NBER WORKING PAPER SERIES

INTERNATIONAL COMPETITIVENESS AND MONETARY POLICY: STRATEGIC POLICY AND COORDINATION WITH A PRODUCTION RELOCATION EXTERNALITY

Paul R. Bergin
Giancarlo Corsetti

Working Paper 19356
http://www.nber.org/papers/w19356

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2013

We thank Yuan Liu and Riccardo Trezzi for excellent research assistance. We thank our discussant Matteo Cacciatore and seminar participants at the 2013 NBER Summer Institute, the 2013 International Finance and Macro Finance Workshop at Sciences Po Paris and the Bank of England, for comments The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

International Competitiveness and Monetary Policy: Strategic Policy and Coordination with a Production Relocation Externality
Paul R. Bergin and Giancarlo Corsetti
NBER Working Paper No. 19356
August 2013
JEL No. F41

ABSTRACT

Can a country gain international competitiveness by the design of optimal monetary stabilization rules? This paper reconsiders this question by specifying an open-economy monetary model encompassing a 'production relocation externality,' developed in trade theory to analyze the benefits from promoting entry of domestic firms in the manufacturing sector. In a macroeconomic context, this externality provides an incentive for monetary authorities to trade-off output gap with pro-competitive profit stabilization. While helping manufacturing firms to set competitively low prices, optimal pro-competitive stabilization nonetheless results in stronger terms of trade, due to the change in the country's specialization and composition of exports. The welfare gains from international policy coordination are large relative to the case of self-oriented, strategic conduct of stabilization policy. Empirical evidence confirms that the effects of monetary policy design on the composition of trade predicted by the theory are present in data and are quantitatively important.

Paul R. Bergin
Department of Economics
University of California, Davis
One Shields Ave.
Davis, CA 95616
and NBER
prbergin@ucdavis.edu

Giancarlo Corsetti
Faculty of Economics
Cambridge University
Sidgwick Avenue
CB3 9DD Cambridge, Cambs
United Kingdom
giancarlo.corsetti@gmail.com

1. Introduction

This paper reconsiders how monetary and exchange rate policy can raise welfare by promoting a country's international competitiveness, contributing a novel approach to the analysis of macro stabilization in open economies. Drawing on trade theory, we allow for incomplete specialization across two tradable sectors, one of which produces differentiated goods with a production externality. Manufacturing industries supplying differentiated goods with monopoly power are typically associated with price stickiness and sunk (entry) investment, arguably making them more sensitive to macroeconomic uncertainty than other industries. We show that optimal monetary stabilization policy can create favorable conditions for such industries, leading to potentially large welfare gains. We provide empirical evidence that the effects of monetary policy design on the composition of trade predicted by the theory are present in data and are quantitatively meaningful.

The conventional approach to competitiveness in the Keynesian tradition focuses on ex-post currency devaluation, as a way to lower the relative cost of production over the span of time that prices and wages are sticky. In line with the New Open Economy Macroeconomics (NOEM) or the new-Keynesian literature, we instead focus on the implications of monetary rules and exchange rate regimes on firms' entry and price setting. In the existing NOEM and new-Keynesian literature, however, the key policy trade-off is between stabilizing the output gap and strengthening the terms of trade, i.e., raising the international price of home goods --- seemingly the opposite of improving competitiveness.[1] In contrast, this paper shows that monetary policy can improve welfare by taking advantage of price stickiness to have a long-lasting effect on the competitiveness of manufacturing firms, and thereby shape the composition of a country's exports and comparative advantage. In this perspective, we emphasize the benefits from 'competitive stabilization' over those of 'competitive devaluations'

[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), as well as Benigno and Benigno (2003), and Corsetti et al. (2010) 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.

studied in the early literature. We believe that our approach to the assessment and design of monetary policy in open economies is more closely in line with actual policy debates, often reflecting concerns regarding international competitiveness.

Essential to our approach is a well-defined structure of comparative advantage, that we model allowing for more than one sector producing tradable goods (as is common in trade but not so in macroeconomics), and heterogeneous sectoral responses to monetary stabilization. We borrow a two-sector market structure from the international trade literature, embedding it in a stochastic general equilibrium macro model. In the first sector, which we identify with manufacturing, monopolistically competitive firms produce differentiated goods subject to trade costs.[2] In this sector, productivity is subject to country-specific stochastic shocks, and firms are required to pay their fixed entry cost and set their prices (here in producer currency units) before the realization of these shocks.[3] In the second sector, goods may not be differentiated, and the degree of nominal rigidities and trade costs are lower. For the sake of deriving insightful analytical results, but without loss of generality, we posit that firms in this sector produce a homogeneous good under perfect competition, implying price flexibility, and assume away both trade and entry costs altogether.[4]

While each of these model features on its own is standard in its respective trade or macro literature, in combination they have key novel implications for both empirical and theoretical open-economy analysis. Because the monopolistically competitive (manufacturing) sector must invest in differentiated products and set prices ahead of production, entry and pricing decisions are quite sensitive to uncertainty about demand and marginal costs. As shown

---

[2] The assumption that trade costs are associated with the monopolistic sector is a long-standing feature in trade literature, and is the foundation of the home market effect of Krugman (1980), where monopolistically competitive firms locate production in the larger market in order to minimize exposure to trade costs. Empirical literature is inconclusive whether differentiated industries are associated with greater trade costs (Davis, 1998). Later work shows this assumption is not strictly essential; what is necessary is a sector where labor can move to if it moves out of the differentiated manufacturing sector (Krugman and Venables, 1999).

[3] In a macro perspective, it is a logical as well as standard assumption to associate both sunk entry costs and sticky prices with the monopolistically competitive sector: monopoly profits are required to pay for sunk costs of entry, while monopoly power is a natural assumption in models where firms chooses prices.

[4] The assumption that firms in the second sector produce a homogenous good facilitates the derivation of anaytical results, but it is not crucial for our results. As shown in the text, these hinge on differential trade costs affecting goods produced in the two sectors. They would not be affected by modeling monopolistically competitive firms in the second sector.

in previous work carried out in a closed economy context (such as Bergin and Corsetti (2008) and Bilbiie, Ghironi and Melitz (2008)), uncertainty can imply a 'risk premium' in a firm's prices.[5] A monetary policy that is effective in eliminating this risk induces firms to set a lower price on average, fostering the comparative advantage of the home country in producing and exporting differentiated manufacturing goods. Such a policy encourages entry of home manufacturing firms at the expense of the foreign country, which in turn produces relatively more non-differentiated good, amplifying the shift in trade patterns. In the presence of a production relocation externality (as developed in Ossa 2011 in a trade context), acquiring a larger share of the world production of differentiated goods produces welfare gains due to savings on trade costs.

