International Competitiveness and Monetary Policy

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October 9, 2014

PRELIMINARY. NOT FOR QUOTE.

Abstract

A classic question in open macro concerns the contribution of monetary and exchange rate policy to a country's international competitiveness. We bring a new perspective on this question by developing an open macro model showing that effective macroeconomic stabilization policies promote a country's comparative advantage in differentiated manufacturing sectors. In each country there are two sectors producing tradables. In one sector, firms operate under perfect competition. In the other, firms produce differentiated goods under monopolistic competition subject to sunk entry costs and nominal rigidities, hence their performance is more sensitive to macroeconomic uncertainty. Monetary stabilization fosters the competitiveness of these firms, encouraging investment and entry in the differentiated goods sector. Conversely, lack of stabilization tends to skew the endogenous specialization away from it. Based on exports to the US by country in the period 1972-2004, we provide empirical evidence consistent with our theoretical predictions.

Keywords: international coordination, monetary policy, production location externality, firm entry, optimal tariff
JEL classification: F41

We thank our discussant Matteo Cacciatore and Hélène Rey, as well as Mary Ammiti, Giovanni Maggi, Sam Kortum and seminar participants at the 2013 NBER Summer Institute, the 2013 International Finance and Macro Finance Workshop at Sciences Po Paris, the 2013 Norges Bank Conference The Role of Monetary Policy Revisited, the 2014 ASSA meetings, the 2014 West Coast Workshop on International Finance and Open Economy Macroeconomics, Bank of England, Bank of Spain, London Business School, New York FED the National University of Singapore, Universidade Nova de Lisboa, and the Universities of Cambridge, Wisconsin, and Yale for comments. We thank Yuan Liu, Riccardo Trezzi and Jasmine Xiao for excellent research assistance. Giancarlo Corsetti acknowledges the generous support of the Keynes Fellowship at Cambridge University, the Cambridge Inet Institute and Centre for Macroeconomics.
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1. Introduction

This paper aims to bring a new perspective on how monetary and exchange rate policy may affect a country's international competitiveness. Conventional models in the Keynesian tradition emphasize the competitive gains from currency devaluation, as a way to lower the relative cost of production and the international price of domestic goods, over the span of time that wages and prices are sticky in local currency. More recent contributions to the New Open Macro Macroeconomics and new-Keynesian tradition, however, also stress that monetary policy can exploit a country's monopoly on its terms of trade. As this typically means pursuing a higher international price of home goods, the policy objective appears to be the opposite of improving competitiveness.[1] Differently from either approach, we call attention to the implications of monetary and exchange rate regimes for a country's comparative advantage in differentiated manufacturing goods.

We motivate our analysis with the observation that monetary policy aimed at stabilizing marginal costs and demand conditions at an aggregate level (weakening or strengthening the exchange rate in response to cyclical disturbances) is likely to have asymmetric effects across sectors. These effects can be expected to be more consequential in industries where firms face higher up-front investment to enter the market and price products subject to nominal rigidities---features typically associated with differentiated manufacturing goods. To the extent that monetary policy ensures domestic macroeconomic stability, it creates favorable conditions for firms' entry in such industries, with long-lasting effects on their competitiveness, up to increasing their weigh in domestic output and exports

At a theoretical level, we contribute a stochastic general-equilibrium monetary model of open economies with incomplete specialization across two tradable sectors. In one sector, conventionally identified with manufacturing, firms produce an endogenous set of

[1] In virtually all contributions to the new-open economy macroeconomics and New-Keynesian literature, the trade-off between output gap and exchange rate stabilization is mainly modeled emphasizing a terms-of-trade externality (see Obstfeld and Rogoff (2000) and Corsetti and Pesenti (2001,2005), Canzoneri et al. (2005) in the NOEM literature, as well as Benigno and Benigno (2003), and Corsetti et al. (2010) in the New-keynesian literature, among others). Provided the demand for exports and imports is relatively elastic, an appreciation of the terms of trade of manufacturing allows consumers to substitute manufacturing imports for domestic manufacturing goods, without appreciable effects in the marginal utility of consumption, while reducing the disutility of labor. The opposite is true if the trade elasticity is low.

differentiated varieties operating under imperfect competition; in the other sector, firms produce highly substitutable, non-differentiated goods under perfect competition. One key distinction between these sectors is that establishing a differentiated product requires a sunk entry investment, which does not apply to nondifferentiated goods producers. A second key distinction is that nominal rigidities are relevant only for the differentiated producers, who have some monopoly power and therefore are able to set their product prices.

A fundamental result from the model is that efficient stabilization rules lowers the average relative price of a country's differentiated goods in terms of its nondifferentiated goods, conferring comparative advantage in the sale of differentiated goods both at home and abroad. Underlying this result is a transmission channel at the core of modern monetary literature: in the presence of nominal rigidities, uncertainty implies the analog of a risk premium in a firm's prices, depending on the covariance of demand and marginal costs (See Obstfeld and Rogoff 2000, Corsetti and Pesenti 2005 and more recently Fernandez-Villaverde et al. 2011). We show that, by affecting this covariance, and thus the variability of the ex-post markups, monetary policy contributes to manufacturing firms setting low, competitive prices *on average,* with a positive demand externality affecting the size of the market. A larger market in turn strengthens the incentive for new manufacturing firms to enter, see e.g., Bergin and Corsetti (2008) and Bilbiie, Ghironi and Melitz (2008). We derive a key testable implication of the theory: everything else equal, countries with a reduced ability to stabilize macro shocks will tend to specialize away from differentiated manufacturing goods, relative to the countries that use their independent monetary policy to pursue inflation and output gap stabilization. We calibrate our model based on novel estimates of the TFP process for differentiated and non-differentiated sectors in the US vis-à-vis an aggregate of European countries. For our baseline calibration, we find that the unconditional mean of the share of a country's exports in differentiated goods falls by more than 1 percentage point, if a country replaces optimal monetary rules with a unilateral peg, implying inefficient output gap stabilization.

At an empirical level, we contribute novel empirical evidence on the key prediction of the model, by conducting panel regressions of the composition of exports to the U.S. by country, on indicators of domestic monetary stabilization (or lack thereof), namely, dummies for the exchange rate and/or monetary regime of that country. The regression model includes country and year fixed effects, to account for the determinants of comparative advantage, as well as a number of controls to account for macroeconomic and financial factors that may weigh on a country's exports: the real exchange rate, the current account balance, currency and banking crisis dummies, as well as an index of capital account liberalization.

We find that a peg does reduce the share of differentiated goods in a country's exports. This result is robust to changing the reference sample (e.g. to excluding oil exports and oil exporting countries), as well as to adopting alternative classifications of the exchange rate regime, and/or of instruments designed to control for the endogeneity of a peg. The point estimate of this effect is in the range between 2 and 6 percentage points. By the same token, we find that adopting an inflation-targeting regime raises the differentiated-good share a similar amount. We should stress here that our study is entirely distinct from the macroeconomic literature on the effects of exchange rate volatility on the volume of exports; we instead provide theoretical arguments and evidence that exchange rate and monetary regimes have appreciable effects on the *composition* of exports by types of good.

In line with well-known contributions to the NOEM and NK literature,[3] our model suggests that efficient stabilization affects a country's terms of trade. The underlying mechanism, however, is distinct. The NOEM and NK literature appeals to a terms-of-trade externality and the (monetary-analog) of the optimal tariff argument. While a terms of trade externality is also present in our model, our main result actually rests on a change in the composition of exports. Namely, by lowering average markups in the manufacturing sector, stabilization policy fosters the production of high value-added goods. As the average supply of these goods rises, their share in export increases, more than offsetting any fall in manufacturing

[3] Our theory has implications for the analysis of cross-border policy cooperation. Namely, the impact of monetary policy on trade and production patterns creates welfare incentives to deviate from monetary rules that are efficient from a global perspective, defining a policy game over comparative advantages. While related to the NOEM literature studying strategic policy and coordination (see the discussion in Corsetti et al. 2010), the mechanism producing gains from cooperation in our model is different.

prices.[4] From the perspective of trade theory, our analysis is related to leading work on tariffs by Ossa (2011), also lending theoretical support to the competitiveness argument. This paper, like ours, models a country's comparative advantage drawing on the literature on the 'home market effect' after Krugman (1980), implying production relocation externalities associated with the expansion of manufacturing.[6]

The text is structured as follows. The next section describes the model. Section 3 derives some analytical results for a special case, and section 4 uses stochastic simulations to demonstrate a broader set of implications Section 5 presents empirical evidence in support of the theory. Section 6 concludes.

2. Model

In what follows, we develop a two-country DSGE monetary model, with a key novel element, in the way we specify the goods market structure. Namely, each country—home and foreign--- produce two types of tradable goods. The first type of good comes in differentiated varieties produced under monopolistic competition. This is the market where firms face entry costs and nominal rigidities. The second type of good is produced by perfectly competitive firms, and is modeled according to the standard specification in real business cycle models. For this good, there is perfect substitutability among producers within a country (indeed, the good is produced under perfect competition), but imperfect substitutability across countries, as summarized by an Armington elasticity.

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[6] According to the 'home market effects', the size of the market (i.e. a high demand) is a source of comparative advantage in manufacturing In this literature, the social benefits from gaining comparative advantage in the manufacturing sector stem from a 'production relocation externality.' In the presence of such externality, acquiring a larger share of the world production of differentiated goods produces welfare gains due to savings on trade costs. Our work is also related to Corsetti et. al (2007), which considers the role of the home market effect in a real trade model, as well as Ghironi and Melitz (2005). We differ in modeling economies with two tradable sectors, as well as considering the implications of price stickiness and monetary policy.

2.1. Goods market structure

Households consume goods from two sectors. The *D* sector consists of differentiated goods, which are produced by *n* and *n** monopolistically competitive firms in the home and foreign country, respectively---from now on, foreign variables will be denoted with an asterisk *. The *N* sector consists of non-differentiated goods, produced by perfectly competitive firms. The home and foreign versions of the *N* and D good are imperfect substitutes for each other, with elasticity ϕ and η, respectively. For convenience, hereafter we may refer to the first sector as 'manufacturing', rather than differentiated manufacturing, although it should be clear that manufacturing goods may fall in either class.

The overall consumption index is specified:

$$C_t \equiv C_{D,t}^{\theta} C_{N,t}^{1-\theta},$$

where

$$C_{D,t} \equiv \left(\int_0^{n_t} c_t(h)^{\frac{\phi-1}{\phi}} dh + \int_0^{n_t^*} c_t(f)^{\frac{\phi-1}{\phi}} df \right)^{\frac{\phi}{\phi-1}}$$

is the index over the home and foreign varieties of manufacturing good, $c(h)$ and $c(f)$, and

$$C_{N,t} \equiv \left(\nu^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + (1-\nu)^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

is the index over goods differentiated only by country of origin, with ν accounting for the weight on domestic goods. The corresponding consumption price index is

$$P_t \equiv \frac{P_{D,t}^{\theta} P_{D,t}^{1-\theta}}{\theta^{\theta}(1-\theta)^{1-\theta}}, \tag{1}$$

where

$$P_{Dt} = \left(n_t p_t(h)^{1-\phi} + n_t^* p_t(f)^{1-\phi} \right)^{\frac{1}{1-\phi}} \tag{2}$$

is the index over the prices of all varieties of home and foreign manufacturing goods, and

$$P_{Nt} = \left(\nu P_{Ht}{}^{1-\eta} + (1-\nu) P_{Ft}{}^{1-\eta} \right)^{\frac{1}{1-\eta}} \tag{3}$$

is the index over the prices of home and foreign non-differentiated goods.

These definitions imply relative demand functions for domestic residents:

$$c_t(h) = \left(p_t(h) / P_{Dt} \right)^{-\phi} C_{Dt} \tag{4}$$

$$c_t(f) = \left(p_t(f) / P_{Dt} \right)^{-\phi} C_{Dt} \tag{5}$$

$$C_{Dt} = \theta P_t C_t / P_{Dt} \tag{6}$$

$$C_{Nt} = (1-\theta) P_t C_t / P_{Nt} . \tag{7}$$

$$C_{Ht} = \nu \left(P_{Ht} / P_{Nt} \right)^{-\eta} C_{Nt} \tag{8}$$

$$C_{Ft} = (1-\nu) \left(P_{Ft} / P_{Nt} \right)^{-\eta} C_{Nt} \tag{9}$$

2.2. Home household problem

The representative home household derives utility from consumption (*C*), and from holding real money balances (*M/P*); it derives disutility from labor (*l*). The household derives income by selling labor at the nominal wage rate (*W*); it receives real profits from home firms $\left(\pi(h) \right)$, and interest income on holding domestic bonds (i*B*), which are in zero net supply. It pays lump-sum taxes (*T*). In our baseline specification of the model, we assume incomplete markets and impose no international trade in assets---an assumption relaxed in our robustness analysis and the appendix.

