t / (q_t N_{t+1}) - r_t$. The ratio $d_t N_t / (q_t N_{t+1})$ measures the relative return from funding a marginal (and average) firm. Similar equations and bank markup definition hold abroad.²⁷

²⁵When $H = 1$, equation (2) becomes $q_t = \beta(1 - \delta)E_t [(C_{t+1}/C_t)^{-\gamma} q_{t+1}]$. This is a contraction mapping because of discounting, and by forward iteration under the assumption $\lim_{T \rightarrow \infty} (\beta(1 - \delta))^T E_t q_{t+T} = 0$ (the value of firms is zero when reaching the terminal period), the only stable solution is $q_t = 0$, which implies $N_{E,t} = 0$.

²⁶ N_t will fall to 0 over time if the economy had started with higher H and a positive number of firms. This starvation of the economy would not happen if we assumed that the single monopolist bank takes into account its influence on aggregate consumption. This would be reminiscent of the “Ford effect” described in D’Aspremont, Ferreira, and Gerard-Varet (1996).

²⁷An alternative definition of bank markup would be $\mu_{B,t} \equiv d_t N_t / (q_{t-1} N_t) - r_t = d_t / q_{t-1} - r_t$. In this definition, q_{t-1} was the $t - 1$ value to the bank of an additional firm producing at t (whose entry was funded at $t - 1$), d_t is the

Aggregate Accounting and Balanced Trade

Aggregating the budget constraint (1) across home households and imposing the equilibrium conditions ($x_{t+1} = x_t = 1$ and $B_{t+1} = (w_t/Z_t)N_{E,t}$) yields the aggregate accounting equation $C_t + B_{t+1} = d_t N_t + w_t L$.²⁸ Consumption in each period must equal labor income plus investment income net of the cost of investing in new firms. Since this cost $B_{t+1} = (w_t/Z_t)N_{E,t}$ 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). We denote GDP with Y_t below.

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

Model Summary

Table 1 summarizes the main equilibrium conditions of the model. The equations in the table constitute a system of 29 equations in 29 endogenous variables: r_{t+1} , w_t , d_t , π_t , q_t , $N_{E,t}$, v_t , $\rho_{D,t}$, $\rho_{X,t}$, $\rho_{T,t}$, $\rho_{N,t}$, N_{t+1} , B_{t+1} , C_t , r_{t+1}^* , w_t^* , d_t^* , π_t^* , q_t^* , $N_{E,t}^*$, v_t^* , $\rho_{D,t}^*$, $\rho_{X,t}^*$, $\rho_{T,t}^*$, $\rho_{D,t}^*$, N_{t+1}^* , B_{t+1}^* , C_t^* , Q_t . 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 and r_t^* , and the deposits, B_t and B_t^* . Additionally, the model features two exogenous variables: the aggregate productivities Z_t and Z_t^* . We model banking deregulation as a one-time, permanent increase in the number of home banks, H .²⁹

3 Financial Deregulation and the Real Exchange Rate

This section discusses real exchange rate determination in our model and the mechanism for appreciation following banking deregulation. For this purpose, it is useful to introduce the distinction

realized return that this same firm generates. The benchmark definition in the main text compares the return from firms that were funded in period $t-1$ (and earlier) to the value to the bank of firms producing at $t+1$ and funded in period t (i.e., there is a discrepancy in the timing of entry funding at numerator and denominator of $d_t N_t / (q_t N_{t+1})$). The advantage of the alternative definition is that, by focusing on “the same firm,” it provides a more accurate measure of the return from funding an entrant. However, the benchmark definition is closer to empirical measures of bank interest margins. Importantly, both definitions imply countercyclical responses of the bank markup to shocks.

²⁸Labor 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 aggregate labor supply: $L = (\theta - 1) d_t N_t / w_t + N_{E,t} / Z_t + (1 - \alpha) C_t / (Z_t \rho_{N,t})$. As in Ghironi and Melitz (2005) and Bilbiie, Ghironi, and Melitz (2005), there are labor market dynamics, as labor is reallocated between production of existing goods and creation of new ones in response to shocks.

²⁹Since this is the only change we allow in the number of banks, we do not denote the latter with a time subscript to economize on notation.

between welfare-consistent and data-consistent price indexes as in Ghironi and Melitz (2005).

Up to now, we have used a definition of the real exchange rate, $Q_t \equiv \varepsilon_t P_t^*/P_t$, computed using welfare-based price indexes (P_t and P_t^*). Under C.E.S. product differentiation, it is well-known that price indexes can be decomposed into components reflecting average prices and product variety. In our benchmark model, domestic and foreign price indexes for tradable goods can be decomposed as $P_{T,t} = (N_t + N_t^*)^{1/(1-\theta)} \tilde{P}_{T,t}$ and $P_{T,t}^* = (N_t + N_t^*)^{1/(1-\theta)} \tilde{P}_{T,t}^*$, respectively, where the sum $N_t + N_t^*$ reflects product variety available in the two economies, and $\tilde{P}_{T,t}$ and $\tilde{P}_{T,t}^*$ are the average nominal prices for all varieties sold in the two countries. The consumption-based price indexes then can be decomposed as $P_t = (N_t + N_t^*)^{\alpha/(1-\theta)} \tilde{P}_t$ and $P_t^* = (N_t + N_t^*)^{\alpha/(1-\theta)} \tilde{P}_t^*$, where \tilde{P}_t and \tilde{P}_t^* are the average nominal price levels in the two countries. As noted in Ghironi and Melitz (2005), these average prices (\tilde{P}_t and \tilde{P}_t^*) correspond much more closely to empirically measured CPIs than the welfare-based indexes.³⁰ Thus, we define $\tilde{Q}_t = \varepsilon_t \tilde{P}_t^*/\tilde{P}_t$ as the theoretical counterpart to the empirical real exchange rate – since the latter relates CPI levels best represented by \tilde{P}_t and \tilde{P}_t^* .

In our benchmark model with exogenously non-traded goods, the welfare-based real exchange rate, Q_t , and the data-consistent real exchange rate, \tilde{Q}_t , coincide:

$$\tilde{Q}_t = \frac{\varepsilon_t \tilde{P}_t^*}{\tilde{P}_t} = \frac{(N_t + N_t^*)^{-\alpha/(1-\theta)} \varepsilon_t P_t^*}{(N_t + N_t^*)^{-\alpha/(1-\theta)} P_t} = \frac{\varepsilon_t P_t^*}{P_t} = Q_t.$$

The reason is that (differently from Ghironi and Melitz, 2005) consumers have access to the same set of tradable goods in the two countries, and they attach identical weights to non-tradable consumption.³¹

Using the price index equations, we obtain:

$$Q_t = (TOL_t)^{1-\alpha} \left[\frac{\frac{N_t^*}{N_t} (TOL_t)^{1-\theta} + \tau^{1-\theta}}{1 + \frac{N_t^*}{N_t} (\tau^* TOL_t)^{1-\theta}} \right]^{\frac{\alpha}{1-\theta}}, \quad (3)$$

where, following Ghironi and Melitz (2005), we defined the terms of labor $TOL_t \equiv \varepsilon_t (W_t^*/Z_t^*) / (W_t/Z_t)$.

The terms of labor measure the relative cost of effective labor across countries. A decrease in TOL_t indicates an appreciation of home effective labor relative to foreign. Note that, absent trade costs ($\tau = \tau^* = 1$), the real exchange rate reduces to $Q_t = (TOL_t)^{1-\alpha}$, reflecting the presence of

³⁰This is so because adjustment for variety in CPI data (when it happens) does not happen at the frequency captured by periods in our model. Even more importantly, adjustment for variety in CPI data is not tied to the specific preference specification that we adopt.

³¹All goods are *tradable* in Ghironi and Melitz (2005); some are endogenously *non-traded* in equilibrium. This implies that different sets of varieties are available to consumers at home and abroad.

non-traded goods with weight $1 - \alpha$ in consumption.

Dropping time subscripts to denote a variable's level in steady state, we assume $Z = Z^* = 1$. Assume further that the number of banks is equal in the two countries in the initial steady state ($H = H^*$) and that $\tau = \tau^*$ and $L = L^* = 1$. The model then features a unique, symmetric steady state with $Q = TOL = 1$, and log-linearizing equation (3) around the steady state yields:

$$Q_t = \left(1 - \alpha \frac{2\tau^{1-\theta}}{1 + \tau^{1-\theta}}\right) TOL_t + \frac{\alpha(1 - \tau^{1-\theta})}{(\theta - 1)(1 + \tau^{1-\theta})} (N_t - N_t^*), \quad (4)$$

where we use sans serif fonts to denote percentage deviations from the steady state. It is possible to verify that the coefficients of TOL_t and $N_t - N_t^*$ in this equation are strictly positive (as long as $\tau > 1$). An appreciation of home effective labor relative to foreign induces real exchange rate appreciation. In the absence of trade costs, this is motivated by an increase in the relative price of the non-traded good. Trade costs strengthen the effect of the terms of labor on the real exchange rate (since $2\tau^{1-\theta} < 1 + \tau^{1-\theta}$) by causing the appreciation of the former to induce an increase also in the relative price of home traded goods. An increase in the number of home tradable goods relative to foreign induces the real exchange rate to depreciate. The reason is that the number of varieties on which home households are not paying trade costs rises, with a positive welfare effect.³² The empirically plausible restriction $\theta > 3/2$ is sufficient for the coefficient of TOL_t to be strictly larger than the coefficient of $N_t - N_t^*$ in equation (4).³³

Consider now a permanent increase in the number of home banks H (holding the number of foreign banks constant). Reduced monopoly power induces home banks to be willing to finance a larger number of entrants. This amounts to a decrease in effective entry costs facing firms.³⁴ From the perspective of prospective entrants, relative to the old steady state, the decrease in monopoly power of home banks makes the home economy a more attractive location. Absent any change in the relative cost of effective labor (TOL_t), all new firms would only enter the home economy (there would be no new entrants into foreign). Thus, in the new long-run equilibrium, home effective labor

³²The $\alpha/(\theta - 1)$ portion of the coefficient of $N_t - N_t^*$ reflects the welfare benefit of additional traded goods.