Empirical work confirms a key testable implication of our analysis, that countries in a fixed exchange rate regime, all else equal, will tend to specialize away from differentiated goods supplied under imperfect competition and subject to entry costs and nominal rigidities, relative to the countries with an independent monetary policy. This is due to the fact that fixed exchange rate regimes prevent optimal stabilization of macro shocks. We conduct panel regressions of exports on a measure of product differentiation interacted with the exchange rate regime. We find that this interaction term has a highly robust and quantitatively significant effect consistent with our theory. These results are entirely distinct from the macroeconomic literature testing the effect of exchange rate volatility on the volume of exports, which are often inconclusive; we instead provide evidence that the exchange rate regime has appreciable effects on the *composition* of exports.

A specific contribution of our analysis concerns the design of optimal monetary stabilization policy and gains from cross border cooperation. Namely, the impact of monetary policy on trade and production patterns create welfare incentives to deviate from monetary rules that are efficient from a global perspective, defining a policy game over comparative advantages. Strategic behavior in turn gives rise to significant beggar thy neighbor effects. In contrast with the literature, gains from international policy coordination are a large share of the overall welfare benefits from monetary stabilization.

[5] See also Corsetti and Pesenti (2005) and Obstfeld and Rogoff (2000).

While these results are new in the NOEM literature, our analysis nonetheless suggests an insightful reinterpretation of the main findings in this literature regarding the relevance of the policy trade-off between output gap stabilization and terms of trade improvement. In our model, the optimal policy is aimed at lowering the terms of trade specific to the manufacturing sector, to gain competitive advantage in the production of differentiated goods. However, since markups are higher in this sector, the shift in composition of home production and exports toward manufacturing results in an improvement in the overall terms of trade, defined as the trade-weighted average of differentiated and non-differentiated imports and exports.

Our results are closely related to the production relocation externality studied in a trade context by Ossa (2011). Our paper shows that this externality has a clear macroeconomic dimension, and casts new light on its role in monetary policy analysis. Our main conclusions could however follow from other types of externalities, shaping the welfare implications of acquiring comparative advantage in manufacturing.

Our model is distinct from the NOEM literature studying strategic policy and coordination (see e.g. Benigno and Benigno (2003), Corsetti and Pesenti (2005), Corsetti et al. (2010), Obstfeld and Rogoff (2002) and Sutherland (2004)). Not only the mechanism producing gains from cooperation is different; these gains are larger, in terms of the overall social benefits from monetary stabilization. Our argument is also conceptually distinct from the conclusions of the literature assuming a traded and a non-traded goods sector (see e.g. Canzoneri et. al 2005). Gains from coordination in this case may result from trade-offs in stabilizing marginal costs across two sectors in each country, potentially creating stronger cross-border spillovers than in the standard model where all goods are traded. Our work is 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.[6]

[6] There are a number of contributions studying the effects of monetary policy regimes on entry, see, e.g., Cavallari (2010), or the effect of exchange rate policy on trade, see, e.g., Staiger and Sykes (2010). However, to our knowledge, no study has focused on competitiveness encompassing production relocation.

The next section describes the model, and section 3 discusses the effects of monetary policy in the model, and characterizes globally optimal stabilization rules. Section 4 traces the implications of unilateral pegs for comparative advantage and welfare. Section 5 uses simulations to find optimal policy rules, and discusses gains from international coordination over a Nash equilibrium. Section 6 presents empirical evidence.

2. Model

Consider a model of two countries, home and foreign, each with households, firms and a government. Households derive income from supplying labor to domestic firms, and they consume a basket of differentiated goods as well as a homogeneous good. The differentiated good is produced by monopolistically competitive firms subject to a fixed entry cost and iceberg trade costs. The homogeneous good is perfectly competitive and is not subject to the costs. All goods are traded. We abstract from international trade in assets, so international trade is balanced. However, as will be discussed below, the model specification implies that productivity risk nonetheless will be perfectly diversified through the homogeneous sector, making asset trade irrelevant in equilibrium. In what follows, we will focus our exposition of the model on the home country, with the understanding that analogous expression will hold for the foreign one. Foreign variables will be denoted with a star.

2.1 Goods market structure

Household consumption (C) in the home country is an aggregate of n varieties of home manufacturing goods and n^* foreign varieties, as well as a homogeneous non-manufacturing good (C_D):

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

where

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

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

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

where

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

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

These definitions imply relative demand functions for domestic residents:

$$c_t(h) = \left(p_t\left(h\right)/P_{Mt}\right)^{-\phi} C_{Mt} \tag{3}$$

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

$$P_{Mt}C_{Mt} = \theta P_t C_t \tag{5}$$

$$P_{Dt}C_{Dt} = \left(1-\theta\right)P_t C_t . \tag{6}$$

2.2 Home household problem

The representative home household derives utility from consumption (*C*), holding real money balances (*M/P*), and disutility from labor (*l*). The household derives income by selling labor at the nominal wage rate (*W*), receiving real profits from home firms $\left(\pi\left(h\right)\right)$ net of fixed costs *Wq*, and interest (*i*) on holding domestic bonds (*B*), which are in zero net supply. They pay lump-sum taxes (*T*).

Household optimization for the home country may be written:

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

subject to the budget constraint:

$$P_t C_t = W_t l_t + \int_0^{n_t} \pi_t\left(h\right) dh - W_t q + M_t - M_{t-1} + B_t - \left(1+i_{t-1}\right) B_{t-1} - T_t ,$$

where utility is defined

$$U_t = \ln C_t + \chi \ln \frac{M_t}{P_t} - \kappa l_t .$$

Defining $\mu_t = P_t C_t$, optimization implies an intertemporal Euler equation:

$$\frac{1}{\mu_t} = \beta(1+i_t)E_t\left[\frac{1}{\mu_t+1}\right] \tag{7}$$

a labor supply condition:

$$W_t = \kappa\mu_t \tag{8}$$

and a money demand condition:

$$M_t = \chi\mu_t\left(\frac{1+i_t}{i_t}\right). \tag{9}$$

An analogous problem and first order conditions apply to the foreign household.

2.3 Home firm problem and export entry condition

In the manufacturing sector, production is linear in labor employed by that firm:

$$y_t(h) = \alpha_t l_t\,(h), \tag{10}$$

where $l(h)$ is the labor employed by firm h, and where α represents stochastic technology common to all production firms in the country (no productivity heterogeneity among firms). 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 $p^*(h)$ for export equal to $p(h)/e$, where the nominal exchange rate, e, is defined as home currency units per foreign currency unit. Production involves a fixed cost in labor units q, paid each period. Exports involve an iceberg trade cost, τ, so that

$$y(h) = c_t(h) + (1+\tau_t)c_t^*(h). \tag{11}$$

Firm profits are computed as:

$$\pi_t\,(h) = p_t(h)c_t(h) + e_t p_t^*(h)c_t^*(h) - W_t y_t(h)/\alpha_t . \tag{12}$$

Nominal rigidities are introduced as in the New Open-Economy Macroeconomics literature, by assuming that firms preset the price of their products before shocks are realized, and stand ready to meet demand at the ongoing price for one period. Firms choose their price by maximizing the expected discounted value of their profits

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

This implies the price setting function for domestic sales:

$$p_{t+1}(h) = \frac{\phi}{\phi - 1} \frac{E_t\left[\Omega_{t+1}\left(\frac{\kappa \mu_{t+1}}{\alpha_{t+1}}\right)\right]}{E_t\left[\Omega_{t+1}\right]} \tag{13}$$

$$\text{where } \Omega_{t+1} = P_{M,t+1}{}^{\phi-1} + (1+\tau)^{1-\phi}\left(\frac{\mu_{t+1}}{\mu^*{}_{t+1}}\right)^{\phi-1} P^*{}_{M,t+1}{}^{\phi-1}.$$

We assume producer currency pricing for exports, so the home firm export price is set:

$$p^*{}_{t+1}(h) = (1+\tau)\, p_{t+1}(h)/e_{t+1} \tag{14}$$

where home export prices are set in foreign currency units.