Household optimization for the home country may be written:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U\left(C_t, l_t, \frac{M_t}{P_t} \right)$$

where utility is defined by

$$U_t = \frac{1}{1-\sigma} C_t^{1-\sigma} + \ln \frac{M_t}{P_t} - \frac{1}{1+\psi} l_t^{1+\psi} ,$$

subject to the budget constraint:

$$P_tC_t = W_tl_t + \int_0^n \pi_t(h)\,dh - W_t\theta_tK_t + M_t - M_{t-1} + B_t - (1+i_{t-1})B_{t-1} - T_t.$$

Above, σ denotes risk aversion and ψ (the inverse of) the Frisch elasticity. Defining $\mu_t = P_tC_t^{\sigma}$, optimization implies an intertemporal Euler equation:

$$\frac{1}{\mu_t} = \beta(1+i_t)E_t\left[\frac{1}{\mu_{t+1}}\right] \tag{10}$$

a labor supply condition:

$$W_t = L_t^{\psi}\mu_t \tag{11}$$

and a money demand condition:

$$M_t = \chi\mu_t\left(\frac{1+i_t}{i_t}\right). \tag{12}$$

The problem and first order conditions above are analogous for the foreign household.

2.3. Home firm problem and export entry condition

In the differentiated goods sector, production is linear in labor:

$$y_t(h) = \alpha_{Dt}l_t(h), \tag{13}$$

where $l(h)$ is the labor employed by firm h, and α_D is stochastic technology common to all production firms in the country. Exports involve an iceberg trade cost, τ_D, so that

$$y(h) = d_t(h) + (1+\tau_D)d_t^*(h), \tag{14}$$

where $d_t(h) = c_t(h) + d_{AC,t}(h) + d_{K,t}(h)$ is total demand for the product in the home country, for use in consumption, adjustment costs, and entry costs, respectively; $d_t^*(h)$ is the corresponding demand for home goods abroad. Firm profits are computed as:

$$\pi_t(h) = p_t(h)d_t(h) + e_tp_t^*(h)d_t^*(h) - W_ty_t(h)/\alpha_t - AC_{p,t}(h). \tag{15}$$

There is free entry into the sector with a one-period lag subject to a one-time sunk cost. It is assumed that a fraction δ of all firms must exogenously exit each period. Let n_t represent the number of firms, and define new entrants to the export market, ne_t. By the flow condition:

$$n_{t+1} = (1-\delta)(n_t + ne_t)\,. \tag{16}$$

The value function of firms that enter period *t* may be represented as the discounted sum of profits of domestic sales and export sales,

$$v_t(h) = E_t\left\{\sum_{s=0}^{\infty}\left(\beta(1-\delta)\right)^s \frac{\mu_{t+s}}{\mu_t}\pi_{t+s}(h)\right\}.$$

Firms enter until the point that firm value equals the entry sunk cost, composed of a fixed proportion of labor units (θ_K) and differentiated goods units (1- θ_K).

$$v_t(h) = \left(\theta_K W_t + (1-\theta_K)P_{Dt}\right)K_t\,. \tag{17}$$

The goods portion of entry cost uses a composite of differentiated goods, following the consumption index:

$$d_{K,t}(h) = \left(p_t(h)/P_{Dt}\right)^{-\phi}(1-\theta_K)ne_t K_t \tag{18}$$

$$d_{Kt}(f) = \left(p_t(f)/P_{Dt}\right)^{-\phi}(1-\theta_K)ne_t K_t\,. \tag{19}$$

The home firm *h* sets a price *p(h)* in domestic currency units for domestic sales. Under the assumption of producer currency pricing, this implies a foreign currency price

$$p^*{}_t(h) = (1+\tau_M)\,p_t(h)/e_t\,, \tag{20}$$

where the nominal exchange rate, *e*, is defined as home currency units per foreign currency unit. Firms face a nominal cost of adjusting prices

$$AC_t(h) = \frac{\psi_P}{2}\left(\frac{p_t(h)}{p_{t-1}(h)} - 1\right)^2 p_t(h)\,y_t(h)\,. \tag{21}$$

For the sake of tractability, we follow Bilbiie et. al (2008) in making the simplifying assumption that new firm entrants inherit from the price history of incumbents the same price adjustment cost, and so make the same price setting decision. The aggregate value of adjustment costs are:

$$AC_t(h) = n_t AC_t(h)\,. \tag{22}$$

The adjustment cost uses final goods, and the composition follows that assumed for consumers in equation (4)-(9):

$$d_{AC,t}(h) = \left(p_t(h)/P_{Mt}\right)^{-\phi} D_{AC,Dt} \tag{23}$$

$$d_{ACt}(f)=\left(p_t(f)/P_{Mt}\right)^{-\phi}D_{AC,Dt} \tag{24}$$

$$D_{AC,Mt} = \theta P_t AC_t / P_{Dt} \tag{25}$$

$$D_{AC,Nt}=(1-\theta)P_t AC_t/P_{Nt} \tag{26}$$

$$D_{AC,Ht}=\nu\left(P_{Ht}/P_{Nt}\right)^{-\eta}D_{AC,Nt} \tag{27}$$

$$D_{AC,Ft}=(1-\nu)\left(P_{Ft}/P_{Nt}\right)^{-\eta}D_{AC,Nt}. \tag{28}$$

Maximizing firm value subject to the constraints above leads to the price setting equation:

$$\begin{aligned} p_t(h)=&\frac{\phi}{\phi-1}\frac{W_t}{\alpha_t}+\frac{\psi_P}{2}\left(\frac{p_t(h)}{p_{t-1}(h)}-1\right)^2 p_t(h)-\psi_P\frac{1}{\phi-1}\left(\frac{p_t(h)}{p_{t-1}(h)}-1\right)\frac{p_t(h)^2}{p_{t-1}(h)}\\ &+\frac{\beta\psi_P}{\phi-1}E_t\left[\frac{\mu_t}{\mu_{t+1}}\frac{\Omega_{t+1}}{\Omega_t}\left(\frac{p_{t+1}(h)}{p_t(h)}-1\right)\frac{p_{t+1}(h)^{2-\phi}}{p_t(h)^{1-\phi}}\right]\end{aligned} \tag{29}$$

where the optimal pricing is a function of the average price of world manufacturing:

$$\begin{aligned}\Omega_{t+1}=&P_{M,t+1}{}^{\phi}\left(C_{D,t+1}+D_{AC,Dt+1}+(1-\theta_K)ne_tK_t\right)\\ &+(1+\tau_D)^{1-\phi}\left(e_{t+1}P^*{}_{M,t+1}\right)^{\phi}\left(C^*{}_{D,t+1}+D^*{}_{AC,Dt+1}+(1-\theta_K)ne_t^*K^*{}_t\right).\end{aligned}$$

In the second sector firms are assumed to be perfectly competitive in producing a good differentiated only by country of origin. The production function for the home non-differentiated good is linear in labor:

$$y_{H,t}=\alpha_{H,t}l_{H,t}, \tag{30}$$

where $\alpha_{H,t}$ is subject to shocks. It follows that the price of the homogeneous goods in the home market is equal to marginal costs:

$$p_{H,t}=W_t/\alpha_{H,t}. \tag{31}$$

An iceberg trade cost specific to the non-differentiated sector implies prices of the home good abroad are

$$p^*_{H,t}=p^*_{H,t}\left(1+\tau_N\right)/e_t. \tag{32}$$

Analogous conditions apply to the foreign non-differentiated sector.

2.4. Government

The model abstracts from public consumption expenditure, so that the government uses seigniorage revenues and taxes to finance transfers, assumed to be lump sum. The home government faces the budget constraint:

$$M_t - M_{t-1} + T_t = 0. \tag{33}$$

In the home country, monetary authorities are assumed to pursue an independent monetary policy, approximated by the following Taylor rule:

$$1 + i_t = \left(1 + \bar{i}\right)\left(\frac{p_t(h)}{p_{t-1}(h)}\right)^{\gamma_p}\left(\frac{Y_t}{\bar{Y}}\right)^{\gamma_Y}. \tag{34}$$

In this rule, inflation is defined in terms of differentiated goods producer prices, while Y is a measure of output defined as:

$$Y_t = \left(\int_0^{n_t} p_t(h)\, y_t(h)\, dh + p_{Ht} y_{Ht}\right) / P_t.$$

In running the model, we will use either the above or a narrower definition of output, including only manufacturing. Given our calibration of the Taylor rule, with a high coefficient on inflation, this will be immaterial for our results. In the foreign country, monetary authorities are assumed to pursue either a Taylor rule similar to (34) or, alternatively, an exchange rate peg:

$$e_t = \bar{e}. \tag{35}$$

2.5. Market clearing

The market clearing condition for the manufacturing goods market is given in equation (14) above. Market clearing for the non-differentiated goods market requires:

$$y_{H,t} = C_{H,t} + C^*_{H,t} + D_{AC,H,t} + D^*_{AC,H,t} \tag{36}$$

$$y_{F,t} = C_{F,t} + C^*_{F,t} + D_{AC,F,t} + D^*_{AC,F,t}. \tag{37}$$

Labor market clearing requires:

$$\int_0^{n_t} l_t(h)\, dh + l_{H,t} + \theta n e_t K_t = l_t. \tag{38}$$

Bond market clearing requires:

$$B_t = 0. \tag{39}$$

Under the assumption of no trade in assets in our baseline model, international trade in goods must be balanced period by period. Balance of payments in this case requires:

$$\begin{aligned}&\int_0^{n_t} p_t^*(h)\left(c_t^*(h)+d_{Kt}^*(h)+d_{AC,t}^*(h)\right)dh-\int_0^{n_t^*} p_t(f)\left(c_t(f)+d_{Kt}(f)+d_{AC,t}(f)\right)df\\&+P_{Ht}^*\left(C_{Ht}^*+D_{AC,H,t}^*\right)-P_{Ft}\left(C_{Ft}+D_{AC,F,t}\right)=0.\end{aligned} \tag{40}$$

In our simulations and the appendix, we will also solve the model allowing for trade in a non-contingent trade, or in a complete set of Arrow-Debreu securities.

2.6. Shocks process and equilibrium definition

The productivity shocks follow the joint log normal distribution:

$$\begin{bmatrix}\log\alpha_{Dt}-\log\overline{\alpha_D}\\ \log\alpha_{Dt}^*-\log\overline{\alpha_D}^*\\ \log\alpha_{Ht}-\log\overline{\alpha_H}\\ \log\alpha_{Ft}-\log\overline{\alpha_F}\end{bmatrix}=\rho\begin{bmatrix}\log\alpha_{Dt-1}-\log\overline{\alpha_D}\\ \log\alpha_{Dt-1}^*-\log\overline{\alpha_D}^*\\ \log\alpha_{Ht-1}-\log\overline{\alpha_H}\\ \log\alpha_{Ft-1}-\log\overline{\alpha_F}\end{bmatrix}+\varepsilon_t$$

With the covariance matrix $E\left[\varepsilon_t\varepsilon_t^{'}\right]=\Omega$.

A competitive equilibrium for the world economy presented above is defined along the usual lines, as a set of processes for quantities and prices in the Home and Foreign country satisfying: (i) the household and firms optimality conditions; (ii) the market clearing conditions for each good and asset, including money; (iii) the appropriate resource constraints—whose specification can be easily derived from the above and is omitted to save space.

2.7. Relative price and export share measures

Along with the *real exchange rate* ($e_tP_t^*/P_t$), we report two alternative measures of international prices. First, as common practice in the production of statistics on international relative prices, we compute the terms of trade weighting goods with their respective expenditure shares:

$$TOTS_t \equiv \frac{\omega_{Ht} p(h)_t + \left(1-\omega_{Ht}\right) p_{H,t}}{\omega_{Ft} e_t p^*(f)_t + \left(1-\omega_{Ft}\right) e_t p^*_{F,t}}, \tag{41}$$

where the weight ω_{Ht} measures the share of differentiated goods in the home country's overall exports:

$$\omega_{Ht} \equiv \frac{p^*{}_t(h) n_{t-1}\left(c^*{}_t\left(h\right) + d^*{}_{Kt}\left(h\right) + d^*{}_{AC,t}\left(h\right)\right)}{p^*_t(h) n_{t-1}\left(c^*{}_t\left(h\right) + d^*{}_{Kt}\left(h\right) + d^*{}_{AC,t}\left(h\right)\right) + P^*{}_{Ht}\left(C^*{}_{Ht} + D^*{}_{AC,H,t}\right)}, \tag{41a}$$

and ω_{Ft} measures the counterpart for the foreign country:

$$\omega_{Ft} \equiv \frac{p_t(f) n^*_{t-1}\left(c_t\left(f\right) + d_{Kt}\left(f\right) + d_{AC,t}\left(f\right)\right)}{p_t(f) n^*_{t-1}\left(c_t\left(f\right) + d_{Kt}\left(f\right) + d_{AC,t}\left(f\right)\right) + P_{Ft}\left(C_{Ft} + D_{AC,F,t}\right)}. \tag{41b}$$

Since the share of differentiated goods in a country's overall exports is readily available in data, we will report values for ω_{Ht} and ω_{Ft} generated in our simulations, as they provide a useful means for comparing model implications to data. Following the trade literature, we also compute the terms of trade as the ratio of ex-factory prices set by home firms relative to foreign firms in the manufacturing sector: $TOTM_t \equiv p_t(h)/\left(e_t p^*_t(f)\right)$.[7] This measure ignores the non-differentiated good sector.