³³If there are no non-traded goods ($\alpha = 1$), equation (4) becomes

$$Q_t = \frac{1 - \tau^{1-\theta}}{1 + \tau^{1-\theta}} TOL_t + \frac{1 - \tau^{1-\theta}}{(\theta - 1)(1 + \tau^{1-\theta})} (N_t - N_t^*),$$

and, of course, PPP holds ($Q_t = 1$) if there are no trade costs.

³⁴Relative to the deregulation scenario studied in Ghironi and Melitz (2005) and Bilbiie, Ghironi, and Melitz (2005), in which deregulation is modeled as an exogenous reduction in the sunk entry costs that entrants must pay, here – as in Stebunovs (2006) – banking deregulation lowers the financial barrier to entry erected by banks for given size of the exogenous sunk cost. The effects on firm behavior are intuitively similar.

must appreciate (TOL_t must decrease) in order to keep foreign labor employed.³⁵ It is precisely the entry of a larger number of firms into home that puts pressure on home labor demand and induces the terms of labor to appreciate. In turn, this causes real exchange rate appreciation as described above. As we show below, for plausible parameter values, the terms of labor term prevails on the variety term in equation (4), implying that an economy with permanently more competitive banking (relative to its trading partners) has a permanently appreciated real exchange rate.³⁶

In the Appendix, we present a version of the model in which there is no non-traded good, but preferences for tradables are characterized by a bias in favor of domestically produced goods. In this case, the welfare-based and data-consistent real exchange rates Q_t and \tilde{Q}_t no longer coincide, and it is:

$$Q_t = \left[\frac{\alpha N_t + (1 - \alpha) N_t^*}{\alpha N_t^* + (1 - \alpha) N_t} \right]^{\frac{1}{\theta-1}} \tilde{Q}_t, \quad (5)$$

where $\alpha \in (1/2, 1)$ now denotes the weight of domestic goods in consumption. Importantly, Q_t and \tilde{Q}_t need not move in the same direction following shocks. As we illustrate below, TOL_t remains the main determinant of \tilde{Q}_t , so that banking deregulation continues to induce appreciation of the data-consistent real exchange rate. However, the same banking deregulation can now induce the welfare-based real exchange rate to depreciate. Suppose this is indeed the case: \tilde{Q}_t falls (driven by TOL_t) and Q_t rises (because N_t increases by more than N_t^*). The intuition for this result is straightforward and hinges on the welfare gains from increased product variety: Even if average prices are higher in the home country, home agents are better off (on welfare grounds) spending a given nominal amount at home because they have access to a larger number of goods toward which their preferences are biased.

To conclude this section, we note that the results and intuitions we mentioned do not depend on the assumption of financial autarky. Equations (3)-(5) hold also when households can hold deposits abroad (or under any other assumption on international asset markets), and terms of labor and variety remain the fundamental determinants of real exchange rate dynamics.

³⁵ Absent entry into the foreign country, the number of foreign producing firms would steadily decrease with the death shock.

³⁶ Terms of labor dynamics are also the key determinant of the terms of trade in our model. The terms of trade are given by $T_t \equiv \varepsilon_t p_{X,t} / p_{X^*,t} = (\tau/\tau^*) TOL_t^{-1}$. Hence, appreciation of the terms of labor implies an improvement in the terms of trade.

4 Financial Deregulation and Macroeconomic Dynamics

In this section, we substantiate the results and intuitions of Section 3 by means of a numerical example, which allows us to characterize the full response path of the home and foreign economy to home banking deregulation from the impact period of the shock to the new long run. For this purpose, we log-linearize the system in Table 1 around the initial, symmetric steady state under assumptions of log-normality and homoskedasticity

Calibration

We calibrate parameters as follows. We interpret periods as quarters and set $\beta = .99$ and $\gamma = 1$, both standard choices for quarterly business cycle models.³⁷ We set the size of the exogenous firm exit shock $\delta = .025$ to match the U. S. empirical level of 10 percent job destruction per year.³⁸ We use the value of θ from Bernard, Eaton, Jensen, and Kortum (2003) and set $\theta = 3.8$, which was calibrated to fit U.S. plant and macro trade data.³⁹ We postulate that $\tau = \tau^* = 1.33$, which is in line with Obstfeld and Rogoff (2001).⁴⁰ Given the trade cost, we calibrate the share of tradable goods in consumption to match the average 12 percent U.S. import share of GDP.⁴¹ This results in $\alpha = .397$. As noted above, we set labor effort, $L = L^*$, and steady-state productivity, $Z = Z^*$, equal to one without loss of generality. These parameters determine the size of economy, but leave dynamics unaffected. We set the initial steady-state number of banks $H = H^*$ such that it implies a bank markup of about 10 percentage points. To determine the size of the financial deregulation

³⁷The choice of log utility from consumption is motivated by consistency with the elastic labor supply case below. King, Plosser, and Rebelo (1988) show that under separable preferences, log utility of consumption ensures that income and substitution effects of real wage variation on effort cancel out in steady state. This guarantees constant steady-state effort and is necessary for balanced growth if the model features trend productivity growth.

³⁸Empirically, job destruction is induced by both firm exit and contraction. We include the latter portion of job destruction in the exit shock in our model, consistent with interpreting productive units as production lines within potentially multi-product firms. The fraction of firm closures and bankruptcies over the total number of firms reported by the U.S. Small Business Administration – consistently around 10 percent per year over the recent years – yields the same calibration.

³⁹It may be argued that the value of θ results in a steady-state markup that is too high relative to the evidence. However, it is important to observe that, in models without any fixed cost, $\theta/(\theta - 1)$ is a measure of both markup over marginal cost and average cost. In our model with entry costs, free entry ensures that firms earn zero profits *net* of the entry cost. This means that firms price at average cost (inclusive of the entry cost). Thus, although $\theta = 3.8$ implies a fairly high markup over marginal cost, our parametrization delivers reasonable results with respect to pricing and average costs. The main qualitative features of the impulse responses below are not affected if we set $\theta = 6$, resulting in a 20 percent markup of price over marginal cost as in Rotemberg and Woodford (1992) and several other studies.

⁴⁰Among other things, trade costs include tariffs, non-tariff barriers, and transport costs. As Obstfeld and Rogoff (2001) 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). Anderson and van Wincoop (2004) estimate international trade costs in the range of 40 to 70 percent ad-valorem tax equivalent.

⁴¹The steady-state import share of GDP is $\alpha N^* (\rho_X^*)^{1-\theta} C/Y$.

shock, we calculate the change in H that induces a 30 percent long-run increase in the number of firms in home country. According to Davis, Haltiwanger, Jarmin, and Miranda (2006), the number of U.S. firms (both total and privately held) increased by approximately 34 percent between 1980 and 2000. Hence, for simplicity, our calibration attributes most of the increase to the effects of the banking deregulation that started in 1977.

Impulse Responses

Figure 1 shows selected responses (percent deviations from steady state) to a permanent banking deregulation in the home economy. The number of quarters after the shock is on the horizontal axis. Consider first the long-run effects in the new steady state. These substantiate the discussion in Section 3. With the fall in bank monopoly power, the home economy draws a permanently higher number of entrants, which translates into a permanently higher number of producers and generates increased labor demand and upward pressure on wages. This induces TOL_t to appreciate, causing appreciation of the real exchange rate Q_t . The less regulated economy exhibits higher prices relative to its trading partner.⁴² Consumption (and welfare) increase at home and abroad, due to the access to a larger range of (home) tradable goods

We now describe the transitional dynamics in response to the permanent deregulation. Absent sunk entry costs, and the associated time-to-build lag before production starts, the number of producing firms N_t 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 $N_{E,t}$ represents the home consumers' investment, which translates into increases in the stock N_t over time.⁴³ The terms of labor steadily appreciate with the increase in home labor demand generated by entry. Home consumption decreases in the short run, as households save to finance the entry of new firms with increased deposits into banks. Foreign consumption also falls in the short run, as real depreciation of the foreign currency increases the cost of purchasing home goods. We note that the real exchange rate change is slow to unfold. Reaching the new long-run level takes over 7 years.

The responses to financial deregulation are qualitatively similar when the model features home

⁴²If banking competitiveness is associated with economic development, this is consistent with the Harrod-Balassa-Samuelson evidence that more developed economies exhibit appreciated real exchange rates relative to their trading partners.

⁴³The figures plot the end-of-period response of the number of firms. In other words, consistent with the model, the response plotted in each period is the response of the number of firms with which the economy enters the following period.

bias in preferences for tradables rather than non-traded goods. The figure can be found in the Appendix.⁴⁴ The only notable difference is that the welfare-based real exchange rate appreciates in the short run, but it depreciates in the long run (while the data-consistent real exchange rate appreciates steadily). The intuition follows from the discussion in Section 3: The number of firms does not respond to deregulation on impact. Hence, Q_t is driven by TOL_t in the very short run, as \tilde{Q}_t . However, as the number of home firms increases, the welfare benefit of having access to a larger number of goods toward which preferences are biased pushes Q_t upward and eventually induces depreciation.

5 International Deposits

We now extend the model of the previous section to allow households to hold deposits abroad. We study how international deposits affect the results we have previously described and how micro-economic dynamics affect the current account in our model. 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 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. We assume that agents must pay quadratic transaction fees to banks when adjusting their deposits abroad.⁴⁵ These fees pin down the deterministic steady-state allocation of deposits and ensure stationary responses of the model to non-permanent shocks. Since agents pay fees only when they adjust their deposits abroad, the steady state of the model with international deposits coincides with the steady state of the model under financial autarky. In particular, $\beta(1+r) = \beta(1+r^*) = 1$, $B = B_*^* = wN_E/Z$, and $B_* = B^* = 0$, where B (B_*) is home (foreign) holdings of home (foreign) deposits, B_* (B^*) is home (foreign) holdings of foreign (home) deposits, and we assumed $Z = Z^*$. Realistic parameter

⁴⁴In this case, the steady-state import share of GDP is $(1-\alpha)N^*(\rho_X^*)^{1-\theta}C/Y$ and $\alpha = .755$ to match the 12 percent U.S. average import share. The same initial value of H (1.468) results in a 10 percent bank markup, but the new value required to generate a 30 percent increase in the number of firms changes slightly to 1.739.