Given that entry into the market requires payment of a fixed cost in labor units, q, in the period prior to production, free entry will ensure that the following entry condition holds:

$$W_t q_t = E_t\left[\beta \frac{\mu_t}{\mu_{t+1}} \pi_{t+1}(h)\right]. \tag{15}$$

In the second sector, where firms are assumed to produce a homogenous good, the production function is also linear in labor:

$$y_{D,t} = \alpha_D l_{D,t}, \tag{16}$$

but productivity α_D is non-stochastic, and assumed to be identical across countries. It follows that the price of the homogeneous goods is equal to marginal costs:

$$p_{D,t} = W_t / \alpha_D. \tag{17}$$

2.4 Government

The model abstracts from public consumption expenditure. The government uses seigniorage revenues and taxes to finance transfers. The home government faces the budget constraint:

$$M_t - M_{t-1} + T_t = 0\,. \tag{18}$$

Monetary policy will be defined as a rule setting μ as a function of productivity levels:

$$\mu_t = \mu\left(\alpha_t, \alpha^*{}_t\right). \tag{19}$$

2.5 Market clearing

The market clearing condition for the goods market was already given in equation (11) above. Labor market clearing requires:

$$l_{M,t} = \int_0^{n_t} l_t\left(h\right)dh = n_t l_t\left(h\right), \tag{20}$$

and

$$l_{M,t} + l_{D,t} + n_{t+1} q = l_t\,. \tag{21}$$

Bond market clearing requires:

$$B_t = 0\,. \tag{22}$$

Market clearing in the homogenous good sector requires:

$$C_{Dt} + C^*_{Dt} = y_{Dt} + y^*_{Dt}\,. \tag{23}$$

With no trade costs in this sector, arbitrage ensures that:

$$P_{Dt} = e_t P^*_{Dt}\,. \tag{24}$$

We assume no international trade in assets, thus requiring balanced trade:

$$\int_0^{n_t} p_t^*\left(h\right)c^*_t\left(h\right)dh - \int_0^{n^*_t} p_t\left(f\right)c_t\left(f\right)df - p_{Dt}\left(C_{Dt} - y_{Dt}\right) = 0\,. \tag{25}$$

2.6 Equilibrium definition and dynamic stability:

Equilibrium is a sequence of the following 47 variables: C, P, $c(h)$, $c^*(h)$, $p(h)$, $p^*(h)$, C_M, C_D, P_M, P_D, W, l, $l(h)$, l_D, l_M, $y(h)$, y_D, $\pi(h)$, n, M, i, T, B and foreign counterparts for each of these, along with e. Of the 47 equilibrium conditions needed, 44 are given by equations (1)-(22) and foreign counterpart, the remaining 3 by equations (23)-(25).

2.7 Risk sharing and exchange rate determination

Analytical results for the exchange rate are greatly facilitated by assuming that both economies produce the same homogeneous good with identical technology under perfect competition. Note that, by equations (8) and (17), the exchange rate may be expressed as:

$$e_t = \frac{p_{Dt}}{p^*_{Dt}} = \frac{W_t}{W^*_t} = \frac{P_t C_t}{P^*_t C^*_t} = \frac{\mu_t}{\mu^*_t}. \tag{26}$$

The exchange rate is 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 linear disutility of labor, then, the exchange rate is a function of the ratio of nominal consumption demands (and hence is the ratio of the monetary policy stance variables).

A key implication is that trade in the perfectly competitive good guarantees complete risk sharing in the goods market regardless of market structure or specification of the rest of the goods market. Rewrite the above equation as:

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

This is the risk sharing condition implied by complete asset markets for the case of log utility: 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. In our economy, risk sharing is complete per effect of nominal wage equalization (due to trade in a single homogenous good), even in the absence of trade in financial assets.

Along with the *real exchange rate*, we report two alternative measures of international prices. Following the trade literature, we compute the terms of trade as the ratio of ex-factory prices set by a home firm relative to a foreign firm in the manufacturing sector: $TOTM_t \equiv p_t(h) / \left(e_t p^*_t(f)\right)$.[7] This measure ignores the homogeneous good, which in

[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), as well as Campolmi et al. (2012).

equilibrium may be either imported or exported. In our second measure, instead, we compute the terms of trade taking the homogenous good into consideration. As common practice in the production of statistics on international relative prices, this version is computed by weighting goods with their respective expenditure shares. For example, in the case where the homogeneous good is imported by the home country,

$$TOTS_t \equiv p(h)_t / [\omega_t e_t p^*(f)_t + (1-\omega_t) p_{D,t}],$$

where the weight is an expenditure share:

$$\omega_t \equiv e_t p_t(f) n^*_{t-1} c_t(f) / [e_t p_t(f) n^*_{t-1} c_t(f) + p_{D,t}(c_{Dt} - y_{Dt})].$$

Finally, we rewrite the home entry condition (15) as a function of price setting and the exchange rate:

$$\frac{\kappa q}{\beta\theta} = E_t\left[\left(p_{t+1}(h) - \frac{\kappa\mu_{t+1}}{\alpha_{t+1}}\right) p_{t+1}(h)^{-\phi}\, \Omega_{t+1}\right] \tag{27}$$

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

$$\begin{aligned} \Omega_{t+1} &= \left(n_{t+1} p_{t+1}(h)^{1-\phi} + n^*_{t+1} p^*{}_{t+1}(f)^{1-\phi} e_{t+1}{}^{1-\phi} (1+\tau)^{1-\phi}\right)^{-1} \\ &+ \left(n_{t+1} p_{t+1}(h)^{1-\phi} + n^*_{t+1} p^*{}_{t+1}(f)^{1-\phi} e_{t+1}{}^{1-\phi} (1+\tau)^{\phi-1}\right)^{-1}. \end{aligned}$$

The foreign entry condition is analogously defined.

Provided that the price setting rules can be expressed as functions of the exogenous shocks and policy settings (a condition satisfied in several useful cases), 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.