3. Analytical Insights from a Simple Version of the Model

The main goal of this section is to clarify the mechanism by which macro uncertainty about demand and marginal costs impinges on pricing by differentiated good manufactures ultimately determining the country's comparative advantage in the sector. To pursue this goal, we will work out a simplified version of the model that is amenable to analytical results. Despite a number of assumptions needed to make the model tractable, we will be able to derive key predictions that remain valid in our more general model specification.

[7] This is the same definition used in Ossa (2011), though in our case it does not imply the terms of trade are constant at unity, because monetary policy does affect factory prices. See also Helpman and Krugman (1989), and Campolmi et al. (2014).

We specialize our general model as follows. First, we posit that manufacturing firms operate for one period only (implying $\delta = 1$ in the entry condition), and symmetrically preset prices over the same horizon. Entry costs are in labor units only, i.e., $\theta_K=1$. Second, we simplify the non-differentiated good by setting its trade costs to zero ($\tau_N = 0$) and let the elasticity substitution between home and foreign goods approach infinity ($\eta \to \infty$). This implies that the sector produces a homogeneous good, an assumption frequently made in the trade literature.[8] Third, we limit productivity shocks in the Differentiated good sector to the i.i.d. case, and abstract from productivity shocks in the Non-differentiated good sector. Fourth, we assume that utility is log in consumption and linear in leisure. Finally, in the NOEM literature (see Corsetti and Pesenti 2005 and Bergin and Corsetti 2008), monetary policy has been modeled by treating $\mu = PC$ as the exogenous monetary stance, under the control of monetary authorities via their ability to set the interest rate. Following this approach, we therefore express monetary policy in terms of μ (and μ^* for the foreign country), instead of the interest rate rule (34).

Under these assumptions, the firms' problem becomes

$$\max_{p_{t+1}(h)} = E_t\left[\beta \frac{\mu_t}{\mu_{t+1}} \pi_{t+1}(h)\right].$$

where $\mu_t = P_t C_t$. The optimal preset price in the domestic market is:

$$p_{t+1}(h) = \frac{\phi}{\phi - 1} \frac{E_t\left[\Omega_{t+1}\left(\frac{\mu_{t+1}}{\alpha_{t+1}}\right)\right]}{E_t\left[\Omega_{t+1}\right]}, \qquad (42)$$

where μ_{t+1}/α_{t+1} is the firm's marginal costs, that is, the ratio of nominal wages to labor productivity. The home entry condition is a function of price setting and the exchange rate:

$$\frac{K_t}{\beta\theta} = E_t\left[\left(p_{t+1}(h) - \frac{\mu_{t+1}}{\alpha_{t+1}}\right) p_{t+1}(h)^{-\phi}\, \Omega_{t+1}\right] \qquad (43)$$

where upon appropriate substitutions (detailed in the appendix) Ω_{t+1} can be written as:

[8] Different from the trade literature, however, we do treat this sector as an integral part of the (general) equilibrium allocation, e.g., exports/imports of the homogeneous good sector enters the terms of trade of the country.

$$\Omega_{t+1} = \left(n_{t+1} p_{t+1}(h)^{1-\phi} + n_{t+1}^* p_{t+1}^*(f)^{1-\phi} e_{t+1}^{1-\phi} \left(1+\tau\right)^{1-\phi} \right)^{-1}$$
$$+ \left(n_{t+1} p_{t+1}(h)^{1-\phi} + n_{t+1}^* p_{t+1}^*(f)^{1-\phi} e_{t+1}^{1-\phi} \left(1+\tau\right)^{\phi-1} \right)^{-1}.$$

Provided that the price setting rules can be expressed as functions of the exogenous shocks and the monetary stance, the home and foreign equilibrium entry conditions along with the exchange rate solution above comprise a three equation system in the three variables: *e*, *n* and *n**. This system admits analytical solutions for several configurations of the policy rules.

Before proceeding, it is worth worth noting two properties of our simplified version of the model. First, since both economies produce the same homogeneous good with identical technology under perfect competition, with no trade costs in this sector arbitrage ensures that $P_{Dt} = e_t P_{Dt}^*$. Using the labor supply condition (11) for the case of a unitary elasticity ($\psi = 0$), the exchange rate may be expressed as:

$$e_t = \frac{p_{Dt}}{p_{Dt}^*} = \frac{W_t}{W_t^*} = \frac{P_t C_t}{P_t^* C_t^*} = \frac{\mu_t}{\mu_t^*}. \tag{44}$$

As long as both economies produce the homogeneous goods, the exchange rate is thus determined through arbitrage in the perfectly competitive sector of the goods market. Given symmetric technology in labor input only, the law of one price implies that nominal wages are equalized (once expressed in a common currency) across the border. By the equilibrium condition in the labor market with an infinite labor supply elasticity, then, the exchange rate is a function of the ratio of nominal consumption demands (and hence of monetary policy stances).

Second, per effect of nominal wage equalization (due to trade in a single homogenous good whose production is not subject to shocks), production risk in our simplified economy is efficiently shared, even in the absence of trade in financial assets, and independently of the way production and trade are specified in the other sector. To wit: rewrite the above equation can be rewritten as the standard perfect risk sharing condition:

$$\frac{e_t P_t^*}{P_t} = rer_t = \frac{C_t}{C_t^*}.$$

Home consumption rises relative to foreign consumption only in those states of the world in which its relative price (i.e. the real exchange rate) is weak.

3.1. The equilibrium consequences of nominal rigidities

To gain insight on the transmission mechanism underlying our results, it is convenient to rewrite (42) as follows:

$$p_{t+1}(h)=\frac{\phi}{\phi-1}\left\{E_t\left[\left(\frac{\mu_{t+1}}{\alpha_{t+1}}\right)\right]+\frac{Cov_t\left[\Omega_{t+1}\left(\frac{\mu_{t+1}}{\alpha_{t+1}}\right)\right]}{E_t\left[\Omega_{t+1}\right]}\right\} \qquad (42')$$

The covariance term on the RHS of this expression shows that optimal preset pricing depends on the comovements of a firm's marginal costs μ_{t+1}/α_{t+1}, and the world price of manufacturing Ω_{t+1} (scaled by the expected price of world manufacturing). Since both marginal costs and the world price of manufacturing are functions of monetary stances, the effect of stabilization rules on pricing (and thus on entry) crucially hinges upon their effect on this covariance term. Assume no monetary stabilization: posit that the monetary stance is constant in either country ($\mu_t=\mu_t^*=1$), corresponding to a constant nominal exchange rate at $e_t=\mu_t/\mu_t^*=1$. Since, with i.i.d. shocks, there are no dynamics in predetermined variables such as prices and numbers of firms, we can obtain relatively simple analytical expressions. Namely, the optimal preset price is constant, and equal to expected marginal costs (coinciding with the inverse of productivity) augmented by the equilibrium markup:

$$p_{t+1}^{no\,stab}(h)=\frac{\phi}{\phi-1}E_t\left[\frac{1}{\alpha_{t+1}}\right] \qquad p_{t+1}^{*no\,stab}(f)=\frac{\phi}{\phi-1}E_t\left[\frac{1}{\alpha^*_{t+1}}\right].$$

Note that, under a constant monetary stance, these optimal pricing decisions do not depend on the term Ω (hence do not vary with trade costs and firms entry), as they do in the general case. The number of firms can be computed by substituting these prices into the entry condition (43), so to obtain:

$$n_{t+1}^{no\,stab}=n_{t+1}^{*no\,stab}=\frac{\beta\theta}{q\phi}.$$

Intuitively, for given monetary stances, there is no change in the exchange rate. With preset prices, there is no change in the terms of trade or the real exchange rate in response to shocks. There is no change in consumption demands, and in the level of production in either type of good. An i.i.d. shock lowering productivity in the home manufacturing sector necessarily leads to an increase in the level of employment in the same sector (not compensated by a change in employment in the other sectors of the economy). Firms end up producing at high marginal costs and thus suboptimally low markups, as nominal rigidities prevent them from re-pricing and scaling down production. Conversely, given nominal prices and demand, a rise in productivity will cause firms to produce too little at low marginal costs, hence at suboptimally high markups.

So, in a regime of no monetary stabilization, firms face random realization of inefficiently low and inefficiently high levels of production and markup. Managers maximize the value of their firm by raising their preset prices, trading off higher markups in the low productivity state, with lower markups in the high productivity states. In our simplified model above, it is easy to see that these preset prices are increasing in the variance of productivity shocks (by Jensen's inequality, $E_t\left[\frac{1}{\alpha_{t+1}}\right] > \frac{1}{E_t\left[\alpha_{t+1}\right]} = 1$).[9] The implications of this result for our argument are detailed next.

3.2. Prices and firms dynamics under efficient and inefficient stabilization of output gaps

Since the model posits that the homogenous good sector operates under perfect competition and flexible prices, there is no trade-off in stabilizing output across different sectors. It is therefore possible to replicate the flex-price allocation under the following simple monetary policy rule: the monetary stance in each country moves in proportion to productivity in the differentiated good sector: $\mu_t = \alpha_t, \quad \mu_t^* = \alpha_t^*$. The exchange rate in this case is not

[9] As discussed in Corsetti and Pesenti (2005) and Bergin and Corsetti (2008) in a closed economy context, given nominal demand, high preset prices allow firms to contain overproduction when low productivity squeezes markups, rebalancing demand across states of nature. High average markups, in turn, exacerbate monopolistic distortions and tend to reduce demand, production and employment on average, discouraging entry.

constant, but contingent on productivity differentials. Namely, the home currency depreciates in response to an asymmetric rise in home productivity:

$$e_t = \frac{\alpha_t}{\alpha_t^*}.$$

The active monetary policy just described affects optimal pricing by firms. By ensuring that the nominal marginal costs μ/α remain constant, the above policy ensures that the covariance term in (see (42')) is zero, thus insulating the optimal price preset by home manufacturing firms from uncertainty about productivity.[10] It follows that the price firms preset is lower than in an economy with no stabilization:

$$p_{t+1}^{stab}(h) = \frac{\phi}{\phi-1} < p_{t+1}^{no\,stab}(h) = \frac{\phi}{\phi-1} E_t\left[\frac{1}{\alpha_{t+1}}\right].$$

To the extent that monetary policy stabilizes marginal costs completely, it also stabilizes markups at their flex-price equilibrium level. In a multi-sector context, a key effect of monetary stabilization is that of reducing a country's differentiated goods' price in terms of domestic nondifferentiated goods, redirecting demand across sectors. This rise in demand for differentiated goods supports the entry of additional manufacturing firms. As shown in the appendix, the number of manufacturing firms is:[11]

$$n_{t+1}^{stab} = \frac{\beta\theta}{q\phi} E_t\left[\frac{2+\left(\frac{\alpha_{t+1}}{\alpha_t^*}\right)^{1-\phi}\left(\left(1+\tau\right)^{1-\phi}+\left(1+\tau\right)^{\phi-1}\right)\left(1+\tau\right)^{1-\phi}}{1+\left(\frac{\alpha_{t+1}}{\alpha_t^*}\right)^{1-\phi}\left(\left(1+\tau\right)^{1-\phi}+\left(1+\tau\right)^{\phi-1}\right)\left(1+\tau\right)^{1-\phi}+\left(\frac{\alpha_{t+1}}{\alpha_{t+1}^*}\right)^{2(1-\phi)}}\right]$$

the same as under flexible prices. The above generalizes to our setup a familiar result of the classical NOEM literature (without entry) assuming that prices are sticky in the currency of the

[10] As is well understood, the policy works as follows: in response to a incipient fall in domestic marginal costs domestic demand and a real depreciation boost foreign demand for domestic product. As nominal wages rise with aggregate demand, marginal costs are completely stabilized at a higher level of production. Vice versa, by curbing domestic demand and appreciating the currency when marginal costs are rising, monetary policy can prevent overheating, driving down demand and nominal wages. Again, marginal costs are completely stabilized as a result.

[11] As discussed in the appendix, it is not possible to determine analytically whether symmetric stabilization policies raise the number of firms compared to the no stabilization case. Model simulations suggest that there is no positive effect for log utility, and a small positive effect for CES utility with a higher elasticity of substitution. Nonetheless, we are able to provide below an analytical demonstration of asymmetric stabilization, which is our main objective.

producers (Corsetti and Pesenti (2001, 2005) and Devereux and Engel (2003), among others): despite nominal rigidities, policymakers are able to stabilize the output gap relative to the natural-rate, flex-price allocation.