⁴⁵We assume that banks then rebate the revenues from deposit adjustment fees to households.

values imply that the cost of adjusting deposits has a very small impact on model dynamics, other than pinning down the deterministic steady state and ensuring mean reversion in the long run when shocks are transitory.⁴⁶

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.⁴⁷ 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 abroad imply that the Euler equations for these deposits feature a term that depends on the stock of deposits – the ingredient pinning down the steady state allocation of deposits and delivering 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.

As before, we analyze the response path of the real exchange rate and other key variables to a permanent banking deregulation. To do so, we log-linearize the model around its unique steady state. 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 dynamics of our model.

⁴⁶Devereux and Sutherland (2006a,b) and Tille and van Wincoop (2007) develop an alternative technique for pinning down steady-state international asset portfolios. A friction of the type we consider is then needed only to ensure stationarity of net foreign assets. We use a convenient specification of adjustment costs also to pin down the steady-state allocation of deposits since our interest is in the dynamics of overall net foreign assets rather than the composition of portfolios, and we are interested in evaluating how the possibility of depositing funds abroad affects dynamics around the same steady state as under financial autarky (while the Devereux-Sutherland/Tille-van Wincoop technique would imply a different steady state).

⁴⁷Net foreign assets and the current account are zero in steady state.

Deregulation and Macroeconomic Dynamics

As under financial autarky, we consider the responses to a deregulation of home banking (a permanent increase in the number of home banks, H) such that the number of home producers increases by 30 percent in the long-run. Figure 2 shows the impulse responses. The responses of home and foreign consumption are qualitatively similar to Figure 1. Initially, households in both countries reduce consumption to finance increased producer entry in the deregulated home economy. Home runs current account deficits for two years in response to the shock, resulting in the accumulation of a persistent net foreign debt position. Home households borrow from abroad to finance higher initial investment (relative to financial autarky) in new home firms. The home household's incentive to front-load producer entry is mirrored by the foreign household's desire to invest savings in the more attractive economy. Although home consumption declines initially, it 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 deposits 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 financed by external borrowing 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 also immediately appreciates.⁴⁸ The opening of the economy to international deposit trading does not qualitatively change the mechanism that leads to real exchange rate appreciation following banking deregulation in our model. Foreign consumption and GDP increase in the long run, even though the number of foreign producers is reduced by the relocation of business creation to the home country. The permanent expansion in the number of home producers more than compensates the loss in the number of foreign firms to determine the increase in long-run foreign consumption.⁴⁹

⁴⁸The terms of labor and the real exchange rate overshoot their new long-run appreciated levels on impact, reflecting the effect on home labor costs of the spike in labor demand from increased business creation on impact.

⁴⁹The impulse responses for the model with home bias in consumption are in the appendix. As before, the main difference is in the dynamics of the welfare-consistent versus data-consistent real exchange rate, which display the

We have thus established two consequences of banking deregulation: real exchange rate appreciation and external borrowing to finance increased business creation. Next, we turn to a more quantitative version of our model to study the consequences of deregulation for macroeconomic volatility.

6 Financial Deregulation and International Business Cycles

We now extend the model with international deposits to incorporate countercyclical firm markups and elastic labor supply. Assuming that fluctuations in home and foreign productivity are the sources of international business cycles, this allows us to illustrate the mechanism behind the moderation of business cycle volatility generated by financial deregulation. This extension exploits the implications of endogenous variety by separating taste for variety and firm monopoly power, and allowing for endogenous demand elasticity and countercyclical firm markups.

The representative home household now supplies L_t units of labor endogenously in each period. The household maximizes expected intertemporal utility from consumption and labor effort: $E_t \sum_{s=t}^{\infty} \beta^{s-t} \left[(C_s)^{1-\gamma} / (1-\gamma) - \chi (L_s)^{1+1/\varphi} / (1+1/\varphi) \right]$, where $\chi > 0$ is 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 optimality condition is the intratemporal optimality condition for labor supply. Elastic labor supply implies that households have an extra margin of adjustment to aggregate productivity shocks. This enhances the propagation mechanism of the model by amplifying the responses of endogenous variables with respect to the benchmark model.

To generate endogenously fluctuating markups, we now define the baskets of goods over discrete numbers of home and foreign varieties. Since the number of firms is endogenous, one cannot assume that the number is sufficiently large for the weight of each producer to be negligible.⁵⁰ The basket of tradeable goods now is $C_{T,t} = \left(\sum_{\omega \in \Omega} c_t(\omega)^{(\theta-1)/\theta} \right)^{\theta/(\theta-1)}$; hence, $P_{T,t} = \left(\sum_{\omega \in \Omega} p_t(\omega)^{1-\theta} \right)^{1/(1-\theta)}$. Each producer no longer ignores the effects of its nominal domestic price, $p_{D,t}(\omega)$, on the home tradable price index, $P_{T,t}$, and the effect of its nominal export price, $p_{X,t}(\omega)$, on the foreign tradable price index, $P_{T,t}^*$.⁵¹ The perceived home demand elasticity is then $\theta_{D,t}(\omega) \equiv \theta \left(1 - (p_{D,t}(\omega)/P_{T,t})^{1-\theta} \right)$

same pattern as under financial autarky.

⁵⁰An alternative way to generate endogenously fluctuating markups with a continuum of producers of negligible size is to use translog preferences as in Bilbiie, Ghironi, and Melitz (2005). Since both specifications result in countercyclical markups, we conjecture that results would be similar for our purposes.

⁵¹See Yang and Heijdra (1993) for an analysis of Dixit-Stiglitz monopolistic competition with a discrete number of producers.

and the foreign demand elasticity is $\theta_{X,t}(\omega) \equiv \theta \left(1 - \left(p_{X,t}(\omega)/P_{T,t}^* \right)^{1-\theta} \right)$. Note that taking into account this indirect price effect decreases the demand elasticities perceived by firm ω ($\theta_{D,t}(\omega) < \theta$ and $\theta_{X,t}(\omega) < \theta$); hence, it increases its monopoly power in both markets. The implied markup in the domestic market is $\mu_{D,t}(\omega) \equiv \theta_{D,t}(\omega)/(\theta_{D,t}(\omega) - 1)$, and in foreign market $\mu_{X,t}(\omega) \equiv \theta_{X,t}(\omega)/(\theta_{X,t}(\omega) - 1)$. Firms set flexible prices that reflect these different markups over marginal cost in the different markets where they sell their output.⁵² As before, define the relative prices $\rho_{D,t}(\omega) \equiv p_{D,t}(\omega)/P_{T,t}$, $\rho_{T,t} \equiv P_{T,t}/P_t$, $\rho_{X,t}(\omega) \equiv p_{X,t}(\omega)/P_{T,t}^*$, and $\rho_{T,t}^* \equiv P_{T,t}^*/P_t^*$. Then, $\rho_{D,t}(\omega) = (\rho_{T,t})^{-1} \mu_{D,t}(\omega) w_t/Z_t$ and $\rho_{X,t}(\omega) = (\rho_{T,t}^*)^{-1} \tau Q_t^{-1} \mu_{X,t}(\omega) w_t/Z_t$. Profits generated by domestic sales are $d_{D,t}(\omega) = \alpha (\rho_{D,t}(\omega))^{1-\theta} C_t/\theta_{D,t}(\omega)$, and profits generated by exports are $d_{X,t}(\omega) = \alpha Q_t (\rho_{X,t}(\omega))^{1-\theta} C_t^*/\theta_{X,t}(\omega)$.⁵³ Since all firms are identical in equilibrium, we drop the index ω . In this version of the model, banks internalize 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 tradable price index, $P_{T,t}$, and the effect of entry on the nominal export price, $p_{X,t}$, and then on the foreign tradable price index, $P_{T,t}^*$.

The equation for firm value, q_t , becomes:

$$q_t = \beta E_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \left[\left(1 - \frac{1}{H} \frac{\theta}{\theta_{D,t+1}} \right) d_{D,t+1} + \left(1 - \frac{1}{H} \frac{\theta}{\theta_{X,t+1}} \right) d_{X,t+1} + (1 - \delta) q_{t+1} \right] \right\}. \quad (6)$$

(The derivation details are in the appendix. A similar equation holds abroad. This equation holds also in the model with home bias.) At one extreme, $H = 1$ or absolute bank monopoly, equation (6) implies that there is no entry as the return from funding an entrant is negative: the portfolio expansion effect is dominated by profit destruction effect (recall that $\theta_{D,t+1} < \theta$ and $\theta_{X,t+1} < \theta$). Bank market power decreases as H increases, and, at the other extreme, $H = \infty$, the equation simplifies to the familiar asset pricing equation with perfectly competitive asset pricing. Over the business cycle generated by an increase in productivity, as the number of firms increases, the perceived demand elasticities $\theta_{D,t}$ and $\theta_{X,t}$ increase, and markups fall. On the one hand, the fact that the ratios $\theta/\theta_{D,t+1}$ and $\theta/\theta_{X,t+1}$ are larger than one reduces bank incentives to invest in new firms. But, on the other hand, since firm profits are procyclical and banks have claims to these

⁵²We implicitly assume that firms have the ability to segment markets, so that consumers cannot arbitrage away deviations from the law of one price in excess of those implied by trade costs. Since firm entry is procyclical in our model, markups are countercyclical, and their movements amplify, rather than stabilize, fluctuations in firm output.

⁵³Similar price and profit equations hold for foreign firms. Note that $\rho_{X,t}^*(\omega) = (\rho_{T,t})^{-1} Q_t \tau^* \mu_{X,t}^*(\omega) w_t^*/Z_t^*$, and hence a foreign firm earns export profits $d_{X,t}^* = \alpha Q_t^{-1} (\rho_{X,t}^*)^{1-\theta} C_t/\theta_{X,t}^*(\omega)$.

profits, the importance of the profit destruction externality terms falls as $\theta/\theta_{D,t+1}$ and $\theta/\theta_{X,t+1}$ decrease, thus strengthening bank incentives to invest.