2.8 Parameter values for numerical experiments

For the numerical experiments to follow, macro parameters are taken from standard real business cycle values: ϕ =6 among differentiated goods (implying a price markup of 20%), and β =0.96 to represent an annual frequency. The share of nonmanufacturing goods is set at

$\theta = 0.5$. The parameters for money demand and labor supply are set at $\chi = 1$ and $\lambda = 1$. Trade cost are set at τ =0.1, and the fixed cost is q=0.1.

For the purpose of deriving analytical results, we assume that productivity in each country follows an i.i.d. log normal distribution, independent of productivity in the other country. For simulations, the mean of productivity is set to unity in each country, and the standard deviation of productivity is set to 0.017, which implies the standard deviation of output used in Backus et al (1992). We set the productivity in the homogeneous sector at $\alpha_D = 1$.

Parameters are set the same across countries to imply a non-stochastic steady state symmetric between the two countries. In what follows, we will rely on analytical results when possible, assuming a log utility function and certain policy rules. Numerical results are nonetheless presented for a wider range of cases and variables, and computed from a second order approximation of the stochastic model. The most original results involve policies that are asymmetric across countries, but as a benchmark for comparison, we first present results for symmetric policies.

3. Flexible price allocation and efficient monetary rules

In this and the following sections, we will address the question of assessing the consequences of alternative stabilization policy regimes on the output composition and welfare in the two economies. We begin with a characterization of the flex-price allocation, and establish that the consequences of nominal rigidities and the design of globally efficient policies in our model are the same as in the baseline NOEM model.

3.1 Flexible prices

If firms set prices after observing (productivity) shocks, with constant demand elasticity, managers will charge a constant markup over marginal costs, which in our case coincide with unit labor costs:

$$p_{t+1}^{flex}(h) = \frac{\phi}{\phi - 1}\kappa\frac{\mu_t}{\alpha_t} \qquad p_{t+1}^{*flex}(f) = \frac{\phi}{\phi - 1}\kappa\frac{\mu^*_t}{\alpha^*_t}.$$

Substituting into the entry condition (27) above, the equilibrium number of firms is:

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

Note that the number of firms is not time-varying and does not respond to productivity shocks. This is because the number of firms is predetermined and shocks are i.i.d.[8] The latter assumption clearly facilitates many of our analytical results below. With no monetary policy response to shocks ($\mu_t = \mu_t^* = 1$, as none is needed under flexible prices), the exchange rate will be constant at $e_t = \mu_t / \mu_t^* = 1$.

Under constant money supply, Figure 1 illustrates the dynamics of key macro variables in response to a one standard deviation productivity shock in manufacturing good. A fall in the price of home goods in both countries raises the demand for home goods at the global level. The home country shifts resources away from production of the non-manufacturing good, and concentrates production in the manufacturing good sector. In the foreign country, the opposite occurs. Overall consumption rises in both countries.

3.2. Consequences of nominal rigidities

Consider now the specification of the model with nominal rigidities impinging on prices of manufacturing goods. A first important consequence is that, unless monetary policy is contingent on shocks, preset prices would prevent the economy from achieving the allocation characterized above. Without loss of generality, we set, as before, $\mu_t = \mu_t^* = 1$, implying a constant exchange rate. ($e_t = \mu_t / \mu_t^* = 1$). With i.i.d. shocks, there are no dynamics in predetermined variables such as prices and numbers of firms. We can thus solve for these

[8] Even in a case where monetary policy endogenously responds to shocks, changing the value of μ_t, the number of firms is not time-varying in response to shocks. While a change in μ_t will affect wage level and hence entry costs on the left side of equation (15), the wage is directly proportional to μ_t, which exactly cancels the appearance of μ_t on the right hand side as part of the discount factor.

analytically. Prices are optimally preset charging the constant, equilibrium markup over expected marginal costs:

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

The number of firms can be computed by substituting these prices into the entry condition (27), so to obtain:

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

With preset prices and no change in the exchange rate, there is no change in the price index or any relative price. For a given monetary stance, there is no change in consumption demands, and so no change in the level of production in any good. The only response to an i.i.d. shock raising home productivity in the manufacturing sector is a fall in the level of employment in the same sector (not compensated by a change in employment in the other sectors of the economy).

Table 1 reports unconditional means of variables computed from a stochastic simulation of a second order approximation to the model. (See column 1.)

3.3. Globally efficient stabilization policy

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. Hence, it is possible to replicate the flex-price allocation under a simple monetary policy rule. That is, 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 constant, but contingent on productivity differentials. Namely. the home currency depreciates in response to an asymmetric rise in home productivity:

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

This result is familiar from the classical NOEM literature assuming that prices are sticky in the currency of the producers (Corsetti and Pesenti (2001, 2005) and Devereux and Engel (2003), among others). Endogenous exchange rate movements contribute to replicating the flexible price equilibrium, by making home (manufacturing) goods cheaper to foreigners when the home country is able to produce them more efficiently.

Under the policy rules specified above, the optimal price preset by home manufacturing firms is lower than the price firms preset in an economy with no stabilization:

$$p_{t+1}^{stab}(h) = \frac{\phi}{\phi - 1}\kappa < p_{t+1}^{no\ stab}(h),$$

given that, by Jensen's inequality, $E_t\left[\frac{1}{\alpha_{t+1}}\right] > \frac{1}{E_t\left[\alpha_{t+1}\right]} = 1$. Moreover, as shown in the appendix, the number of manufacturing firms is the same as the flexible price case.

$$n_{t+1}^{stab} = n_{t+1}^{flex}.$$[9]

In response to a productivity shock, the dynamics of the economy with an efficient stabilization in place, shown in figure 2, are the same as for the flexible price case. With nominal rigidities, of course, the reason why the foreign-currency price of the home manufacturing good falls is the expansionary response of home monetary authorities, which results in a home currency depreciation fully passed through in the import market. As in the flex-price economy, the home country shifts resources away from production of the non-manufacturing good and concentrates production in the manufacturing good sector. The foreign country does the opposite. Consumption of both countries rises.

The numerical exercise reported in Table 1 (column 2) illustrates the analytical results above. Relative to the case of no stabilization, the effects of efficient policy are quite small in magnitude, as is commonly found in analogous quantitative studies. Stabilization policy that is symmetric across countries leads to a rise in the number of manufacturing firms and a rise in overall manufacturing production, with no change in nonmanufacturing production. With greater access to varieties, there is a small drop in the consumer price index and corresponding

[9] 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. Simulations in table 1 show 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.

rise in the consumption index. The effects regarding the manufacturing sector coincide with those found in Bergin and Corsetti (2008).

4. Stabilization policies and 'competitiveness': the case of currency pegs and deterministic money growth rules

The equilibrium allocation is significantly different if countries do not adopt symmetric policy rules. To gain insight into the way our model works, we will now consider the policy configuration of a currency peg. We posit that the home government fully stabilizes its output gap, while the foreign country maintains its exchange rate fixed against the home currency: $\mu_t = \alpha_t, \quad e_t = 1$ so $\mu_t^* = \mu_t = \alpha_t$. As a related exercise, we will extend the analysis to the case in which the foreign country keeps its money growth constant ($\mu_t^* = 1$) while home carries out its stabilization policy as above.