The analysis of a peg provides key insight on our model, and yields a key testable implication. Consider the case in which the home government fully stabilizes its output gap, while the foreign country maintains its exchange rate fixed against the home currency:

$$\mu_t = \alpha_t \text{ and } e_t = 1, \text{ so that } \mu_t^* = \mu_t = \alpha_t .$$[12]

Under the policy scenario just described, the optimally preset prices of domestically and foreign produced differentiated goods are, respectively:

$$p_{t+1}(h) = \frac{\phi}{\phi-1}, \qquad p^*_{t+1}(f) = \frac{\phi}{\phi-1} E_t\left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right].$$

While the home policy makers manage to stabilize the markup of manufacturing firms completely, the foreign firms producing under the peg regime face stochastic marginal costs/markups driven by shocks to productivity, both domestically and abroad. With i.i.d. shocks, preset prices will be increasing in the term $E_t(1/\alpha^*_{t+1})$, as in the no stabilization case.

The equilibrium number of firms *n* and *n** instead solve the following two-equation system:

$$\frac{1}{n_{t+1} + An^*_{t+1}} + \frac{1}{n_{t+1} + Bn^*_{t+1}} = \frac{q\phi}{\beta\theta}$$

$$\frac{A}{n_{t+1} + An^*_{t+1}} + \frac{B}{n_{t+1} + Bn^*_{t+1}} = \frac{q\phi}{\beta\theta}$$

where

$$A \equiv \left(E_t\left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right]\right)^{1-\phi}(1+\tau)^{1-\phi}, \quad B \equiv \left(E_t\left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right]\right)^{1-\phi}(1+\tau)^{\phi-1}.$$

While it is not possible to solve for the number of firms in closed form, the system above does allow one to prove that $n > n^{flex} > n^*$ (the proof is given in the appendix). Other things equal, the constraint on macroeconomic stabilization implied by a currency peg tends to reduce the size of

[12] A related exercise consists of assuming that the foreign country keeps its money growth constant ($\mu_t^* = 1$) while home carries out its stabilization policy as above.

the manufacturing sector in the foreign country: there are fewer firms, each charging a higher price. The home country's manufacturing sector correspondingly expands. In other words, the country pegging its currency tends to specialize in the homogeneous good sector.

To understand the mechanism: insofar as a peg results in higher markups and exacerbates monopolistic distortions in the foreign manufacturing sector, inefficient stabilization redirects demand towards the (now cheaper) non-differentiated good sector. Most crucially, as the ratio of the country's differentiated goods prices to nondifferentiated goods prices rises compared to the home country, the foreign comparative advantage in the sector weakens: domestic demand shifts towards differentiated imports from the home country. Because of higher monopolistic distortions and the higher trade costs in imports of differentiated goods, foreign consumption falls overall (in line with the predictions from the closed economy one-sector counterpart of our model, e.g., Bergin and Corsetti 2008). All these effects combined reduce the incentive for foreign firms to enter in the differentiated good sector. The country's loss of competitiveness is mirrored by a trend appreciation of its welfare-relevant real exchange rate, mainly due to the fall in varieties available to the consumers. But real appreciation is actually associated with weaker, not stronger, terms of trade. Weaker terms of trade follow from the change in the composition of foreign production and exports, with more weight attached to low value added non-differentiated goods.

The consequences of a foreign peg on the home economy are specular. The home country experiences a surge of world demand for its differentiated good production, while stronger terms of trade boost domestic consumption. More firms enter the manufacturing sector, leading to a shift in the composition of its production and exports in favor of this sector.

As a result, with a foreign country passively pegging its currency, there are extra benefits for the home country from being able to pursue stabilization policies. The home manufacturing sector expands driven by higher home demand overall, and fills part of the gap in manufacturing production no longer supplied by foreign firms. At the same time, the shifting pattern of specialization ensures that the home demand for the homogeneous good is satisfied via additional imports from foreign.

4. Numerical simulation

In this section, we evaluate the quantitative implications of our full model, by conducting stochastic simulations. Despite the many differences between the two, we will show that key results from the simple version of our model continue to hold in the general one. Namely, it will be true that, if the foreign country moves from efficient stabilization to a peg, while the home country sticks to efficient stabilization rules, (a) the foreign average markups in manufacturing will tend to increase and (b) there will be production relocation---firm entry in the foreign country will fall on average, while entry in the home country will rise on average. Correspondingly, average consumption will rise at home relative to foreign. We will also show that this relocation will be associated with an average improvements in the home terms of trade (while the home welfare-relevant real exchange rate depreciates).

We first discuss our calibration of the model, then present our main results.

4.1. Calibration

The model is calibrated for an annual frequency, to match the frequency of the data available for sectoral productivity used to calibrate our shocks. The time preferences is calibrated at $\beta = 0.96$. We calibrate risk aversion at the usual value of $\sigma = 2$. Labor supply elasticity is set at $1/\psi = 1.9$ from Hall (2009).

The price stickiness parameter is set at $\psi_p = 8.7$, which in a Calvo setting would correspond to half of firms resetting price on impact of a shocks, with 75 percent resetting their price after one year.[13] The death rate is set at $\delta = 0.1$, which is four times the standard rate of

[13] As is well understood, a log-linearized Calvo price-setting model implies stochastic difference equation for inflation of the form $\pi_t = \beta E_t \pi_{t+1} + \lambda mc_t$, where *mc* is the firm's real marginal cost of production, and where $\lambda = (1-q)(1-\beta q)/q$, with q is the constant probability that firm must keep its price unchanged in any given period. The Rotemberg adjustment cost model used here gives a similar log-linearized difference equation for inflation, but with $\lambda = (\phi - 1)/\kappa$. Under our parameterization, a Calvo probability of $q = 0.5$ implies an adjustment cost parameter of $\kappa = 8.7$. This computation is confirmed by a stochastic simulation of a permanent shock raising home differentiated goods productivity without international spillovers, which implies that price adjusts 50% of the way to its long run value immediately on impact of the shock, and 75% at one period (year in our case) after the shock.

0.025 to reflect the annual frequency. As is standard, the sunk cost of entry is normalized to the value of 1.

To calibrate the differentiated and non-differentiated sectors we draw on Rauch (1999). We choose θ so that differentiated goods represent 57 percent of U.S. trade in value.[14] The home share of non-differentiated goods is set at $\nu = 0.5$, which implies a trade share of about 30%, given the trade costs and elasticities below. To set the elasticities of substitution for the Differentiated and Non-differentiated goods we draw on the estimates by Broda and Weinstein (2006), classified by sectors based on Rauch (1999). The Broda and Weinstein (2006) estimate of the elasticity of substitution between differentiated goods varieties is ϕ=5.2 (the sample period is 1972-1988). The corresponding elasticity of substitution for nondifferentiated commodities is η = 15.3.

To calibrate trade costs, we need to think beyond costs associated with just transportation. These are often thought to be higher for commodities than for high value differentiated goods. As Rauch (1999) points out, differentiated goods involve search and matching costs, whereas commodities and goods traded on an organized exchange with a published reference price avoid such costs. Estimates are available for the tariff equivalent of language costs, with a value of 11% in Hummels (1999) or 6% in Anderson and van Wincoop (2004), so we use 8% in between. Since Obstfeld and Rogoff (2000) recommend a calibration of total trade costs at 16%, our calibration implies that half of this is due to language and matching costs, and the other half due to transportation. This implies a calibration of τ_D = 0.16 for differentiated goods, and τ_N =0.08 for non-differentiated goods.

The parameters in the home monetary policy rule are determined by the values that maximize home utility. As typically found, the optimal weight on inflation is the maximum value considered in the grid search (γ_P =1000), and the optimal value on output is γ_Y =0. The foreign country is assumed to peg its exchange rate at parity with the home country: *e*=1.

[14] Values vary by year and by whether a conservative or liberal aggregation is used. Taking an average over the three sample years and the two aggregation methods reported in Table 2 of Rauch (1999) produces an average of 0.57. Replicating this value in our steady state requires a calibration of the consumption share at θ =0.38, which compensates for the fact that trade for investment purposes (sunk cost) involves differentiated goods only.

To our knowledge, no one else who has calibrated a DSGE model with sectoral shocks distinct to differentiated and nondifferentiated goods. Annual time series of sectoral productivities are available from the Groningen Growth and Development Centre (GGDC), for the period 1980-2007. Data for the U.S. is used to calibrate shocks to the home country, and an aggregate of the EU 10 for the foreign country.[15] TFP is calculated on a value-added basis. For each country, the differentiated goods sector comprises total manufacturing excluding wood, chemical, minerals, and basic metals; the non-differentiated goods sector comprises agriculture, mining, and subcategories of manufacturing excluded from the differentiated sector. To calculate the weight of each subsector within the differentiated (or non-differentiated) sector, we use the 1995 gross value added (at current prices) of each subsector divided by the total value added for the differentiated (or non-differentiated) sector. After taking logs of the weighted series, we de-trend each series using the HP filter. Parameters ρ and Ω, reported in Table 1, are obtained from running a VAR(1) on the four de-trended series.

4.2. Simulation Results

In this subsection, we first illustrate the properties of the model, looking at the impulse responses generated by fluctuations in the productivity of the manufacturing sector. We then discuss results from stochastic simulations of a second order approximation of the model.

4.2.1 Impulse responses

We start by analyzing the dynamics of the benchmark model in response to a one standard deviation positive shock to productivity in the home country, where both countries employ efficient stabilization policy. Results are shown in Figure 1, which plots the percentage deviation from the unconditional mean of key variables of interest. As home policymakers fully stabilize the markup, they react to the shock by expanding domestic demand and depreciating the exchange rate. This policy reaction boosts the differentiated sector, in line with

[15] These EU 10 countries are AUT, BEL, DNK, ESP, FIN, FRA, GER, ITA, NLD and the UK. See http://www.euklems.net/euk08i.shtml.

its enhanced productivity. The number of firms in the sector rises. Production shifts in favor of home differentiated goods, away from nondifferentiated goods. In the foreign country, the shift in production pattern partly reflects the cross-country autocorrelation of shocks in the calibration. Since the foreign country also experiences a rise in differentiated goods productivity, the number of foreign and the volume of differentiated output also rise in this country, though by a smaller magnitude than at home where the shock originated.

To further clarify the role of the cross-country correlation of shocks, in Figure 2 we simplify the analysis by setting the cross-country elements of the shock autorcorrelation matrix equal to zero. This figure thus shows the effects of a rise in the differentiated goods productivity at home that remains asymmetric. Foreign production of differentiated goods falls (while it rises at home); conversely foreign production of nondifferentiated goods rises (while it falls at home).

The case of asymmetric policies---with the foreign country pegging its exchange rate, and the home country employing efficient stabilization policy---is shown in the next two figures. In response to a favorable shock to home differentiated-goods productivity, the behavior of home variables in Figure 3 is very similar to Figure 1. But in Figure 3, the response of the foreign variables closely resembles those of the home variables. This is because the effect of the exogenous cross-country spillover of productivity shocks compounds with the effects of the exchange rate peg. The commitment to exchange rate stability forces the foreign monetary authorities to expand money supply and demand by more, in step with the home country, providing extra stimulus to the foreign differentiated goods sector at the expense of the nondifferentiated goods sector.

Figure 4 shows the effects of a productivity shock to the differentiated sector in the country pursuing a peg (that is, foreign). Relative to the other figures, Figure 4 looks quite different. In the absence of a stabilizing policy response, manufacturing entry in the foreign economy, while positive, is an order of magnitude smaller compared to entry in the home economy in the previous figures. Likewise, the rise in foreign production of differentiated goods is much smaller and much shorter lived. Further, foreign production of nondifferentiated goods does not fall, so there is no significant shift in foreign production between sectors. We should note here that the rise in foreign differentiated goods production is mainly due to the monetary implications of cross-border spillovers of productivity. Driven by the foreign shock, productivity gains also materialize in the home country, in turn triggering an efficient (expansionary) response by the home monetary authorities. Indirectly, this allows the foreign country to expand its money supply while still maintaining its peg.

4.2.2 Unconditional means

Table 2 reports the unconditional means of key variables obtained from stochastic simulations of a second order approximation of the benchmark model. Column (1) reports the values of these means when both countries use stabilization policy, column (2) when the foreign country adopts an exchange rate peg; in column (3) we report the percent change between the previous columns, hence accounting for changes when the foreign country pursues a peg instead of inflation stabilization. Note that country means in column (1) are not completely symmetric despite symmetric policies, due to the cross-border differences in the calibrated shocks.

The simulation results fully confirm the main analytical insights from the previous section. First and foremost, when the foreign country pegs, average production of the differentiated good shifts away from the foreign country and toward the home country; the foreign country instead has higher production of the non-differentiated good. This shift in production is reflected in a 1.4 percent fall in the number of foreign differentiated goods firms, in contrast to a 1.3 percent rise at home. The share of differentiated goods in exports (ω_F) falls by 1.2% in the foreign country, while the share in the home country (ω_H) rises by 1.2%.