Table 2 summarizes the main equilibrium conditions of this version of the model (showing only the equations pertaining to home variables and net foreign assets).⁵⁴ We study the model predictions with Frisch elasticity $\varphi = 10$.⁵⁵ We set the weight of the disutility of labor, χ , to 1. In this and the following section, we set the share of tradable goods in the consumption basket, α , to .5, while iceberg trade costs are kept at $\tau = \tau^* = 1.33$. The choice of α is dictated by difficulties in computing the model's steady state, and it implies a steady-state import share of about 18 percent.⁵⁶ The other preference parameters, and the size of the exogenous exit probability δ , remain the same as in the benchmark model. The calibration strategy for H is the same as before. We set the pre-deregulation H to imply a 10 percent bank markup. Then, a 30 percent long-run increase in the number of domestic firms pins down the size of the increase in H that captures banking deregulation. We keep the steady-state home and foreign productivity levels, Z and Z^* , at 1. Note though that this 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 steady-state productivity, the lower the number of firms, and the higher steady-state firm markups. In turn, this implies more countercyclical markups over the business cycle. The intuition is simple: When the steady-state number of firms is low (so that each of them is operating on a larger share of the market), banks have an incentive to finance more entry (as a percentage of the initial steady state) following a favorable productivity shock than when the steady-state number of firms is large. As a consequence, the markup falls by more (in percent of the initial steady state) when expansions happen around a steady state with a smaller number of firms. This effect is mirrored by household labor supply decisions. By adjusting steady-state productivity, we can affect the interplay of wealth and substitution effects in labor supply. As lower steady-state productivity leads to more countercyclical markups, and hence more procyclical wages, it generates stronger substitution effects and weaker wealth effects in labor supply in the impact response to temporary productivity shocks. The representative household

⁵⁴The model with tradable goods only and home bias in consumption can be summarized by replacing the consumption price index, tradable price index, goods pricing, firm profit, and labor market clearing equations with the equations shown in the appendix.

⁵⁵The case in which $\varphi \rightarrow \infty$ corresponds to linear disutility of effort and is often studied in the business cycle literature.

⁵⁶The lowest steady-state import share we obtained with $\tau = \tau^* = 1.33$ was 16 percent with α approximately .35. In the version of the model with tradable goods only and home bias in consumption, given $\tau = \tau^* = 1.33$, we set the weight of home goods in the consumption basket to .797, which yields a steady-state import share of about 12 percent.

then is willing to take advantage of the temporarily high productivity by supplying more labor to increase substantially the available number of products, 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 should be relatively high (and there should be little or no habits in consumption), so that the representative household is not overly engaged in consumption smoothing. Second, as usual, the strength of wealth effects increases with the persistence of productivity shocks, as when the household does not expect to change consumption by much in the future, it simply takes the opportunity to increase its consumption of leisure.

The Responses to Deregulation

Figure 3 shows the responses to home banking deregulation. Time varying firm markups and elastic labor supply result in amplified responses of endogenous variables. Consistent with a reduction in monopoly power in the economy, home labor supply is permanently higher. Since households can now respond to the shock also by expanding their labor effort and firm markups decline, home consumption no longer falls on impact. Similarly, the response of foreign labor allows the foreign economy to enjoy increased business creation and GDP throughout the transition. As in the model with inelastic labor and fixed firm markups, the terms of labor appreciates, leading to real exchange rate appreciation, and the home economy borrows to finance increased business creation.

Productivity Shocks and Macroeconomic Dynamics

Figure 4 illustrates the business cycle propagation properties of our model by showing the impulse responses to a transitory increase in home productivity. We assume a 1 percent innovation to home productivity with persistence .9. The solid lines are the impulse responses to this shock around the pre-deregulation steady state, while dashes denote the impulse responses to the same shock around the post-deregulation steady state. As the responses 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, it takes over 10 years for the real exchange rate to return to the steady-state level.

Note the initial appreciation of the terms of labor, again motivated by the effect of faster entry of new firms into the home economy on home labor costs. Since shock persistence is relatively low (by real business cycle standards), lending abroad to smooth the consequences of a temporary,

favorable shock on consumption is the main determinant of net foreign asset dynamics, and the home economy runs a current account surplus, accumulating net foreign assets above the steady state.⁵⁷

Importantly, stronger banking competition implies a smaller percent deviation of firm entry from the steady state, less countercyclical firm markups, and weaker substitution effects in labor supply. As a consequence of deregulation, the responses of firm entry, labor supply, consumption, investment, and aggregate output are muted in the home economy. Given the trade and financial ties with home, financial deregulation at home results in dampened fluctuations in the rest of the world too.

The intuition is straightforward, and related to the discussion of the consequences of changes in steady-state productivity above. Post-deregulation, the economy is populated by a larger steady-state number of firms, which are operating on a smaller share of the market and charging lower markups due to increased firm competition. As a consequence, when a favorable productivity shock happens, the banks' incentive to let additional firms into the economy is weakened, and we observe less business creation as a percent of the steady-state number of firms than around the pre-deregulation steady state. In turn, this dampens markup fluctuations around the post-deregulation steady state and is accompanied by weaker substitution effects in labor supply, and muted responses of home and foreign endogenous variables to the productivity shock.

Deregulation and Moderation

The model includes only one source of fluctuations at business cycle frequency, the shocks to aggregate productivity Z_t and Z_t^* . As such, our interest is not in whether it has the ability to replicate a wide range of data moments, but in studying whether it can approximate the magnitude of changes in certain key second moments between the pre- and post-deregulation periods. 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 non-negative, and ξ_t^Z and $\xi_t^{Z^*}$ are normally distributed, zero-mean innovations. We

⁵⁷When the shock is more persistent, financing increased firm entry in the more productive economy becomes the main determinant of the current account, and the home economy runs a deficit in response to higher productivity.

use the symmetrized estimate of the bivariate productivity process for the United States and an aggregate of European economies in Backus, Kehoe, and Kydland (1992) and set

$$\begin{bmatrix} \phi_Z & \phi_{ZZ^*} \\ \phi_{Z^*Z} & \phi_{Z^*Z^*} \end{bmatrix} = \begin{bmatrix} .906 & .088 \\ .088 & .906 \end{bmatrix}.$$

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 percent and the correlation to .258 (corresponding to a .19 percent covariance).⁵⁸ We calculate the implied second moments of endogenous variables (percent deviations from steady state) using the frequency domain technique. We focus on high-frequency moments and report second moments of Hodrick-Prescott (HP)-filtered variables.⁵⁹

We noted above that empirical price deflators are best represented by the average prices \tilde{P}_t and \tilde{P}_t^* in our model (as opposed to the welfare based price indexes P_t and P_t^*). Therefore, when investigating the properties of the model in relation to the data, we focus on nominal variables deflated by the data-consistent price indexes \tilde{P}_t and \tilde{P}_t^* rather than variables in welfare-consistent units. Data-consistent, real variables are thus obtained as $X_{R,t} \equiv X_t P_t / \tilde{P}_t$, where X_t is any variable in units of the consumption basket. As we previously discussed, creation of new firms is the form taken by capital accumulation in our model, and the stock of firms represents the capital stock of the economy. For comparison with investment in standard models, we compute second moments for $\tilde{I}_t = P_t w_t N_{E,t} / (Z_t \tilde{P}_t)$ and $\tilde{I}_t^* = P_t^* w_t^* N_{E,t}^* / (Z_t^* \tilde{P}_t^*)$.

Table 3 reports model-generated standard deviations before and after home's financial deregulation for both our model specifications (the benchmark with non-traded goods and the alternative presented in the Appendix in which all goods are traded, but there is home bias in consumer preferences).⁶⁰ Both models are successful at generating less volatile consumption than GDP, (roughly) as volatile labor as GDP, and more volatile investment than GDP (although the models significantly overpredict the volatility of investment relative to GDP). Both models are also successful at generating significant volatility reduction for the home country's business cycles around the post-deregulation steady state relative to fluctuations in the pre-deregulation era.⁶¹ In particular, the

⁵⁸We set the correlation to the value estimated by Backus, Kehoe, and Kydland (1992). They estimate a .73 percent variance of innovations. Our use of a 1 percent standard deviation has no consequence for the results we focus on.

⁵⁹As customary, we set the HP filter parameter $\lambda = 1,600$.

⁶⁰We scale standard deviations in Table 3 by the standard deviation of productivity shocks.

⁶¹Moderation of markup volatility ensures that firm-level output fluctuations are also less volatile following banking

reduction in business cycle volatility is comparable in magnitude with that observed in the data for the U.S. since the 1980s, and trade and financial ties with the U.S. allow also the rest of the world to enjoy lower volatility in our model world economy.⁶²

Table 4 reports variance decompositions for the two versions of our model. Both model versions predict a slight increase in the importance of the shocks originating in the rest of the world after deregulation for home GDP, investment, and labor effort, but not for consumption.

7 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 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 accumulation of foreign debt that highlights an additional source of cross-country asymmetry in the characteristics of financial sectors relative to those emphasized by Caballero, Fahri, and Gourinchas (2006) and Mendoza, Quadrini, and Ríos-Rull (2007). It complements Fogli and Perri (2006) by connecting external borrowing along the transition to the post-deregulation steady state to an endogenous moderation of the cycle around the new steady state, 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.

deregulation, consistent with the evidence in Correa and Suarez (2007).

⁶²Although the volatility of foreign consumption increases.