Under a currency peg the optimally preset prices are:

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

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

$$\frac{1}{n_{t+1} + An_{t+1}^*} + \frac{1}{n_{t+1} + Bn_{t+1}^*} = \frac{\kappa q \phi}{\beta \theta}$$

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

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 does allow one to prove that $n > n^{flex} > n^*$ (see the appendix). Other things equal, the limit to macroeconomic stabilization implied by a currency peg tends to reduce the size of the manufacturing sector in the foreign country, in favor of the home country. In other words, the country pegging its currency will tend to specialize in the homogeneous good sector.

Column (4) in Table 1 reports unconditional means of variables for the currency peg case. Our numerical exercise corroborates the claim that inefficient stabilization policy in the country that pegs the currency leads to a higher price of foreign manufactures relative to full stabilization in the home economy, hence raising the world demand for home manufactures. Lower prices set by home firms translate into weaker ex-factory terms of trade reported in the table ($TOTM \equiv p(h)/(ep^*(f))$. As production of manufactures in the home country rises, while it falls in the foreign country, the latter specializes in production of the homogeneous good. Firm entry increases in the home county in response to the rise in demand, and it falls correspondingly in the foreign country.

In quantitative terms, the number of home manufacturing firms rises 1.25 percent relative to the no stabilization case, while the number of manufacturing firms in the foreign country falls by an equal amount. The home country now has 2.5% more domestic manufacturing firms compared to the foreign country. Relative to the symmetric policy case shown in column (2), the impact of a currency peg on the allocation is two orders of magnitude larger.

The ability to carry out optimal stabilization policy gives the home country a comparative advantage in producing the good that is sensitive to shocks and uncertainty. In this respect, our results are close in line with the production relocation argument of Ossa (2011), whereas 'tariff policy' is replaced by 'stabilization policy.' Home stabilization policy benefits the home manufacturing sector more when there is a foreign country passively pegging its currency, from which it can draw manufacturing demand. The home country is better able to specialize in the manufacturing industry when there is a foreign country to which it can export manufacturing goods and import the nonmanufacturing goods that it no longer produces at home.

The welfare implications of specialization in manufacturing goods also parallel the trade literature. Because manufacturing goods are subject to trade costs, home consumers benefit from saving on these costs and thus from a lower consumption price index, when these goods are mostly produced domestically. The relatively lower cost of consumption in the home country is reflected in the depreciation of the real exchange rate ($rer \equiv eP^{*} / P$) reported in Table 1. With a lower home price index, consumption and welfare rise accordingly. In consumption units, relative to the case of symmetric monetary policies, the welfare gain is approximately 50% larger when the home country pursues unilateral stabilization, as reported in the table.

However, our model also yields a key result typically not discussed by the trade literature. While the *terms of trade of manufacturing* worsen for the country that stabilizes its output gap completely, its *terms of trade including the homogenous good, TOTS,* actually improve. This is due to a composition effect: the home country exports more manufacturing, and imports the homogenous goods. The improvement in the overall terms of trade corresponds to a much higher consumption (utils) to labor ratio, relative to the pegging country.

It is also worth noting that, in our model, a depreciation of the nominal exchange rate in the short run is systematically correlated with a worsening of the terms of trade, a piece of evidence emphasized by Obstfeld and Rogoff (2000). Given the number of firms in the market, and the fact that their price is preset in domestic currency, the foreign-currency price of domestic products cannot but fluctuate one-to-one with the exchange rate within each period. The improvement in the country's terms of trade at the core of our results, indeed, stems from the effects of monetary stabilization rules on *average* manufacturing prices, firm entry, and thus the composition of a country's exports and imports over time.

The results just described are not significantly different, if we replace the currency peg with the assumption that the foreign country pursues a non-contingent monetary rule, e.g. keeps money constant ($\mu_t = \alpha_t, \mu_t^{*} = 1$). Comparing columns 3 and 4 in the table makes it clear that all variables move in the same direction. Under a peg, however, the fact that the foreign country shadows the home monetary stance means that its producers face some noise in demand and marginal costs (unrelated to domestic productivity), which is not there if the central bank just follows a money growth rule. Foreign residents are better off under the latter arrangement (column 3) than under a peg (column 4).

5. Strategic policy interactions and the benefits from international coordination

The analysis so far emphasizes that a production relocation externality imbues policy with beggar-thy-neighbor implications. We now consider gains from international policy coordination, relative to a Nash equilibrium. To this end, without loss of generality, we write a general form for the policy rule, nesting the cases considered above:

$$\begin{aligned} \mu_t &= \alpha_t^{\gamma_1} \alpha_t^{*\gamma_2} \\ \mu_t^* &= \alpha_t^{*\gamma_1^*} \alpha_t^{\gamma_2^*}. \end{aligned} \tag{28}$$

The full stabilization case above corresponds to the case $\gamma_1 = \gamma_1^* = 1$, $\gamma_2 = \gamma_2^* = 0$. The no-stabilization case corresponds to $\gamma_1 = \gamma_1^* = \gamma_2 = \gamma_2^* = 0$.

We first establish that the symmetric full stabilization case is globally efficient, namely, we verify that $\gamma_1 = \gamma_1^* = 1$, $\gamma_2 = \gamma_2^* = 0$ is a solution to the problem:

$$\underset{\gamma_1, \gamma_1^*, \gamma_2, \gamma_2^*}{Max} \quad E_0\left[\left(\ln C_t - L_t\right) + \left(\ln C_t^* - L_t^*\right)\right]. \tag{29}$$

Figures 3a and 3b report the sum of the unconditional means of home and foreign welfare for various values of the two policy parameters. The figures show that a perturbation up or down in either policy parameter from the values for the full stabilization case produces lower world welfare. In line with the literature, in the presence of appropriate production subsidies compensating for the markup driving a wedge between prices and marginal costs, the full stabilization case would coincide with the social planner optimum.

Next we establish that the case of efficient stabilization policy is not a Nash equilibrium. To this goal, we verify whether $\gamma_1 = 1$, $\gamma_2 = 0$ is a solution to the home policy maker problem:

$$\underset{\gamma_1, \gamma_2}{Max} \quad E_0\left[\ln C_t - L_t\right] \tag{30}$$

under the assumption that foreign policy parameters are $\gamma_1^* = 1$, $\gamma_2^* = 0$. This is equivalent to testing whether there is an incentive for one of the countries to defect from the efficient solution. As expected, Figures 4 and 5 show that the home country can unilaterally raise its own welfare relative to the efficient equilibrium allocation if it mutes the response to domestic productivity disturbances, i.e. if it lowers the value of γ_1 holding γ_2 constant at 0. This means that when the home country experiences a rise (fall) in productivity, it responds with a smaller (larger) monetary expansion than in the symmetric, efficient stabilization case. This translates into reduced exchange rate volatility. A similar conclusion applies to the parameter γ_2 when studied in isolation, holding γ_1 constant at 1. The home country can raise home welfare as well as the number of domestic manufacturing firms if it raises money supply at the same time as the foreign country expands in response to a positive own productivity shock. The effect is clearly that of preventing the exchange rate from moving in favor of the foreign manufacturing sector.