Second, also consistent with the transmission mechanism discussed in the previous section, what drives the foreign loss in the differentiated goods market share under a peg is the higher average markup charged by foreign producers of these goods. Note that the foreign price of differentiated goods rises relative to both wages and non-differentiated goods.

Finally, when the foreign policymakers abandons efficient stabilization policy for a peg, the foreign *terms of trade including the homogenous good, TOTS*, actually worsen. This stands in contrast with the movements in the (conventionally-defined) terms of trade including only differentiated goods, *TOTM*, which remains nearly unchanged. The contrasting behavior of the *TOTS* and TOTM is due to a composition effect: the shift in foreign export share away from differentiated goods means these more expensive goods receive a smaller weight in the average price of foreign exports and a larger weight in the average price of foreign imports.

It is useful to point out that international price adjustment is where there is a notable difference between the simplified and the full model. As our results in Table 2 emphasize, despite a lower markup, the terms of trade of manufacturing do not necessarily fall with better stabilization. This will be so because a high level of entry tends to raise production costs, as wages respond to a higher demand for domestic labor. To the extent that labor supply is inelastic, this effect may become strong enough to prevent the international price of domestic manufacturing from falling in tandem with average markup in the sector. Yet, similar to the simplified model, there is a change in relative consumption levels, with a fall in foreign consumption and a rise at home.

Table 3 summarizes the robustness of our key results for alternative specifications and calibrations of the model. To save space, we only report the percentage change in number of firms and percent change in differentiated export share when the foreign country switches from inflation stabilization to exchange rate peg, by country as well as cumulated across countries. The first column reiterates the key result for the benchmark case from Table 2, adding that the cumulated change in differentiated export share between countries is 2.4 percentage points. Column (2) indicates that the changes in differentiated export share disappear when the number of firms is held fixed exogenously. We conclude that the endogenous shift in number of firms between countries is essential for the change in monetary policy to translate into quantitatively meaningful effects on export shares.

The assumption of balanced trade plays no key role in our results: columns (3) and (4) indicate that the model keeps predicting a significant reallocation of production and a change in the composition of trade when agents can trade non-contingent bonds or have access to complete asset markets---in the appendix we detail changes in our model specification to introduce these alternative asset market arrangements. Columns (5) and (6) show that, as expected, the size of reallocation can be larger when the labor supply elasticity is infinite, as we assumed in the analytical section above.

The last two columns of Table 3 analyze the role of entry costs. The Table shows that, when entry costs are specified in labor units, magnitudes of percent changes in firm number and export shares shrink. Wages tend to rise in the country with more firm entry: if costs are in labor units, this effect tends to counteract the incentive to set up new production lines. Conversely, when entry costs depend on domestic manufacturing goods prices rather than wages, so that entry costs are valued in the same units in which a firm evaluates its profits and firm value, results are similar to our benchmark. This suggests that our benchmark result is not driven by the home terms of trade appreciation, driving down the portion of entry costs falling on imported goods.

5. Empirical evidence

In this section, we carry out an empirical analysis of the key testable implication of the model: countries with monetary policy targeting domestic macro (inflation and output gap) stabilization should have (everything else equal) greater specialization of production and export in differentiated products, relative to countries with a constrained monetary policy. Our empirical strategy consists of taking the U.S. as the base country, and calculate the share of differentiated goods in total exports by country, for the period 1972-2004. Using this share as our dependent variable, we then run panel regressions on a proxy for a country's monetary regime, including country and year fixed effects as well as a number of controls.

To identify countries pursuing efficient domestic stabilization, we distinguish countries with or without monetary policy independence, relying on available classifications of either exchange rate or monetary regimes. Namely, we proxy lack of independence by the adoption of a pegged exchange rate regime. Alternative, we proxy monetary independence with the formal adoption of an inflation targeting regime.

Before proceeding, it is worth clarifying that our empirical strategy does not need to rely on strong assumptions about the exogeneity of a country's monetary regime. A country choice to embrace a peg, rather than a float, or adopt an inflation targeting regime, rather than other strategies, is endogenous, consistent with the maximization of some social welfare function. For our empirical strategy to be sound, we need, first, that a country's policy choice is not specifically driven by changes in the composition of exports; second, that regimes targeting domestic inflation and output gap stabilization are at the margin more favorable to differentiated good industries than other regimes, e.g. a peg. As further discussed below, the fact that policy strategies are endogenously chosen in response to stabilization needs, if anything, should smooth out differences across exchange rates and monetary regimes in the data---hence making it more difficult for us to find statistically significant results.

We should also stress from the start that the inclusion of a country fixed effect in the regression specification controls for different (time-invariant) determinants of comparative advantage, other than monetary policy. A country fixed effect also addresses specific endogeneity issues, arising when time-invariant characteristics of a country (say, oil rich country) determine the composition of exports and at the same time motivate the choice of a particular exchange rate regime (pegging to national currency to the dollar). Nonetheless, there may be issues that cannot be addressed with the inclusion of a country fixed effect. We will resort to splitting the sample according to specific country or product type characteristics, and conduct IV estimations. Finally, a year fixed effect is required to cope for the fact that the share of differentiated goods exports is trended upward, especially in the first part of our sample period.

5.1. Data construction and description

For the classification of exchange rate regimes, we rely on two sources. The International Monetary Fund produces a classification based upon the observed degree of exchange rate flexibility and the existence of formal or informal commitments to exchange rate paths. The definition of peg includes countries with no separate legal tender, currency board arrangements, exchange rate bands, or crawling pegs; this excludes countries classified as managed floating and independent floating. We will also consider the classification system of Shambaugh (2004), which identifies a peg if a country sets its interest rates following systematically the policy decision in some base country. One advantage of this classification is that it focuses on monetary independence rather than exchange rate regime per se. For example, in this classification, before the euro Germany is classified as retaining monetary independence despite participating in different regimes of fixed exchange rates in Europe, because it consistently acted as the leader within pegging blocks. By the same token, countries where capital controls insulated domestic monetary policy from global market pressure are also classified as having monetary independence. So, China is classified as having monetary independence in much of the sample. Note that, for our purposes, the exchange rate classification needs not be defined relative to the country we use as base country in the regression analysis (U.S.). A European country in the euro area has effectively limited or no monetary independence, even if the euro is floating against the dollar.

We date the adoption of an inflation targeting (IT) regime drawing on Roger (2009). This author distinguishes two phases in the adoption process: an initial disinflation period, that lasts for one or more years; and a 'stable IT' regime---motivating the use of a dynamic specification of the regression model. Around 20 countries adopt an IT regime in the years covered by our sample, both high and middle-income ones.

To identify exports of differentiated goods, we rely on Rauch (1999). This author provides a classification of 4-digit SITC industries in terms of the degree of differentiation among products. Some products are traded on organized exchanges, while some others have reference prices published in trade journals. Those products for which neither is true are classified as differentiated. Roughly 58% of the industries fall into the differentiated category.

Trade data come from the World Trade Flows Database (see Feenstra, et al., 2005). Exports to the U.S. (in dollars) are available disaggregated by country and by four-digit industry, on an annual basis for the period 1972-2004.

The set of countries covered both by the trade data and exchange rate classification number 164. The sample years are determined by the availability of U.S. disaggregated import data, covering the period 1972-2004.

5.2. Empirical Specification

Our dependent variable is the share of differentiated goods in exports. Let x_{ijt} denote the dollar value of exports in industry *i* from country *j* to the U.S. in year *t.* Let *DIF* takes the value of 1 for a differentiated industry and 0 otherwise. For country *j* in year *t*, we define a measure of the share of differentiated goods in the overall exports of a country to the U.S.:

$$SDIF_{jt} = \frac{\sum_i DIF_i \cdot x_{ijt}}{\sum_i x_{ijt}}.$$

The index takes values on the continuous interval between 0 and 1. In some of our experiments we will restrict attention to manufacturing exports only. In this case, we will only consider x_{ijt} if belonging to SITC sector with code starting with 5 through 8.

Our regression specification is

$$SDIF_{jt} = \beta_0 + \beta_1 MR_{jt} + \beta_2 X_{jt} + \chi_{jt} + \varepsilon_{jt}, \tag{32}$$

whereX is vector of additional variables that we may include in the analysis as additional controls and χ are country and year fixed effects. The monetary regime MR dummy is, alternatively, PEG or IT. When we proxy monetary independence with the exchange rate regime, *PEG* takes the value of 1 for a fixed exchange rate and 0 otherwise. For the case of inflation targeting, the dummy variable PEG is replaced by IT, which takes the value of 1 in the years in which a country adopts that monetary regime, 0 otherwise. In some of our specifications, we will enter the PEG or the IT regressor with a lag, to allow for the possibility of delayed effects. Across all our regressions, standard errors are clustered by country.

Note that the country fixed effect controls for standard determinants of comparative advantage, such as factor endowments and institutions that do not vary over the sample period. Among the controls, we nonetheless include macroeconomic variables that may have an effect on the composition of trade above and beyond the mechanism highlighted by our model, such as the current account (CA_GDP), and dates of currency (CRISIS_C) or banking crises (CRISIS_B). Access to credit and exposure to credit conditions may in fact vary across industries, in part reflecting the type of markets in which they operate. We also include the real exchange rate level

(RER), as an additional control for the effects on exports of large swings in international prices. Finally, we include a measure of financial openness (CLOSED).[16]

5.3. Regression Results: Peg

For the PEG regression, the model predicts $\beta_1 < 0$: the share of a country's exports in differentiated goods is lower in countries pursuing a fixed exchange rate policy. Results from the regression model are shown in table 4 (without controls) and table 7 (with controls). By the point estimate shown in column 1 of table 4, when a country adopts a peg, the share of its exports in differentiated goods falls by about 6 percentage points. Given that for the typical country differentiated goods account for about half of its exports, the estimated coefficient implies that the export share drops by about 12% of its value. The remainder of the table shows that this result is robust to various subsamples of goods and countries, with the notable exception of the subsample of High-Income, non-oil producers (but see below), as well as an alternative regime classification scheme.

Starting with the latter, Column 7 in the table shows that our result is robust to using the Shambaugh classification of exchange rate regime, which allows for monetary independence in countries with a fixed exchange rate, due to capital controls or because they are the leader of a pegging block.

A concern with endogeneity is raised by the possibility that countries that discover oil or other commodities in their territory may choose to peg their currencies to the dollar *because* these commodities are priced in U.S. dollars. In this case, a peg regime would be the consequence, rather that the cause, of a change in the composition of production and exports away from differentiated goods. One way to address this potential issue consists of excluding Opec members and other large oil exporters from the data set (column 2) and to exclude fuel from the set of export industries (SITC categories beginning with 3, see column 6). In either

[16] The dates of currency and banking crises are provided by Reinhart and Rogoff (2008) and Reinhart (2013). The measure of financial openness is supplied by Chinn and Ito, see bhttp://web.pdx.edu/~ito/Chinn-Ito_website.htm.

exercise, our estimations continue to support our claim. We also show below that the result is robust to instrumenting for endogenous choice of exchange rate regime.

A related source of concern is that poor countries may simultaneously produce mostly non-differentiated goods, and adopt some form of currency peg. Although the country fixed effect takes care of cross-sectional differences, we check for robustness by limiting the sample to more developed countries, with cutoffs in per-capita income of $1035, $4085 and $12,615, according to the World Bank classification.[17] Results are shown in columns 3 to 5. The only case for which, while the sign and magnitude of the coefficient is unaltered, the result is not statistically significant is the case of the richest countries. Nonetheless, we find that the result becomes significant if we allow some dynamics in the specification, or we re-estimate the model using five-year averages, to better account for the effects of monetary regimes.

Table 5 introduces a lagged Peg regressor, with the goal of accounting for the delayed effects of a switch in monetary regimes. The coefficient turns out to be significant for the case of the rich countries.

To further abstract from variations along the business cycle, we average over dynamics, with 5 year non-overlapping averages. The peg coefficient is significant in all cases, including the richest countries.[18] Finally, results are robust to specifications including controls, shown in Table 7. This result is important, because it shows that the exchange rate regime remains significant even when we control for financial conditions, external deficit, financial openness, and the real exchange rate, which may also impinge on exports.

To deal with potential sources of endogeneity (not taken care of by the country fixed effect, and others than the oil discoveries, discussed above), we instrument for the exchange rate regime choice with the variable proposed by Klein and Shambaugh (2006). This consists of the share of neighboring countries that also peg their currency to the same base country. The logic is that if, for instance, France pegs its currency to the U.S. dollar, in doing so it might be motivated by the goal of stabilizing its currency to its neighbor Germany, which also pegs to

[17] This is the World Bank income classification by GNI per capita As of 1 July
Source: http://data.worldbank.org/about/country-classifications.