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Table 1. Benchmark Model, Summary

Consumption price indexes	$1 = (\rho_{T,t})^\alpha (\rho_{N,t})^{1-\alpha}$ $1 = \left(\rho_{T,t}^*\right)^\alpha \left(\rho_{N,t}^*\right)^{1-\alpha}$
Tradable price indexes	$1 = N_t (\rho_{D,t})^{1-\theta} + N_t^* (\rho_{X,t}^*)^{1-\theta}$ $1 = N_t^* (\rho_{D,t}^*)^{1-\theta} + N_t (\rho_{X,t})^{1-\theta}$
Good prices, domestic market	$\rho_{D,t} = (\rho_{T,t})^{-1} \mu w_t / Z_t$ $\rho_{D,t}^* = \left(\rho_{T,t}^*\right)^{-1} \mu w_t^* / Z_t^*$
Good prices, export market	$\rho_{X,t} = \left(\rho_{T,t}^*\right)^{-1} \tau Q_t^{-1} \mu w_t / Z_t$ $\rho_{X,t}^* = (\rho_{T,t})^{-1} \tau^* Q_t^* \mu w_t^* / Z_t^*$
Good prices, non-tradable	$\rho_{N,t} = w_t / Z_t$ $\rho_{N,t}^* = w_t^* / Z_t^*$
Firm profits	$d_t = \alpha (\rho_{D,t})^{1-\theta} C_t / \theta + \alpha Q_t (\rho_{X,t})^{1-\theta} C_t^* / \theta$ $d_t^* = \alpha \left(\rho_{D,t}^*\right)^{1-\theta} C_t^* / \theta + \alpha Q_t^{-1} \left(\rho_{X,t}^*\right)^{1-\theta} C_t / \theta$
Bank profits	$\pi_t = d_t N_t - (1 + r_t) B_t$ $\pi_t^* = d_t^* N_t^* - (1 + r_t^*) B_t^*$
Firm entry	$q_t = w_t / [(1 - \delta) Z_t]$ $q_t^* = w_t^* / [(1 - \delta) Z_t^*]$
Firm value	$q_t = \beta E_t \left\{ (C_{t+1} / C_t)^{-\gamma} [(1 - 1/H) d_{t+1} + (1 - \delta) q_{t+1}] \right\}$ $q_t^* = \beta E_t \left\{ (C_{t+1}^* / C_t^*)^{-\gamma} [(1 - 1/H^*) d_{t+1}^* + (1 - \delta) q_{t+1}^*] \right\}$
Number of firms	$N_{t+1} = (1 - \delta)(N_t + N_{E,t})$ $N_{t+1}^* = (1 - \delta)(N_t^* + N_{E,t}^*)$
Euler equation, deposits	$1 = \beta (1 + r_{t+1}) E_t [(C_{t+1} / C_t)^{-\gamma}]$ $1 = \beta (1 + r_{t+1}^*) E_t [(C_{t+1}^* / C_t^*)^{-\gamma}]$
Euler equation, shares	$v_t = \beta E_t [(C_{t+1} / C_t)^{-\gamma} (v_{t+1} + \pi_{t+1})]$ $v_t^* = \beta E_t [(C_{t+1}^* / C_t^*)^{-\gamma} (v_{t+1}^* + \pi_{t+1}^*)]$
Deposit market clearing	$B_{t+1} = (w_t / Z_t) N_{E,t}$ $B_{t+1}^* = (w_t^* / Z_t^*) N_{E,t}^*$
Aggregate accounting	$C_t + B_{t+1} = d_t N_t + w_t L$ $C_t^* + B_{t+1}^* = d_t^* N_t^* + w_t^* L^*$
Balanced trade	$Q_t N_t (\rho_{X,t})^{1-\theta} C_t^* = N_t^* (\rho_{X,t}^*)^{1-\theta} C_t$

Table 2. Quantitative Model, Summary

Consumption price index	$1 = (\rho_{T,t})^\alpha (\rho_{N,t})^{1-\alpha}$
Tradable price index	$N_t (\rho_{D,t})^{1-\theta} + N_t^* (\rho_{X,t}^*)^{1-\theta} = 1$
Demand elasticity, home market	$\theta_{D,t} = \theta \left[1 - (\rho_{D,t})^{1-\theta} \right]$
Good prices, home market	$\rho_{D,t} = (\rho_{T,t})^{-1} \left(\frac{\theta_{D,t}}{\theta_{D,t}-1} \right) \frac{w_t}{Z_t}$
Demand elasticity, export market	$\theta_{X,t} = \theta \left[1 - (\rho_{X,t})^{1-\theta} \right]$
Good prices, export market	$\rho_{X,t} = (\rho_{T,t}^*)^{-1} \tau Q_t^{-1} \left(\frac{\theta_{X,t}}{\theta_{X,t}-1} \right) \frac{w_t}{Z_t}$
Good prices, non-tradable	$\rho_{N,t} = \frac{w_t}{Z_t}$
Firm profits, home market	$d_{D,t} = \frac{\alpha}{\theta_{D,t}} (\rho_{D,t})^{1-\theta} C_t$
Firm profits, export market	$d_{X,t} = \frac{\alpha}{\theta_{X,t}} Q_t (\rho_{X,t})^{1-\theta} C_t^*$
Bank profits	$\pi_t = (d_{D,t} + d_{X,t}) N_t - (1 + r_t) (B_t + B_t^*)$
Firm entry	$q_t = w_t / [(1 - \delta) Z_t]$
Firm value	$q_t = \beta E_t \left\{ \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \left[\begin{array}{l} \left(1 - \frac{1}{H} \frac{\theta}{\theta_{D,t+1}} \right) d_{D,t+1} \\ + \left(1 - \frac{1}{H} \frac{\theta}{\theta_{X,t+1}} \right) d_{X,t+1} + (1 - \delta) q_{t+1} \end{array} \right] \right\}$
Number of firms	$N_t = (1 - \delta) (N_{t-1} + N_{E,t-1})$
Euler equation, domestic deposits	$1 = \beta (1 + r_{t+1}) E_t [(C_{t+1}/C_t)^{-\gamma}]$
Euler equation, deposits abroad	$1 + \eta B_{*,t} = \beta (1 + r_{t+1}^*) E_t [(Q_{t+1}/Q_t) (C_{t+1}/C_t)^{-\gamma}]$
Euler equation (shares)	$v_t = \beta E_t [(C_{t+1}/C_t)^{-\gamma} (v_{t+1} + \pi_{t+1})]$
Deposit market clearing	$B_{t+1} + B_{t+1}^* = (W_t/Z_t) N_{E,t}$
Labor supply	$\chi (L_t)^{1/\varphi} = w_t (C_t)^{-\gamma}$
Labor market clearing	$L_t = \left(\frac{\theta_{D,t}-1}{w_t} d_{D,t} + \frac{\theta_{X,t}-1}{w_t} d_{X,t} \right) N_t + \frac{N_{E,t}}{Z_t} + \frac{1-\alpha}{Z_t} \frac{C_t}{\rho_{N,t}}$
Net foreign assets	$Q_t B_{*,t+1} - B_{t+1}^* = Q_t (1 + r_t^*) B_{*,t} - (1 + r_t) B_t^*$ $+ \frac{1}{2} (w_t - Q_t w_t^*) + \frac{1}{2} (d_t N_t - Q_t d_t^* N_t^*)$ $-\frac{1}{2} (C_t - Q_t C_t^*) - \frac{1}{2} \left(\frac{w_t}{Z_t} N_{E,t} - Q_t \frac{w_t^*}{Z_t^*} N_{E,t}^* \right)$

Table 3. Standard Deviations Pre- and Post-Deregulation

Model with Non-Traded Goods				Model with Home Bias			
	Before	After	% Change		Before	After	% Change
N_E	120.6096	81.2428	-32.64	N_E	41.2815	28.4702	-31.03
N_E^*	120.6095	106.7946	-11.45	N_E^*	41.2815	40.3765	-2.19
\tilde{C}	1.1207	0.8923	-20.38	\tilde{C}	1.5600	1.1371	-27.11
\tilde{C}^*	1.1207	1.1656	4.00	\tilde{C}^*	1.5600	1.5765	1.06
L	5.6779	4.7502	-16.34	L	4.4332	3.6513	-17.64
L^*	5.6779	4.9439	-12.93	L^*	4.4332	4.3118	-2.74
\tilde{I}	120.6031	81.2282	-32.65	\tilde{I}	41.1512	28.3685	-31.06
\tilde{I}^*	120.6030	106.7659	-11.47	\tilde{I}^*	41.1512	40.2502	-2.19
\tilde{Y}	5.1954	4.5407	-12.60	\tilde{Y}	3.6031	3.2042	-11.07
\tilde{Y}^*	5.1954	4.6788	-9.94	\tilde{Y}^*	3.6031	3.5061	-2.69
\tilde{Q}	0.9777	0.7693	-21.31	\tilde{Q}	1.1267	0.8978	-20.32

Table 4. Variance Decomposition Pre- and Post-Deregulation

Model with Non-Traded Goods					Model with Home Bias				
	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	$\xi_t^{Z^*}$
N_E	55.12	44.88	49.92	50.08	N_E	66.08	33.92	63.58	36.42
N_E^*	20.93	79.07	20.26	79.74	N_E^*	13.43	86.57	12.44	87.56
\tilde{C}	93.81	6.19	95.02	4.98	\tilde{C}	84.17	15.83	90.08	9.92
\tilde{C}^*	10.97	89.03	11.48	88.52	\tilde{C}^*	6.56	93.44	6.75	93.25
L	54.36	45.64	50.83	49.17	L	66.96	33.04	66.84	33.16
L^*	21.50	78.50	21.61	78.39	L^*	12.22	87.78	13.16	86.84
\tilde{I}	55.08	44.92	49.87	50.13	\tilde{I}	66.20	33.80	63.69	36.31
\tilde{I}^*	20.97	79.03	20.25	79.75	\tilde{I}^*	13.32	86.68	12.32	87.68
\tilde{Y}	61.63	38.37	57.72	42.28	\tilde{Y}	75.38	24.62	72.96	27.04
\tilde{Y}^*	17.20	82.80	15.12	84.88	\tilde{Y}^*	9.68	90.32	8.62	91.38
\tilde{Q}	37.10	62.90	40.72	59.28	\tilde{Q}	37.10	62.90	41.67	58.33