The figures also show two important results. First, the highest home welfare coincides with the maximum expansion of the home manufacturing sectors, in terms of the number of manufacturing firms which are active in the country. Second, while curbing exchange rate volatility is beneficial over some range, moving towards a currency peg becomes increasing detrimental to comparative advantage and welfare. Both drop substantially as γ_1 approaches 0 or γ_2 approaches 1, consistent with the analysis in the previous section.

Numerical results describing the effect of an optimal unilateral deviation from the globally efficient rules are shown in Column 7 of Table 1. Relative to column 2, the home country has more manufacturing firms and output. Its real exchange rate and its terms of trade for manufacturing are on average weaker. Yet, its overall terms of trade are stronger, enabling residents to consume more at each level of employment.

To support the claim that the production relocation externality is the principal driver of the incentive to defect from the efficient equilibrium, we run two versions of the model without entry and/or iceberg costs. Results are shown in column 8 and 9 of Table 1. In either case, a terms-of-trade externality creates an incentive for policymakers to deviate from the globally efficient rules, but the deviation is extremely small: the allocation is approximately identical to the one in column 2. On the other hand, running the model without entry, but imposing an asymmetric production structure with n and n^* set at the same level as in column 3, produces large welfare differences relative to the symmetric case in column 2. This exercise confirms that saving on trade costs is the main source of welfare gains in the model.

To find the Nash equilibrium, we iterate over the grid search, where at each iteration the foreign policy parameters are updated to the optimal home policy parameters from the previous round. We find a Nash equilibrium for $\gamma_1 = \gamma_1^*$=0.66, $\gamma_2 = \gamma_2^*$=0.34. Figure 6 illustrates the macroeconomic dynamics following a home positive productivity shock under the Nash policies. Note that, compared to the efficient stabilization case ($\gamma_1 = \gamma_1^*$ = 1, $\gamma_2 = \gamma_2^*$ = 0), each country expands by less. The equilibrium is characterized by understabilization at the global level.

The mechanics by which, in a Nash, policymakers deviate from globally optimal rules is well understood (see e.g. Corsetti and Pesenti 2005). It is best illustrated by noting that, under the full stabilization case, marginal costs are completely stabilized, and then tracing the consequences of uncertainty for price setting and entry. While we refer to the appendix for a detailed derivation, we can provide an intuitive account as follows. We have seen that, in our model, monetary policy can bring the economy to operate at its flex-price level, essentially affecting nominal demand and wages to ensure that firms' markups are at their equilibrium level: policymakers expand the monetary stance in states of the world in which productivity is high, and contract it when productivity is low. Suppose we start in this world, and consider the effect of under-stabilization. A moderate degree of under-stabilization means that, in high productivity states, demand is relatively low, but costs are even lower: markups thus increase relative to the flex-price level. Conversely, in low productivity states, demand and costs remain relatively high, reducing markups below equilibrium. In other words, under-stabilization tends to expand markups in high productivity states, and squeeze them in low productivity states. This is bad for expected discounted profits at the firm level. By presetting lower prices, however, the firms can optimally compensate, at least in part, for monetary under-stabilization. At the margin, lower average prices allow the firm to rebalance markups across states of nature, raising revenues and profits in good times. This is essentially the mechanism underlying the (risk) premium in the optimal pricing formula.

Because the social planner optimum is not a Nash equilibrium, there is an opportunity to benefit from international policy coordination, as a way to enforce the social planner policies.

Column 6 of table 1 reports the unconditional means of variables under the Nash policy rule. If we compute the welfare gains from policy in terms of a percentage increase in steady state consumption units (*x*):

$$E_0 U\left(\left(1+x\right)C^{no\,stab}, L^{no\,stab}\right) = E_0 U\left(C^{stab}, L^{stab}\right)$$

and compare the gains from the social planner optimum and the Nash equilibrium, we find that the gain from the social planner exceeds that of the Nash by 40%. In other words, the additional gain from coordination over Nash is 2/3 of the gain from optimal stabilization done unilaterally.

This result on the benefits from coordination contrasts sharply with a vast body of literature, which finds the gain from coordination to be exceedingly small, when not nil. By way of example, in the models of Corsetti and Pesenti (2005) and Devereux and Engel (2003), with which our model shares many features, there is no benefit from coordination. In our model, under the same assumption, the introduction of firm entry and a production relocation externality changes this conclusion.

Our results also contrast with Obstfeld and Rogoff (2002), which stresses that policy coordination has no benefit under the assumption of log utility, whether prices are preset in the producers' currency or in the local currency.[10] Our paper offers a counterexample, where there are gains from coordination even under log utility. The difference is that the production relocation externality provides a first-order benefit to a country from defecting from the social planner equilibrium, where there was no such first-order effect in the model of Obstfeld and Rogoff (2002).

Clearly the key reason that our model alters the result of preceding literature is the existence of a production relocation externality in a two (tradable) sector economy. The production relocation externality was introduced in the trade literature in Ossa (2011), to provide a rationale for tariff reciprocity, in contrast to the classical optimal tariff argument. Ossa argued that a focus on tariffs as a way to manipulate a country's terms of trade misses the primary motivation for strategic protection policies, that is, to encourage (or prevent) relocation

[10] Moreover, even if coordination produces gains under more general CRRA preferences, these gains are tiny in comparison with the gains from moving from constant money supply to policy responding to shocks.

of production activity. We make the same argument here in a constructive critique of micro-founded macro models. As shown above, the beggar-thy-neighbor effects of production relocation alter the incentive for strategic monetary policy behavior, and hence the benefits for monetary policy coordination.

Our model hence differs from theories of cooperation based on a terms of trade externality, as in Benigno and Benigno (2003) and Sutherland (2004), which essentially builds on the optimal tariff argument (see Corsetti and Pesenti 2001). The standard argument is that policymakers can raise welfare under elastic demand for exports, if they improve the terms of trade; this lowers the disutility of labor while allowing consumers to substitute toward foreign goods. Our result differs in two key respects. Firstly, we model a different mechanism: the production relocation externality is based on the benefits of firm entry in terms of lower trade costs. Secondly, this mechanism reverses the sign of optimal policy. In our model, under elastic demand for exports, it is optimal to mute monetary policy responses to own productivity shocks, in order to lower the mean level of the terms of trade in manufacturing. A weaker real exchange rate and lower prices make home manufacturing goods more competitive and encourages entry. In the model specification featuring a standard terms of trade externality (see Sutherland 2004), the policy prescription is just the opposite. Under elastic foreign demand, policymakers overstabilize domestic productivity shocks, seeking to drive the manufacturing terms of trade up.[11]

6. Empirical evidence

To carry out an empirical exploration of our main argument, we focus on a key testable implication of the model derived in Section 4: countries with monetary policy focused on domestic macro stabilization will have greater specialization of production and export in differentiated products, relative to countries with monetary policy driven instead by the objective of maintaining a fixed exchange rate. In summary, taking the U.S. as the base

[11] In a model similar to ours without the competitive sector, Sutherland (2004) shows that the optimal deviations from globally optimal rules prescribes $\gamma_1 > 1$. Simulation of a version of our model that excludes the competitive sector replicates this result.

country, we run panel regressions to test whether countries with independent monetary policy tend to have a greater share of their exports to the U.S. in industries classified as differentiated. Regressions will be of two types: pooled country-sector analysis first, followed by country-level analysis.