[18] In this case, a country is classified as pursuing a peg if, over the five year comprised in each observation, PEG=1 for 3 years. Results are robust to changing this threshold to 4.

the dollar. To the degree that these regional ties dictate the choice of the exchange rate regime, one can conclude that a French peg to the dollar is not endogenously driven by its trade relationship with the U.S., nor, more importantly, by the composition of its trade with the U.S.. For consistency, we run our IV estimation adopting the classification of the peg regime by Shambaugh (2004), as in the last column of Tables 2 and 3. The results, shown in Table 8, continue to support our claim, with a statistically significant negative coefficient on the peg term. The table also shows that our main results are robust to using another instrument, the lagged exchange rate regime dummy, that is also widely adopted in the literature. For consistency and to verify robustness of our result, in this case the table reports estimation based on the exchange rate classification regime by the IMF.

In assessing the above results, we should stress that the exchange rate regime provides only an imperfect proxy for the extent to which monetary policy falls short of stabilizing the domestic economy. By way of example, one could argue that a peg may be a good stabilization strategy depending on the type of shocks. According to a standard argument, in the presence of financial shocks, a credible strategy of fixed exchange rate could ensure better stabilization than a float. Moreover, capital controls may relax the external financial constraints on monetary policy even under regimes of limited exchange rate flexibility. While these considerations are well-grounded, we observe that they both work against our hypothesis: other things equal, they tend to smooth out differences between a peg and a floating regime, in terms of their implications on competitiveness. In other words, if the estimation is confounded by such form of endogeneity, our estimates would underestimate the importance of efficient domestic stabilization policy on competitiveness, biasing our results towards zero.

5.4. Regression Results: Inflation Targeting

So far, we have proceeded in our analysis focusing on the effect of a peg on comparative advantage. We now elaborate on our theoretical prediction, and run the model focusing on the formal adoption of an inflation targeting regime. Countries that adopt an inflation-targeting regime are widely regarded as using prudent domestic stabilization policy.

Consistently with our model, they should provide a better economic environment for industries producing differentiated goods.

In what follows, we run our empirical model replacing the peg indicator with the inflation targeting indicator variable, and estimate the benchmark regression with and without a lag. For the IT regression, the model predicts $\beta_1 > 0$: the share of a country's exports in differentiated goods is higher in countries where policymakers adopt an IT regime.

For the share of differentiated goods in total exports (not reported in the table), results have the correct sign (positive: IT countries have a larger share of differentiated exports). Yet the estimates are not statistically different from zero consistently across subsamples---they tend to be so for OECD countries, and upper- and middle-income countries, but not for our sample as a whole. Results are however consistently significant if we use as dependent variable the share of differentiated goods in manufacturing exports. As shown in tables 9 and 10, the coefficient on inflation targeting is positive and significant with a magnitude similar to that of the peg in earlier regressions.

As a final exercise, we also use the IT dummy as an instrument in the peg regression. The idea is to identify more sharply the set of countries that, under a flexible exchange rate, would make use more fully of the stabilization properties of monetary policy. This strategy works well in favor of our hypothesis, especially for the sample of high income and non-oil exporting countries, for which the evidence is mixed in the non-IV regressions.

6. Conclusion

According to a widespread view in policy and academic circles, monetary policy can contribute to the competitiveness of the domestic manufacturing sector. This paper revisits the received wisdom on this issue, exploring a new direction for open-economy monetary models and empirical research. Our argument is that macroeconomic uncertainty affects the comparative advantage of a country in producing goods with the characteristics (high upfront investment, monopoly power and nominal frictions) typical of manufacturing. A stabilization regime that reduces output gap (and marginal cost) uncertainty can strengthen a country's comparative advantage in the production of these goods, beyond the short run.

This paper provides an example of how integrating trade and macro models can bring the literature closer to addressing core concerns shaping the policy debate. The conventional view is that monetary policy cannot be expected to play the same pivotal role as real factors such as factor endowments, market size and taxation, in determining a country's competitiveness. Yet, results from our analysis suggest that its potential role may be more consequential than commonly assumed.

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Appendix:

1. **Entry condition**:

The single-period version of the entry condition (17) is:

$$W_t K = E_t\left[\beta \frac{\mu_t}{\mu_{t+1}} \pi_{t+1}(h)\right].$$

Combine with the single-period version of the profit function (15), in which the dynamic adjustment cost ($AC_{p,t}(h)$) is set to zero, and simplify:

$$W_t K = E_t\left[\beta \frac{\mu_t}{\mu_{t+1}}\left(\left(p_{t+1}(h) - \frac{W_{t+1}}{\alpha_{t+1}}\right)c_{t+1}(h) + \left(e_{t+1}p^*_{t+1}(h) - (1+\tau)\frac{W_{t+1}}{\alpha_{t+1}}\right)c^*_t(h)\right)\right]$$

Under producer currency pricing of exports:

$$W_t K = E_t\left[\beta \frac{\mu_t}{\mu_{t+1}}\left(\left(p_{t+1}(h) - \frac{W_{t+1}}{\alpha_{t+1}}\right)c_{t+1}(h) + \left((1+\tau)p_{t+1}(h) - (1+\tau)\frac{W_{t+1}}{\alpha_{t+1}}\right)c^*_{t+1}(h)\right)\right]$$

$$W_t K = E_t\left[\beta \frac{\mu_t}{\mu_{t+1}}\left(\left(p_{t+1}(h) - \frac{W_{t+1}}{\alpha_{t+1}}\right)\left(c_{t+1}(h) + (1+\tau)c^*_{t+1}(h)\right)\right)\right]$$

Using demand equations for C_M and $c(h)$, as well as definition of P_M:

$$W_t K = E_t\left[\beta \frac{\mu_t}{\mu_{t+1}}\left(\left(p_{t+1}(h) - \frac{W_{t+1}}{\alpha_{t+1}}\right)\left(\left(\frac{p_{t+1}(h)}{P_{M,t+1}}\right)^{-\phi}\theta\left(\frac{P_{t+1}}{P_{Mt+1}}\right)C_{t+1} + (1+\tau)^{1-\phi}\left(\frac{p_{t+1}(h)/e_{t+1}}{P^*_{M,t+1}}\right)^{-\phi}\theta\left(\frac{P^*_{t+1}}{P^*_{Mt+1}}\right)C^*_t\right)\right)\right]$$

$$W_t K = E_t\left[\beta \frac{\mu_t}{\mu_{t+1}}\left(\left(p_{t+1}(h) - \frac{W_{t+1}}{\alpha_{t+1}}\right)p_{t+1}(h)^{-\phi}\theta\begin{pmatrix}\left(n_{t+1}p_{t+1}(h)^{1-\phi} + n^*_{t+1}p_{t+1}(f)^{1-\phi}\right)^{-1}P_{t+1}C_{t+1} \\ +(1+\tau)^{1-\phi}e_{t+1}{}^{\phi}\left(n_{t+1}p^*{}_{t+1}(h)^{1-\phi} + n^*_{t+1}p^*{}_{t+1}(f)^{1-\phi}\right)^{-1}P^*{}_{t+1}C^*{}_t\end{pmatrix}\right)\right]$$

Under log utility, where $W_t = \mu_t$ and $P_t C_t = \mu_t$, this becomes equation (43).

2. Entry under full stabilization

Substitute prices, $p_{t+1}(h) = p^*{}_{t+1}(f)(\phi/(\phi-1))$, and policy rules ($\mu = \alpha, \quad \mu^* = \alpha^*$) into (43) and simplify:

$$\frac{K\phi}{\beta\theta} = E_t\left[\left(n_{t+1} + n^*_{t+1}\left(\frac{\alpha_{t+1}}{\alpha^*{}_{t+1}}\right)^{1-\phi}(1+\tau)^{1-\phi}\right)^{-1} + (1+\tau)^{1-\phi}\left(\frac{\alpha_{t+1}}{\alpha^*{}_{t+1}}\right)^{\phi-1}\left(n_{t+1}\left(\frac{\alpha_{t+1}}{\alpha^*{}_{t+1}}\right)^{\phi-1}(1+\tau)^{1-\phi} + n^*_{t+1}\right)^{-1}\right]$$

Impose symmetry across countries:

$$n_{t+1} = \frac{\beta\theta}{K\phi}E_t\left[\left(1 + \left(\frac{\alpha_{t+1}}{\alpha^*{}_{t+1}}\right)^{1-\phi}(1+\tau)^{1-\phi}\right)^{-1} + (1+\tau)^{1-\phi}\left(\frac{\alpha_{t+1}}{\alpha^*{}_{t+1}}\right)^{\phi-1}\left(\left(\frac{\alpha_{t+1}}{\alpha^*{}_{t+1}}\right)^{\phi-1}(1+\tau)^{1-\phi} + 1\right)^{-1}\right]$$

$$n_{t+1}=\frac{\beta\theta}{K\phi}E_t\left[\frac{2+\left(\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right)^{1-\phi}\left((1+\tau)^{\phi-1}+(1+\tau)^{1-\phi}\right)}{1+\left(\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right)^{1-\phi}\left((1+\tau)^{\phi-1}+(1+\tau)^{1-\phi}\right)+\left(\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right)^{2(1-\phi)}}\right]$$

Which is the same as for the flexible price case.

To compare to the no stabilization case, write this as

$$n^{stab}_{t+1}=n^{no\,stab}_{t+1}E_t\Omega_{t+1}$$

$$\text{where }\Omega=\frac{2+\left(\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right)^{1-\phi}\left((1+\tau)^{\phi-1}+(1+\tau)^{1-\phi}\right)}{1+\left(\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right)^{1-\phi}\left((1+\tau)^{\phi-1}+(1+\tau)^{1-\phi}\right)+\left(\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right)^{2(1-\phi)}}$$

Note that $n^{stab}_{t+1}>n^{no\,stab}_{t+1}$ if $E_t\Omega_{t+1}>1$. However Ω_{t+1} switches from a concave function of $\alpha_{t+1}/\alpha^*_{t+1}$ to a convex function near the symmetric steady state value of $\alpha_{t+1}/\alpha^*_{t+1}=1$. Hence we cannot apply Jensen's inequality to determine whether $E_t\Omega_{t+1}>1$. This finding reflects the fact that the effects of symmetric stabilization are small. Our analysis, nonetheless, will show that the effects of asymmetric stabilization can be large.

<u>3. Case of fixed exchange rate rule:</u>

Substitute prices and policy rules ($\mu=\alpha_*,\ \mu^*=\mu=\alpha\quad(\text{so }e=1)$) into (43):

$$\frac{K}{\beta\theta}=E_t\left[\left(\left(\frac{\phi}{\phi-1}-1\right)\left(\frac{\phi}{\phi-1}\right)^{-\phi}\left(\begin{array}{l}\left(n_{t+1}\left(\frac{\phi}{\phi-1}\right)^{1-\phi}+n^*_{t+1}\left(\frac{\phi}{\phi-1}E_t\left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right]\right)^{1-\phi}(1+\tau)^{1-\phi}\right)^{-1}\\+(1+\tau)^{1-\phi}\left(n_{t+1}\left(\frac{\phi}{\phi-1}\right)^{1-\phi}(1+\tau)^{1-\phi}+n^*_{t+1}\left(\frac{\phi}{\phi-1}E_t\left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right]\right)^{1-\phi}\right)^{-1}\end{array}\right)\right)\right]$$

Pass through expectations and simplify

$$\frac{K\phi}{\beta\theta}=\left(\left(n_{t+1}+n^*_{t+1}\left(E_t\left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right]\right)^{1-\phi}(1+\tau)^{1-\phi}\right)^{-1}+\left(n_{t+1}+n^*_{t+1}\left(E_t\left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right]\right)^{1-\phi}(1+\tau)^{1-\phi}\right)^{-1}\right)$$

Do the same for the foreign entry condition:

$$\frac{K\phi}{\beta\theta}=\left(E_t\left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right]\right)^{1-\phi}\left(\left(n^*_{t+1}\left(E_t\left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right]\right)^{1-\phi}+n_{t+1}(1+\tau)^{1-\phi}\right)^{-1}+\left(n^*_{t+1}\left(E_t\left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right]\right)^{1-\phi}n_{t+1}(1+\tau)^{\phi-1}\right)^{-1}\right)$$

Rewrite the home and foreign conditions as fractions:

Home: $\frac{K\phi}{\beta\theta} = \frac{1}{n_{t+1} + An^*_{t+1}} + \frac{1}{n_{t+1} + Bn^*_{t+1}}$

Foreign: $\frac{K\phi}{\beta\theta} = \frac{A}{n_{t+1} + An^*_{t+1}} + \frac{B}{n_{t+1} + Bn^*_{t+1}}$

Where we define:

$$A \equiv \left(E_t \left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}} \right] \right)^{1-\phi} (1+\tau)^{1-\phi}, \quad B \equiv \left(E_t \left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}} \right] \right)^{1-\phi} (1+\tau)^{\phi-1}$$

Equating across countries:

$$\frac{2n_{t+1} + (A+B)n^*_{t+1}}{(n_{t+1} + An^*_{t+1})(n_{t+1} + Bn^*_{t+1})} = \frac{(A+B)n_{t+1} + 2ABn^*_{t+1}}{(n_{t+1} + An^*_{t+1})(n_{t+1} + Bn^*_{t+1})}$$

$$\frac{n_{t+1}}{n^*_{t+1}} = \frac{2AB - A - B}{2 - A - B}$$

so $\frac{n_{t+1}}{n^*_{t+1}} > 1$ if $\frac{2AB - A - B}{2 - A - B} > 1$

Note that the denominator will be negative provided the standard deviation of shocks is small relative to the iceberg costs, which will be true for all our cases:

$$\sigma < \left(\ln\left(2 / \left((1+\tau)^{1-\phi} + (1+\tau)^{\phi-1} \right) \right) / \frac{1-\phi}{2} \right)^{0.5}$$

For shocks independently log normally distributed with standard deviation σ so that

$E_t \left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}} \right] = e^{\frac{1}{2}\sigma^2}$. For example, with τ=0.1 and ϕ =6, σ must be less than 0.209. Our calibration of σ is 0.017.