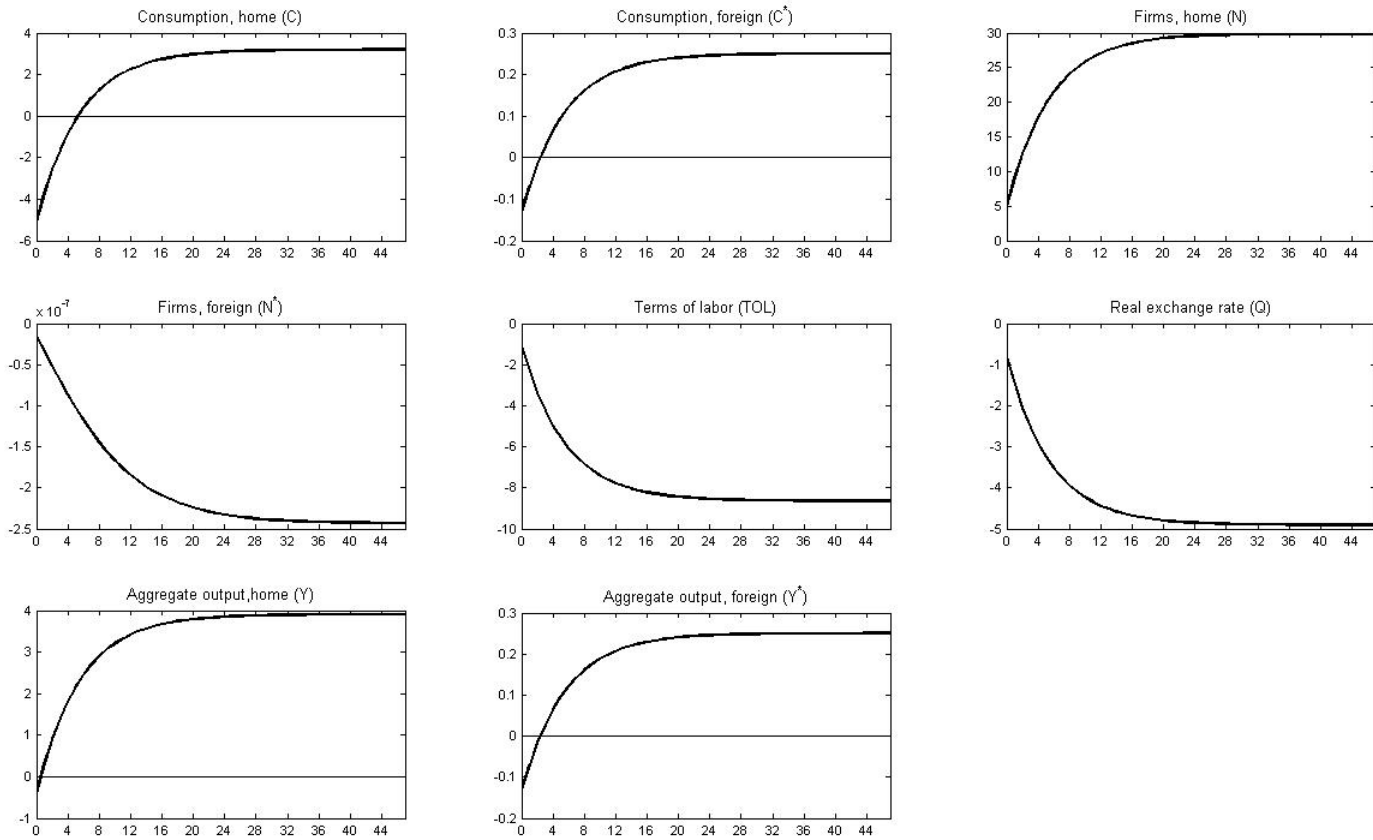


Figure 1. Banking Deregulation under Financial Autarky

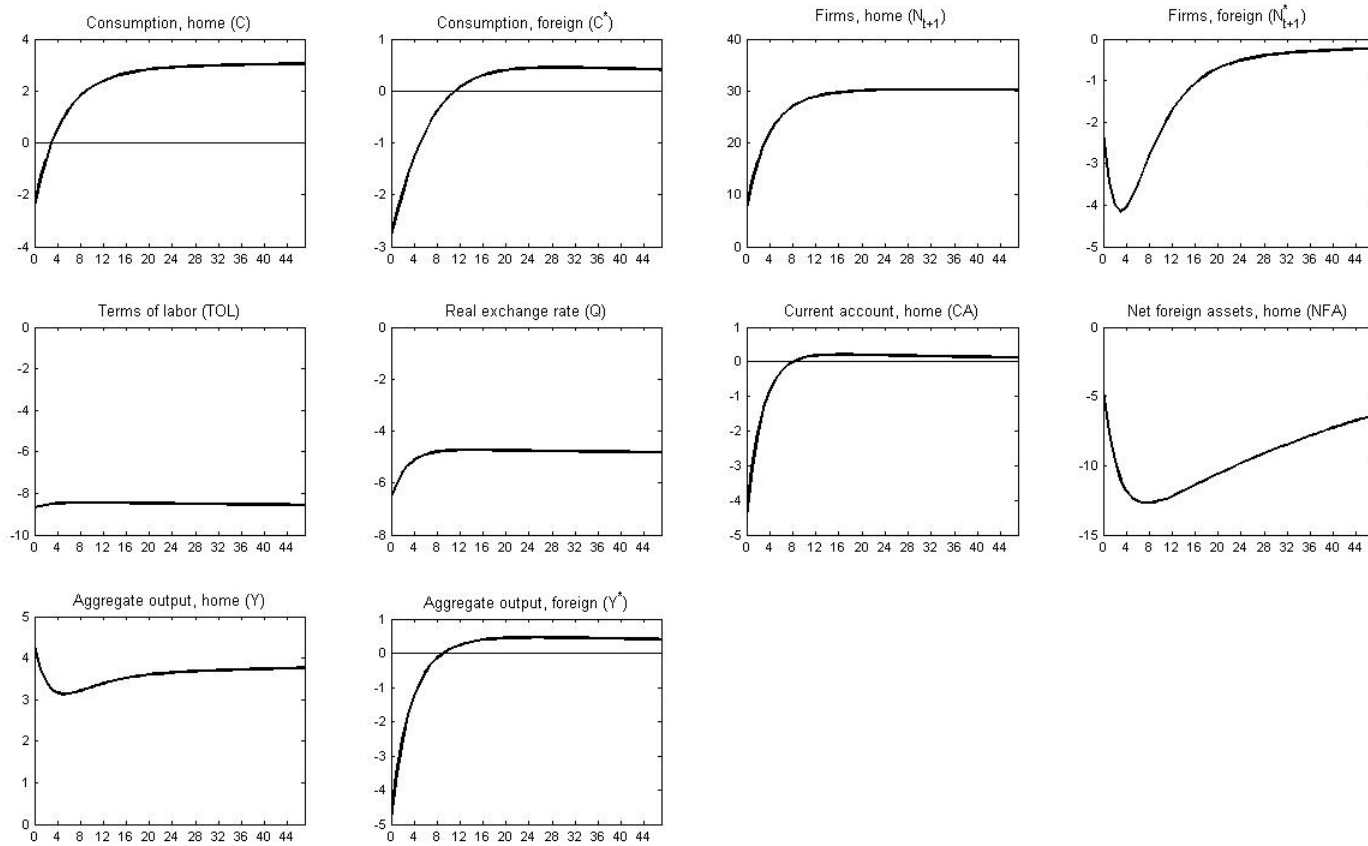


Figure 2. Banking Deregulation with International Deposits

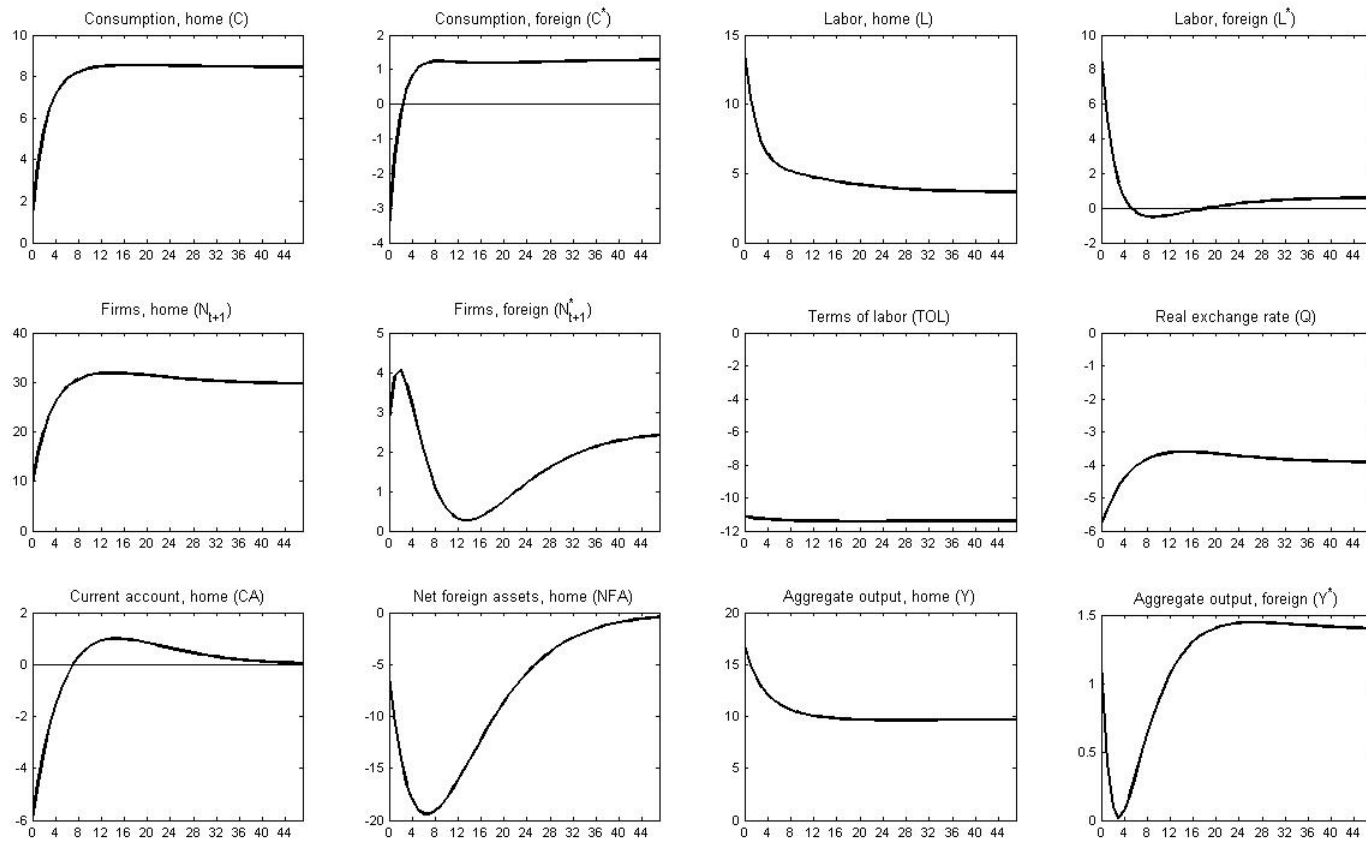