6.1 Data construction and description

A key step in our analysis is to identify exports in differentiated industries. Rauch (1999) provides a useful classification of 4-digit SITC industries in terms of the degree of differentiation among products. Some products are traded on organized exchanges, and 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, and they represent somewhat above one half of the value of U.S. imports. Let DIF_i represent the Rauch classification of industry *i*, taking a value of 1 for a differentiated industry, and 0 otherwise.

Trade data come from the World Trade Flows Database (see Feenstra, et al., 2005). Exports to the U.S. are available disaggregated by country and by four-digit industry, on an annual basis 1972-2004. We use notation x_{ijt} to represent the dollar value of exports in industry *i* from country *j* to the U.S. in year *t*, and we take logs.[12]

The final key ingredient is a classification of monetary policy regime. The International Monetary Fund produces a de facto classification of exchange rate regimes 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. Let the index PEG_{jt}, take a value of 1 for a country *j* with some form of fixed exchange rate in period *t*, and let it take a 0 for counties with a flexible exchange rate. For the sake of robustness, we will also consider the

[12] Before taking logs, industries with zero trade value are replaced by a value of 1.

classification system of Shambaugh (2004), which identifies pegging countries as those where interest rates systematically follow the interest rate of a base country.

The set of countries covered both by the trade data and exchange rate classification number 164. The set of sectors covered both by the trade data and the Rauch index number 773. The sample years are determined by the availability of U.S. disaggregated import data, covering the period 1972-2004.

6.2 Pooled country-sector analysis

We consider two types of panel regression analysis. The first focuses on exports disaggregated at the four-digit industry level. The baseline specification is

$$\log x_{ijt} = \beta_0 + \beta_1 PEG_{jt} \bullet DIF_{it} + \beta_2 PEG_{jt} + \chi_i + \chi_j + \chi_t + \varepsilon_{ijt} \qquad (31)$$

where *PEG* takes the value of 1 for a fixed exchange rate and 0 otherwise, and *DIF* takes the value of 1 for a differentiated industry and 0 otherwise. Hence, the interaction term takes a value of 1 only for exports in a differentiated sector by a country that had a fixed exchange rate in that year. We also allow for various configurations of fixed effects to control for unmeasured factors specific to a country, time period, and sector. Given that *DIF* varies only by sector, it is subsumed in the sector fixed effect and does not need to appear in the regression.

The theoretical model predicts that $\beta_1 < 0$. Results in Table 2 support this prediction with a high degree of statistical significance.[13] Comparing magnitudes of coefficients in the full sample (column 1), it appears that when a given country adopts a fixed exchange rate, this raises exports in non-differentiated industries by about 10 percent; however for differentiated industries this effect is more than cancelled out by the negative effect of the interaction term, so that exports of differentiated goods instead fall on net by about 10 percent. We conclude that a peg shifts the composition of a country's exports toward non-differentiated goods.

It is standard in cross-sectional regressions of trade composition to include controls for other determinants of comparative advantage, such as explicit measures of factor abundance of a country and factor intensity of an industry. Our macroeconomic dataset and regression

[13] Standard errors are robust to heteroskedasticity and are clustered.

specification are unusual in that they include variation in the time dimension. This permits us to use a fixed effect that interacts country and sector as a comprehensive way to control for other determinants of comparative advantage that do not vary over time. Table 3 shows that our result is robust to this specification. We also include a fixed effect interacting country with year, which is useful for controlling for the effects of macroeconomic variables such as exchange rate level and current account. For example, a country abandoning a peg, say after a currency crisis, might suddenly devalue and raise its level of exports, which might affect the export mix. The interaction fixed effect is a comprehensive means of controlling for these and other conceivable effects of time-varying macroeconomic variables that affect all sectors of a country's exports.

The remaining columns of tables 2 and 3 show the result is robust to alternative samples. One concern may be that countries adopt a fixed exchange rate because they are endowed with oil or other commodities, which are invoiced in foreign currency. One way to check this is to exclude 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 7).[14] Both sets of estimations continue to strongly support our claim.

The result is also robust to limiting the sample to more developed countries, with cutoffs in per-capital income of $2000, $5000 and $10,000. It is also robust to a sample of just manufacturing industries (SITC categories beginning with of 5 and higher). Although we phrase the discussion of our model in the preceding sections focusing on the choice between 'manufacturing' and 'non-manufacturing' goods, the empirical content of our theory clearly requires a finer classification. By the logic of the model, we should distinguish manufacturing goods with a different degree of product differentiation, entry and trade costs. Finally, the result also is robust to using the Shambaugh classification of exchange rate regime.

[14] The following countries are excluded as a result: Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Norway, Qatar, Russia, Saudi Arabia, United Arab Emirates, Venezuela.

6.3 Country-level analysis

The second analysis we carry out is at the aggregate country level. The dependent variable in this case is the share of differentiated goods in total exports of a country. We adopt the following differentiation index. For country *j* in year *t*, we define:

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

The index takes values on the continuous interval between 0 and 1. Note that while in our first regressions, DIF_i did not vary by country or time, $SDIF_{jt}$ varies both over countries and years due to variation in the trade weights. The regression specification is now

$$SDIF_{jt} = \beta_0 + \beta_1 PEG_{jt} + \chi_j + \chi_t + \varepsilon_{jt} . \quad (32)$$

We also include controls for country and year fixed effects.

The model predicts $\beta_1 < 0$: the share of a country's exports in differentiated goods falls when it adopts a fixed exchange rate policy. Results in table 4 support this prediction. Baseline estimates in column 1 indicate that, when a country adopts a peg, the share of its exports in differentiated goods falls 6 percentage points. Given that for the typical country, differentiated goods account for about half of its exports, the estimated coefficient suggests that the effect of pegging the currency on the pattern of specialization and trade is economically meaningful.

Our result is robust to the various checks considered previously for the pooled regression. In addition, because we cannot include fixed effects that interact country and year, we include explicit controls for the macroeconomic variables discussed above that might affect trade composition: real exchange rate level, current account, and indicators for a country in a currency or banking crisis. The result is robust to these additional controls.

7. Conclusion

According to a widespread view in policy and academic circles, monetary policy can contribute to national welfare by boosting the competitiveness of the domestic manufacturing sector, with potential beggar-thy-neighbor effects. This paper revisits the received wisdom on this issue, exploring a new direction for open-economy monetary models.