So $\frac{n_{t+1}}{n^*_{t+1}} > 1$ if $2AB - A - B < 2 - A - B$ or $AB < 1$

$$AB = \left(E_t \left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}} \right] \right)^{1-\phi} (1+\tau)^{1-\phi} \left(E_t \left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}} \right] \right)^{1-\phi} (1+\tau)^{\phi-1} = \left(E_t \left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}} \right] \right)^{2(1-\phi)}$$

For independent log normal distributions of productivity:

$$\left(E_t \left[\frac{\alpha_{t+1}}{\alpha^*_{t+1}} \right] \right)^{2(1-\phi)} = e^{(1-\phi)\sigma^2} < 1 \text{ since } \phi > 1$$

We can conclude that *n*>*n**.

4. Specification of alternative asset market arrangements:

To introduce complete asset markets, the balance trade condition (40) is replaced by the risk sharing condition:

$$\frac{\mu_t}{\mu^*_t} = e_t .$$

To specific international asset trade limited to noncontingent nominal bonds, we introduce the notation B_H for home holding of home currency bonds and B_F home holding of foreign currency bonds, with foreign holdings indicated with a '*.' The balanced trade condition (40) now is replaced by a richer balance of payments condition including asset trades:

$$\int_0^n p_t^*(h)\left(c_t^*(h)+d_{Kt}^*(h)+d_{AC,t}^*(h)\right)dh-\int_0^{n^*} p_t(f)\left(c_t(f)+d_{Kt}(f)+d_{AC,t}(f)\right)df$$
$$+P_{Ht}^*\left(C_{Ht}^*+D_{AC,H,t}^*\right)-P_{Ft}\left(C_{Ft}+D_{AC,F,t}\right)-i_{t-1}B_{Ht}^*+e_t i_{t-1}^* B_{Ft}=\left(B_{Ht}^*-B_{Ht-1}^*\right)+e_t\left(B_{Ft}-B_{Ft-1}\right).$$

We also have two asset market clearing conditions:

$$B_{Ht}+B_{Ht}^*=0$$
$$B_{Ft}+B_{Ft}^*=0$$

As well as two distinct uncovered interest rate parity conditions governmening asset choices. Note that there is a small quadratic cost of holding bonds of the other country, ψ_B, calibrated at 0.001.

$$\mathrm{E}_t\left[\frac{\mu_t}{\mu_{t+1}}\frac{e_{t+1}}{e_t}\left(1+i_t^*\right)\left(1+\psi_B\left(\frac{e_t B_{ft}}{p_{Ht}y_{Ht}}\right)\right)\right]=\mathrm{E}_t\left[\frac{\mu_t}{\mu_{t+1}}\left(1+i_t\right)\right]$$
$$\mathrm{E}_t\left[\frac{\mu_t^*}{\mu_{t+1}^*}\frac{e_t}{e_{t+1}}\left(1+i_t\right)\left(1+\psi_B\left(\frac{B^*{}_{Ht}}{e_t\, p^*{}_{Ft}\, y^*{}_{Ft}}\right)\right)\right]=\mathrm{E}_t\left[\frac{\mu_t^*}{\mu_{t+1}^*}\left(1+i_t^*\right)\right]$$

Table 1. Benchmark Parameter Values

Preferences

Risk aversion	$\sigma = 2$
Time preference	$\beta = 0.96$
Labor supply elasticity	$1/\psi = 1.9$
Differentiated goods share	$\theta = 0.38$
Non-differentiated goods home bias	$\nu = 0.5$
Differentiated goods elasticity	$\phi = 5.2$
Non-differentiated elasticity	$\eta = 15.3$

Technology

Death rate	$\delta = 0.1$
Price stickiness	$\kappa = 8.7$
Differentiated good trade cost	$\tau_D = 0.16$
Non-differentiated good trade cost	$\tau_N = 0.08$

Shocks:

$$\rho = \begin{bmatrix} 0.6665 & -0.6145 & 0.1328 & -0.2064 \\ 0.3724 & 0.0447 & 0.0360 & -0.0250 \\ 0.5194 & -1.6747 & 0.1289 & 0.6588 \\ 0.2646 & -0.4435 & -0.0474 & 0.4407 \end{bmatrix}$$

$$\Omega = \begin{bmatrix} 5.11e-4 & 1.68e-4 & 9.25e-5 & 3.45e-5 \\ 1.68e-4 & 1.45e-4 & 1.82e-5 & 6.47e-5 \\ 9.25e-5 & 1.82e-5 & 6.76e-4 & 7.50e-5 \\ 3.45e-5 & 6.47e-5 & 7.50e-5 & 1.70e-4 \end{bmatrix}$$

Table 2: Unconditional Means under Alternative Policies

	symmetric stabilization	foreign fixed exchange rate	% difference
n	1.975	2.001	1.32
*n**	1.945	1.917	-1.44
ω_H	0.574	0.580	1.16
ω_F	0.567	0.560	-1.20
ym	0.469	0.475	1.29
yd	0.604	0.600	-0.78
*ym**	0.465	0.458	-1.38
*yd**	0.609	0.615	0.97
c	0.982	0.982	0.01
*c**	0.981	0.981	-0.03
p(h)	1.281	1.294	1.04
p(f)*	1.291	1.293	0.14
w	1.035	1.046	1.04
*w**	1.043	1.043	0.06
p(h)/w	1.239	1.239	0.00
p(f)/w**	1.238	1.240	0.13
p(h)/pdh	1.239	1.239	0.00
p(f)/pdf**	1.238	1.240	0.13
rer	1.000	1.000	0.03
TOT-Man	1.001	1.001	0.02
TOT-total	1.001	1.005	0.38

Results come from a stochastic simulation of a second-order approximation to the model. ω_H represents the share of differentiated goods in overall exports of the home country, and it is computed

$$\omega_{Ht} \equiv \frac{p^*_t(h) n_{t-1}\left(c^*_t(h) + d^*_{Kt}(h) + d^*_{AC,t}(h)\right)}{p^*_t(h) n_{t-1}\left(c^*_t(h) + d^*_{Kt}(h) + d^*_{AC,t}(h)\right) + P^*_{Ht}\left(C^*_{Ht} + D^*_{AC,H,t}\right)};$$

ω_F represents the counterpart for the foreign country.

Table 3: Summary of implications of alternative model specifications for key variables

	(1) benchmark	(2) no entry	(3) bonds trade	(4) complete asset markets	(5) infinite labor supply elast	(6) entry cost in labor units	(7) entry cost in own good
n	1.32	0.00	1.08	1.16	1.57	0.03	0.63
n^*	-1.44	0.00	-1.18	-1.26	-1.55	-0.07	-0.66
n^*-n	-2.76	0.00	-2.27	-2.42	-3.12	-0.10	-1.29
ω_H	1.16	0.04	1.00	1.04	1.14	0.07	0.98
ω_F	-1.20	0.05	-0.86	-0.92	-1.54	-0.08	-1.00
$\omega_F - \omega_H$	-2.36	0.01	-1.86	-1.96	-2.68	-0.15	-1.98

Table reports the percent change in a variable when the foreign country replaces inflation stabilization with exchange rate peg. Table also reports the difference between the home and foreign percent changes.

Results come from a stochastic simulation of a second-order approximation to the model.

ω_H represents the share of differentiated goods in overall exports of the home country, and it is computed

$$\omega_{Ht} \equiv \frac{p^*_t(h) n_{t-1}\left(c^*_t(h)+d^*_{Kt}(h)+d^*_{AC,t}(h)\right)}{p^*_t(h) n_{t-1}\left(c^*_t(h)+d^*_{Kt}(h)+d^*_{AC,t}(h)\right)+P^*_{Ht}\left(C^*_{Ht}+D^*_{AC,H,t}\right)};$$

ω_F represents the counterpart for the foreign country.

Table 4: Baseline Regression

	(1) Benchmark	(2) Non-oil exporting countries	(3) Exclude Low Income	(4) High & Upper Middle Income	(5) High Income & Non-oil	(6) No Energy Goods	(7) Shambaugh Peg
PEG	-0.0585***	-0.0635***	-0.0632***	-0.0642***	-0.0234	-0.0487***	-0.0367**
	(0.0163)	(0.0166)	(0.0169)	(0.0195)	(0.0191)	(0.0164)	(0.0162)
Obs.	3646	3256	2942	2094	953	3645	4757
R-sq	0.741	0.725	0.786	0.816	0.818	0.712	0.718
adj. R-sq	0.728	0.710	0.774	0.805	0.803	0.696	0.706
Country Fixed Effect	yes	yes	yes	yes	yes	yes	yes
Year Fixed Effect	yes	yes	yes	yes	yes	yes	yes

Notes: DIF not included as regressor because subsumed in fixed effects.
Standard errors (clustered by country) in parentheses:
* significance at 10%; ** significance at 5%; ***significance at 1%

Table 5: Baseline Regression with Lagged Peg

	(1) Benchmark	(2) Non-oil exporting countries	(3) Exclude Low Income	(4) High & Upper Middle Income	(5) High Income & Non-oil	(6) No Energy Goods	(7) Shambaugh Peg
PEG	-0.0270*	-0.0228*	-0.0292*	-0.0476**	0.0000364	-0.0179	-0.0177
	(0.0158)	(0.0136)	(0.0176)	(0.0212)	(0.0140)	(0.0146)	(0.0127)
L.PEG	-0.0360**	-0.0488***	-0.0422***	-0.0188	-0.0253*	-0.0345*	-0.0257**
	(0.0154)	(0.0157)	(0.0156)	(0.0145)	(0.0130)	(0.0181)	(0.0124)
Obs.	3481	3113	2809	1997	911	3480	4580
R-sq	0.747	0.731	0.791	0.822	0.820	0.722	0.727
adj. R-sq	0.733	0.715	0.779	0.810	0.805	0.706	0.715
Country Fixed Effect	yes	yes	yes	yes	Yes	yes	yes
Year Fixed Effect	yes	yes	yes	yes	Yes	yes	yes

Notes: DIF not included as regressor because subsumed in fixed effects.

Standard errors (clustered by country) in parentheses:

* significance at 10%; ** significance at 5%; ***significance at 1%

Table 6: Non-Overlapping 5-Year Averages

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Benchmark	Non-oil	Exclude Low Income	High & Upper Middle Income	High Income & Non-oil	No Energy Goods	Shambaugh Peg
PEG	-0.0573***	-0.0654***	-0.0671***	-0.0673***	-0.0339	-0.0519***	-0.0394**
	(0.0201)	(0.0210)	(0.0200)	(0.0236)	(0.0222)	(0.0198)	(0.0203)
Obs.	796	711	642	458	208	796	1024
R-sq	0.823	0.813	0.843	0.864	0.880	0.807	0.808
adj. R-sq	0.779	0.766	0.803	0.830	0.846	0.759	0.771
Country Fixed Effect	yes	yes	yes	yes	yes	yes	Yes
Year Fixed Effect	yes	yes	yes	yes	yes	yes	Yes

Notes: DIF not included as regressor because subsumed in fixed effects.

Standard errors (clustered by country) in parentheses:

* significance at 10%; ** significance at 5%; ***significance at 1%

Table 7: Baseline Regressions with Controls

	(1) benchmark	(2) 5 year averages	(3) high income nonoil
PEG	-0.0528***	-0.0465**	0.000689
	(0.0186)	(0.0221)	(0.0180)
L.PEG			-0.0301*
			(0.0174)
CA_GDP	0.000337	0.00101	0.00203***
	(0.000619)	(0.00181)	(0.000326)
RER	0.00855	0.0182*	-0.0250***
	(0.0122)	(0.0101)	(0.00617)
CRISIS_C	0.00646	0.0154	-0.00710
	(0.0111)	(0.0210)	(0.0185)
CRISIS_B	0.00521	0.0126	-0.0337***
	(0.0154)	(0.0249)	(0.00979)
CLOSED	-0.0185	-0.00285	-0.0431
	(0.0261)	(0.0329)	(0.0318)
Obs.	2523	646	2626
R-sq	0.785	0.853	0.774
adj. R-sq	0.769	0.804	0.758
Country and Year Fixed Effects	yes	yes	yes

Table 8: IV Regressions

	IV: Lagged IMF Exchange Rate		IV: Klein-Shambaugh Index	
PEG	-0.0739***	-0.0739***	-0.108***	-0.108***
	(0.0206)	(0.0104)	(0.0273)	(0.0133)
Obs.	3481	3481	3443	3443
R-sq	0.183	0.183	0.165	0.165
adj. R-sq	0.137	0.137	0.120	0.120
Standard Errors	Clustered	Robust	Clustered	Robust
Country Fixed Effect	yes	yes	yes	yes
Year Fixed Effect	yes	yes	yes	yes

Notes: DIF not included as regressor because subsumed in fixed effects.