Figure 3. Banking Deregulation with Elastic Labor and Endogenous Firm Markups

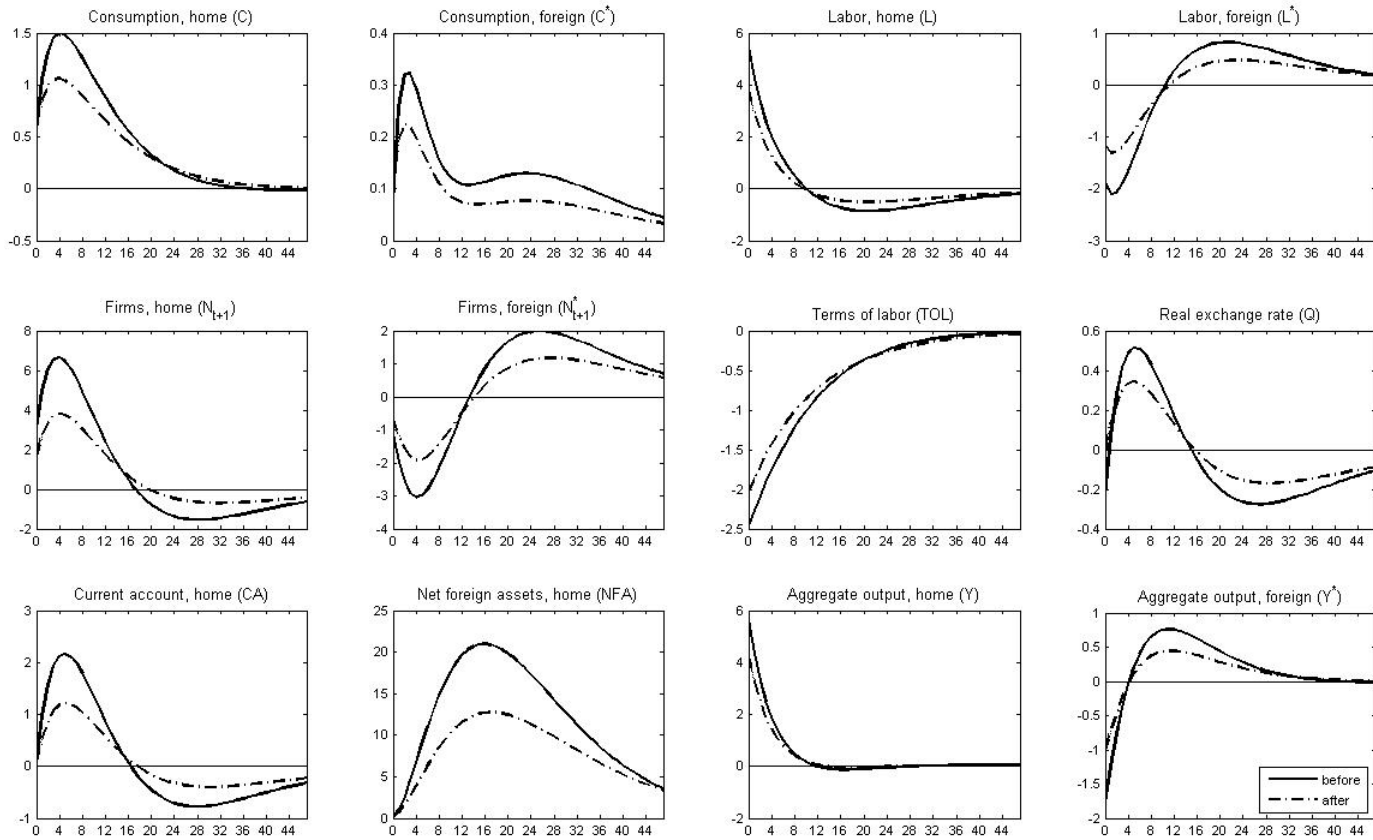


Figure 4. Business Cycles, Pre- and Post-Deregulation

Appendix

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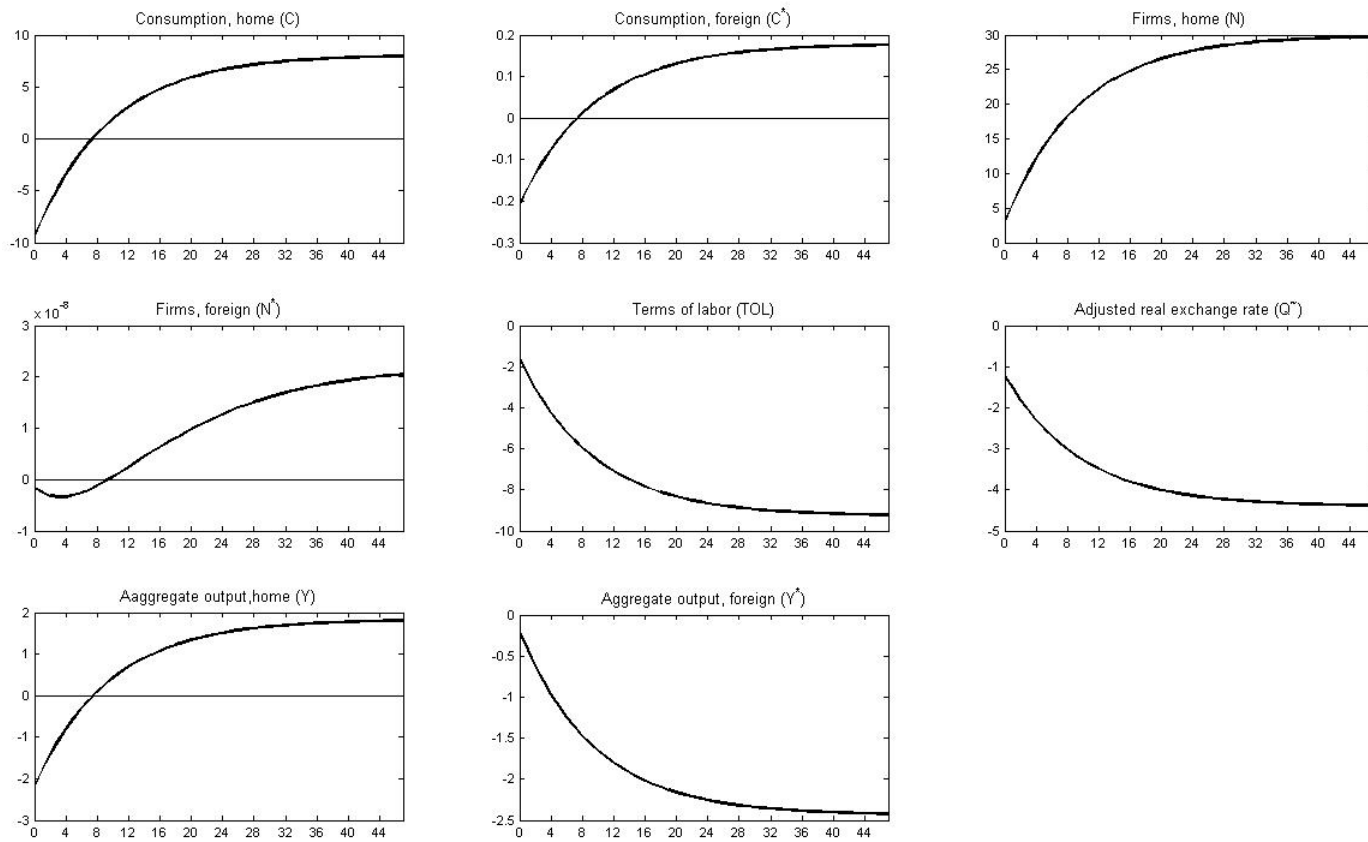


Figure A.1. Banking Deregulation under Financial Autarky, Home Bias Model

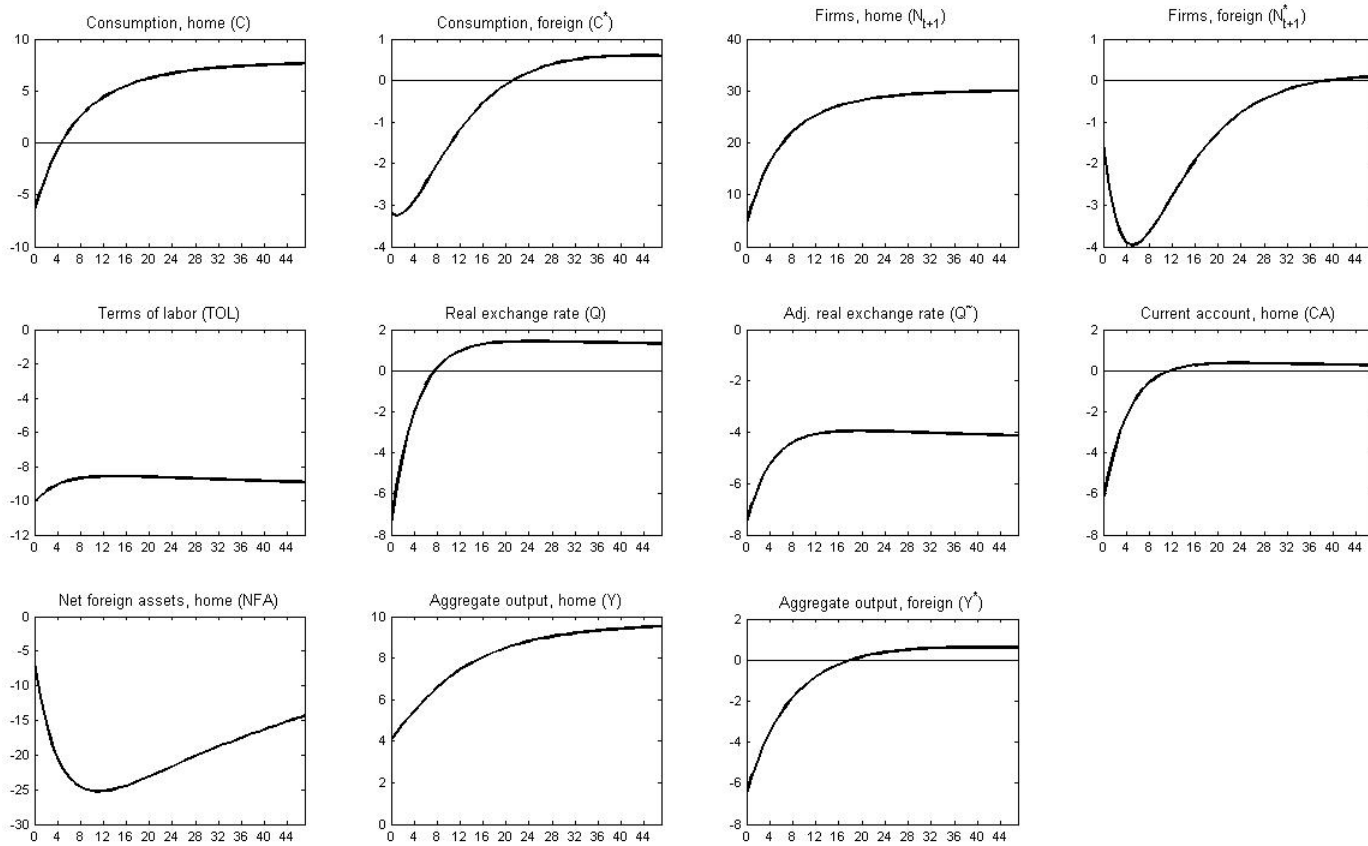


Figure A.2. Banking Deregulation with International Deposits, Home Bias Model

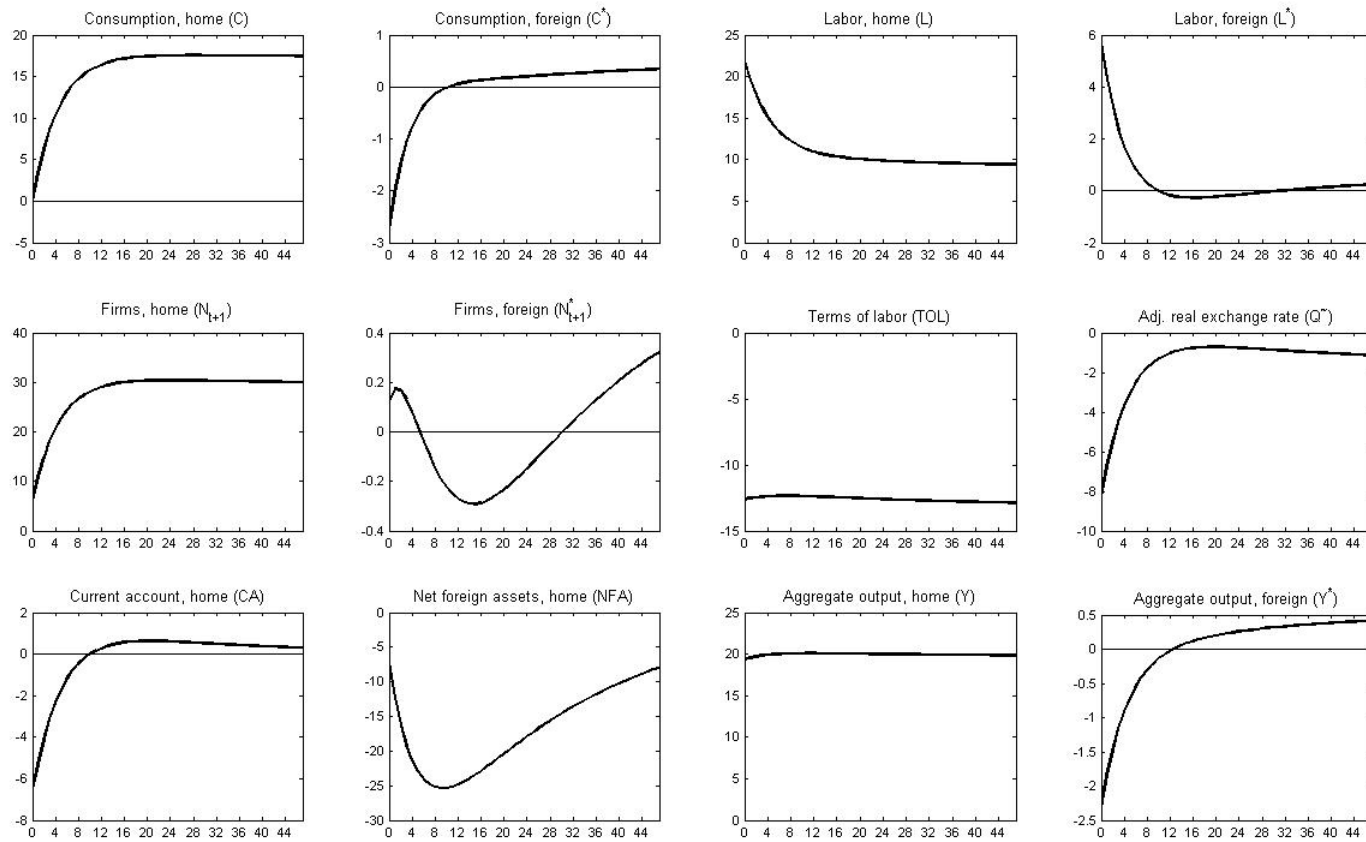


Figure A.3. Banking Deregulation with Elastic Labor and Endogenous Firm Markups, Home Bias Model

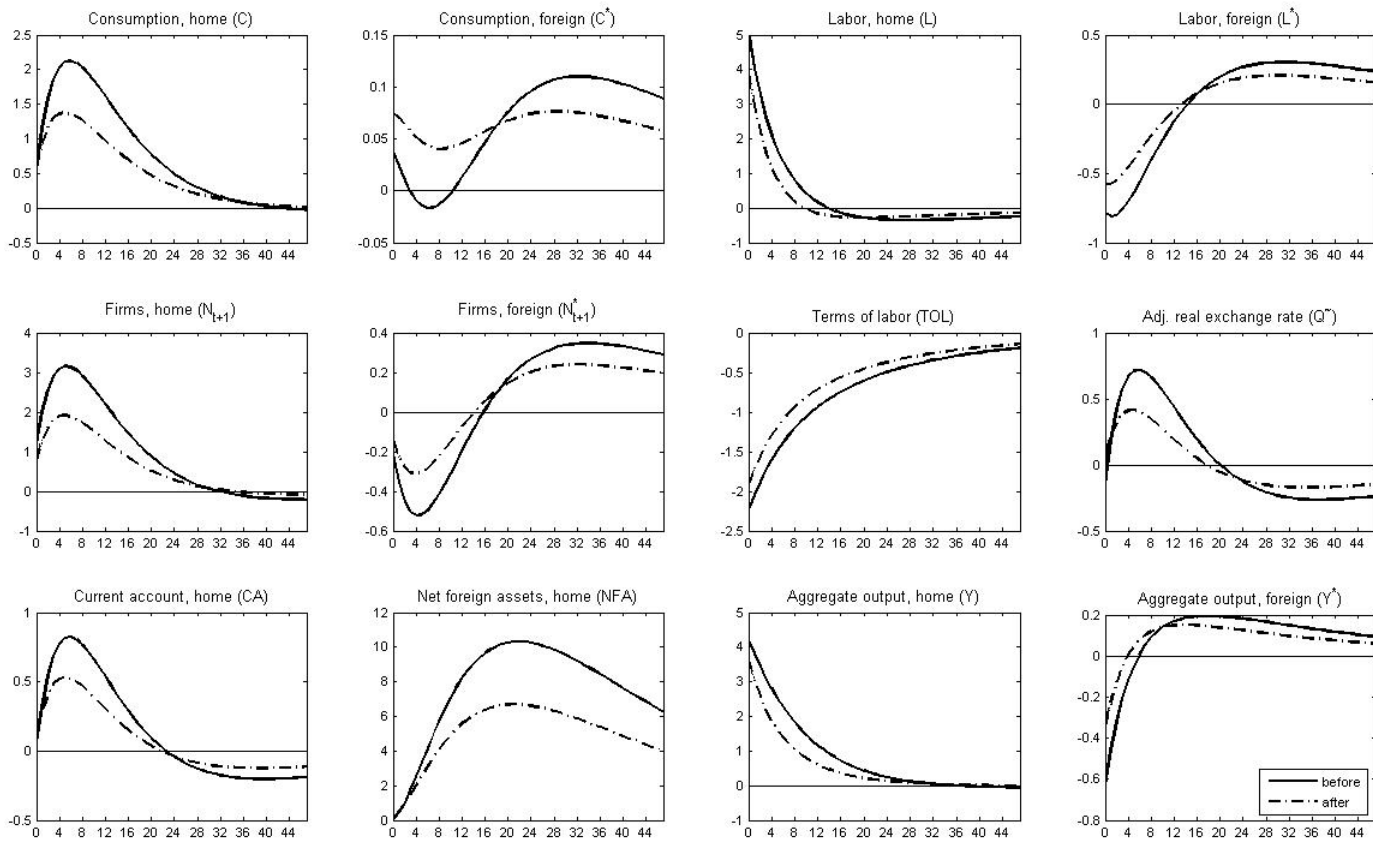


Figure A.4. Business Cycles, Pre- and Post-Deregulation, Home Bias Model