If the instrument is Klein and Shambaugh, the instrumented variable is the Shambaugh peg;
If the instrument is the lagged IMF exchange rate index, the instrumented is the contemporaneous IMF exchange rate index.

Under "IV: Klein-Shambaugh Index":

Standard errors (either clustered by country or heteroskedasticity-robust) in parentheses:

* significance at 10%; ** significance at 5%; ***significance at 1%

Table 9: Baseline Regressions with Inflation Target and Lag (Sample: manufacturing goods)

	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample	Exclude Low Income	High & Upper Middle Income	High & Upper Middle Income & Non-Oil	High Income	OECD
IT	-0.0147	-0.00866	-0.00472	-0.0116	0.0171	0.0175
	(0.0218)	(0.0226)	(0.0244)	(0.0253)	(0.0369)	(0.0563)
L.IT	0.0284**	0.0391***	0.0390***	0.0339**	0.0327**	0.0495***
	(0.0132)	(0.0133)	(0.0135)	(0.0148)	(0.0151)	(0.0153)
Obs.	2183	1702	1204	1019	679	280
R-sq	0.754	0.804	0.804	0.827	0.869	0.838
adj. R-sq	0.733	0.786	0.786	0.810	0.856	0.815
Country Fixed Effect	yes	yes	yes	yes	yes	yes
Year Fixed Effect	yes	yes	yes	yes	yes	yes

Notes: DIF not included as regressor because subsumed in fixed effects.

Standard errors (clustered by country) in parentheses:

* significance at 10%; ** significance at 5%; ***significance at 1%

Table 10: Baseline Regressions with Inflation Target, 5 year averages (Sample: manufacturing goods)

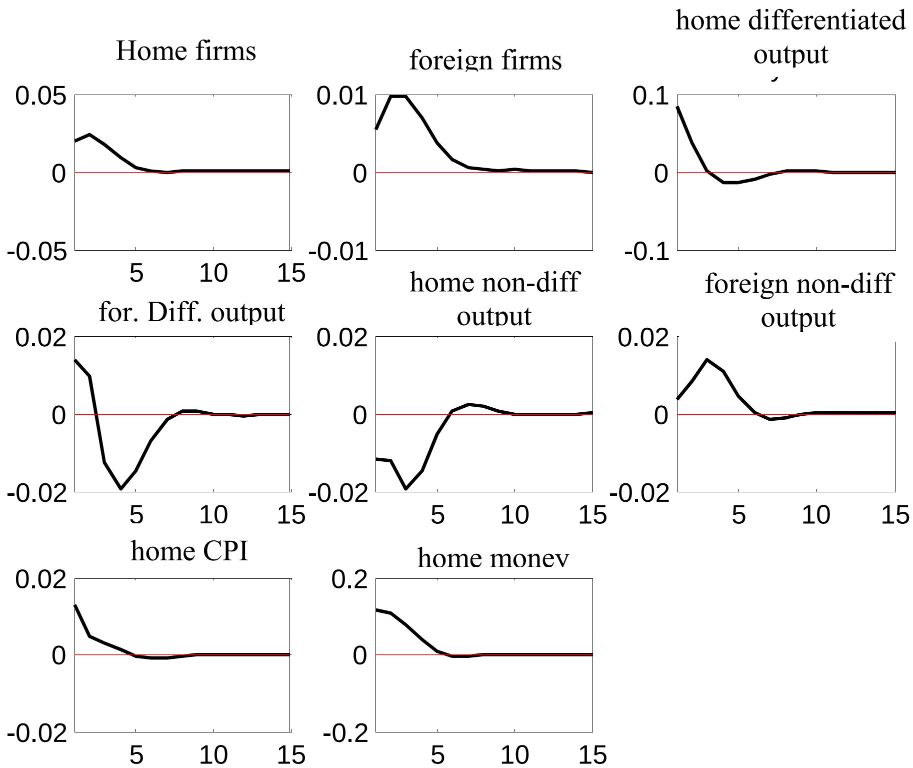
	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample	Exclude Low Income	High & Upper Middle Income	High & Upper Middle Income and Non-Oil	High Income	OECD
IT	0.0605*	0.0756**	0.0968**	0.0810*	0.144***	0.0692*
	(0.0328)	(0.0336)	(0.0382)	(0.0430)	(0.0535)	(0.0382)
Obs.	1035	801	565	469	313	140
R-sq	0.733	0.753	0.721	0.737	0.764	0.793
adj. R-sq	0.680	0.704	0.663	0.682	0.713	0.745
Country Fixed Effect	yes	yes	yes	yes	yes	yes
Year Fixed Effect	yes	yes	yes	yes	yes	yes

Notes: DIF not included as regressor because subsumed in fixed effects.

Standard errors (clustered by country) in parentheses:

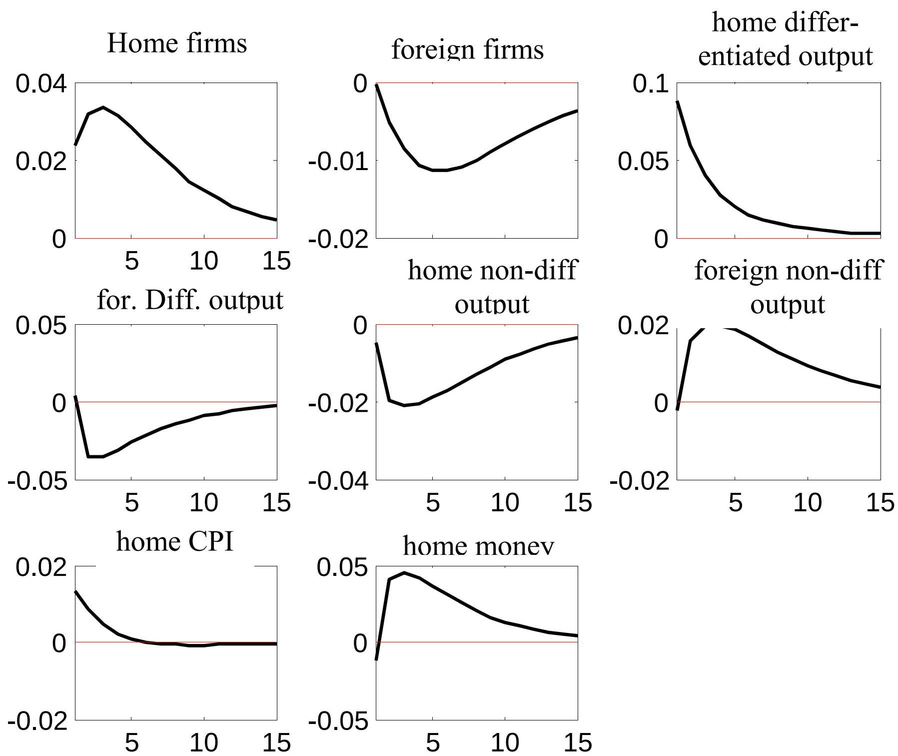
* significance at 10%; ** significance at 5%; ***significance at 1%

Fig 1.
Responses to a 1 std dev rise in home manufacturing productivity;
both countries use efficient stabilization monetary policy



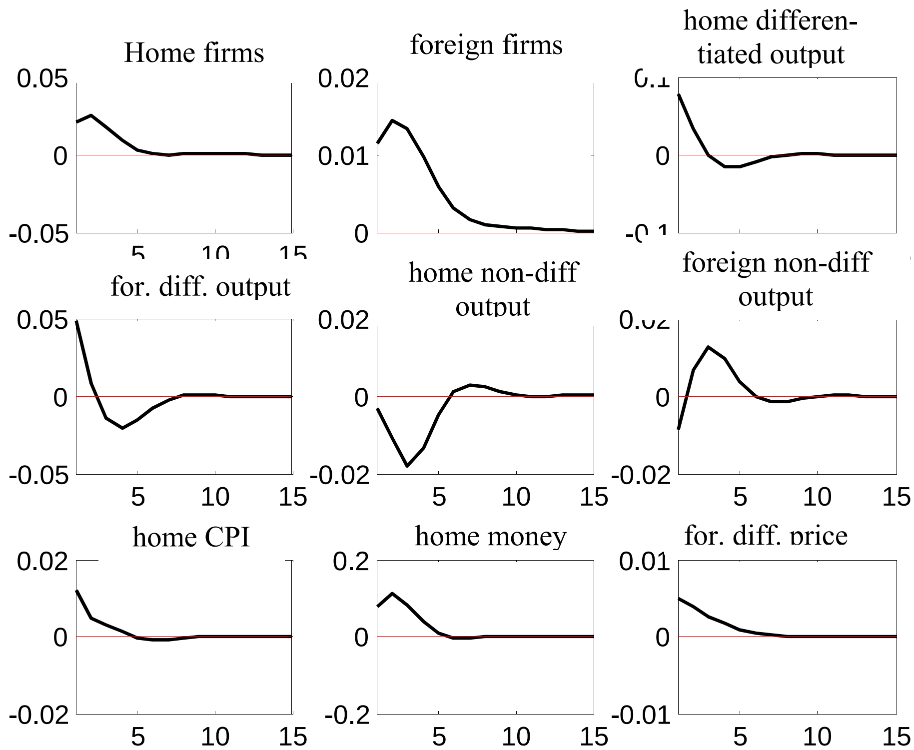
Vertical axis is percent deviation (0.01=1%) from steady state levels. Horizontal axis is time (in quarters).

Fig 2.
Responses to a 1 std dev rise in home manufacturing productivity;
both countries use efficient stabilization monetary policy;
No autocorrelation in shocks across countries



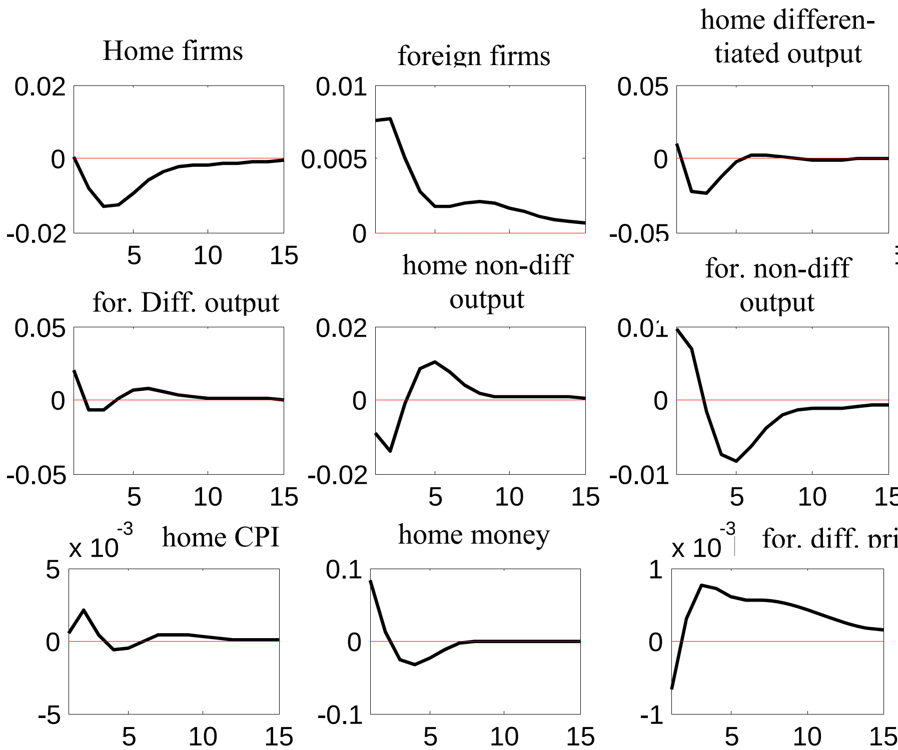
Vertical axis is percent deviation (0.01=1%) from steady state levels. Horizontal axis is time (in quarters).

Fig 3:
Responses to a 1 std dev rise in home manufacturing productivity;
foreign country pegs



Vertical axis is percent deviation (0.01=1%) from steady state levels. Horizontal axis is time (in quarters).

Fig 4:
Responses to a 1 std dev rise in foreign manufacturing productivity;
foreign country pegs



Vertical axis is percent deviation (0.01=1%) from steady state levels. Horizontal axis is time (in quarters).