The literature has so far focused on terms of trade externalities as key considerations shaping strategic policy interactions across countries. In the standard new-Keynesian model, optimal monetary policy essentially acts as if it pursued an ‘optimal tariff’ objective, moving the terms of trade in favor of the domestic residents. In contrast, the main idea underlying our approach consists of allowing for incomplete specialization in the production of two (or more) tradable goods, with fundamental asymmetries regarding their contribution to national welfare. In our specification, acquiring comparative advantage in the monopolistic sector producing differentiated goods is desirable, insofar as it brings about saving in trade costs --- the main implication of a production relocation externality. Alternative specifications could build upon differences in market power across sectors, (knowledge) externalities and other sources of increasing returns.

We have shown that the standard model augmented with two tradable sectors and a production relocation externality brings the main lessons from the literature closer to addressing core concerns shaping the policy debate, regarding the implications of monetary and exchange rate policies for competitiveness. Industries with monopoly power are typically associated with sunk (entry) investment and price stickiness, arguably making them more sensitive to macroeconomic uncertainty than other industries. By stabilizing macro shocks affecting their marginal costs and revenues, monetary policy can attract such industries, leading to potentially large welfare gains.

From a domestic (non-cooperative) perspective, welfare-maximizing monetary stabilization rules thus optimize over a trade-off between output gap stabilization, the international competitiveness of domestic industries, and the strength of the country’s terms of trade. Monetary rules contribute to shape domestic comparative advantage in manufacturing, by creating conditions for domestic firms to charge low average prices on their exports and so acquire a larger share of world demand for manufacturing. In spite of low domestic manufacturing prices, however, per effect of a changing composition of output and exports towards high markup goods, the country actually improves its overall terms of trade. Because of strong beggar-thy-neighbor effects associated with strategic deviations from the globally efficient rule, we find sizable gains from international policy coordination relative to the case of opportunistic conduct of monetary policy.

Our analysis also provides a novel perspective on the benefits of alternative exchange rate regimes. In our stylized model, from a country's vantage point, it is beneficial to pursue a stabilization policy that contains (fundamental) exchange rate volatility relative to the benchmark case of complete output gap stabilization. Yet, fixing the exchange rate is not optimal. Critical views of currency pegs typically emphasize the costs of giving up the ability to respond to shocks with ex-post monetary expansion and currency depreciation, boosting domestic and external demand. Our analysis unveils a different dimension of the same problem, which consists of the policymakers' ability to influence firms' pricing policies, contributing to the country's competitiveness. In our analysis, adopting a currency peg has a negative effect on a country's comparative advantage in the production of differentiated goods, a proposition that finds support in our explorative empirical analysis.

Monetary policy of course cannot be expected to play the same pivotal role as real factors, such as research and development, investment in human and physical capital, market structure, taxation and the like, in determining a country's competitiveness. Nonetheless, the theoretical and empirical results from our analysis suggest that its potential role is far from negligible, and may be larger than the standard welfare gains from stabilization in the monetary policy literature.

References

Backus, David K., Patrick J. Kehoe and Finn E. Kydland, 1992. "International Real Business Cycles," *Journal of Political Economy* 100, 745-775.

Benigno, Gianluca and Pierpaolo Benigno, 2003. "Price Stability in Open Economies," *Review of Economic Studies* 70, 743-764.

Bergin, Paul and Giancarlo Corsetti, 2008. "The Extensive Margin and Monetary Policy," *Journal of Monetary Economics* 55, 1222-1237.

Bilbiie, Florin O., Fabio Ghironi, and Marc J. Melitz, 2008. "Monetary Policy and Business Cycles with Endogenous Entry and Product Variety," in Acemoglu, D., K. S. Rogoff, and M. Woodford, eds., NBER Macroeconomics Annual 2007, University of Chicago Press, Chicago, 299-353.

Campolmi, Alessia, Harald Fadinger, and Chiara Forlati, 2012. "Trade Policy: Home Market Effect Versus Terms-of-trade Externality, forthcoming in the *Journal of International Economics.*

Canzoneri, Matthew B. Robert E. Cumby and Behzad Diba, 2005. "The Need for International Policy Coordination; What's old, what's new, what's yet to come?" *Journal of International Economics* 66, 363-384.

Cavallari, Lilia, 2010. "Exports and Foreign Direct Investments in an Endogenous-Entry Model with Real and Nominal Uncertainty," *Journal of Macroeconomics* 32, 300-313.

Corsetti, Giancarlo, Luca Dedola, and Sylvain Leduc, 2010. "Optimal Monetary Policy in Open Economies," *Handbook of Monetary Economics*, vol III, ed by B. Friedman and M. Woodford, 861-933.

Corsetti, Giancarlo, Philippe Martin and Paolo Pesenti, 2007. "Productivity, Terms of Trade and the `Home Market Effect'," *Journal of International Economics* 73(1), pages 99-127.

Corsetti, Giancarlo, and Paolo Pesenti, 2001. "Welfare and Macroeconomic Interdependence," *Quarterly Journal of Economics* 116, 421-446.

Corsetti, Giancarlo, and Paolo Pesenti, 2005. "International Dimensions of Optimal Monetary Policy," *Journal of Monetary Economics*, 52(2), 281-305

Davis, Donald R, 1998. "The Home Market, Trade and Industrial Structure," *American Economic Review* 88, 1264-1276.

Devereux, Mick and Charles Engel, 2003. "Monetary Policy in the Open Economy Revisited: Price Setting and Exchange Rate Flexibility," *Review of Economic Studies* 70, 765-783.

Feenstra, Robert C., Robert E. Lipisey, Haizan Deng, Alyson, C. Ma and Hengyong Mo, 2005. "World Trade Flows, " NBER Working Paper 11040.

Ghironi, Fabio and Marc J. Melitz, 2005. "International Trade and Macroeconomic Dynamics with Heterogeneous Firms," *The Quarterly Journal of Economics* 120(3), 865-915.

Helpman, Elhanan and Paul Krugman, 1989. *Trade Policy and Market Structure*, MIT Press.

Krugman , Paul, 1980. “Scale Economies, Product Differentiation, and the Pattern of Trade,” *American economic Review* 70, 950-59.

Krugman, Paul and Anthony J. Venables, 1999. “How Robust is the Home Market Effect?” Manuscript MIT.

Obstfeld, Maurice and Kenneth Rogoff, 2000. “New directions for stochastic open economy models”, *Journal of International Economics* 50, 117-154.

Obstfeld, Maurice and Kenneth Rogoff, 2002. “Global Implications of Self-Oriented National Monetary Rules,” *The Quarterly Journal of Economics* 117, 503-535.

Ossa, Ralph. 2011, “A “New Trade” Theory of GATT/WTO Negotiations,” *Journal of Political Economy* 119, 122-152.

Rauch, James E., 1999. “Networks versus Markets in International Trade,” *Journal of International Economics* 48, 7–35.

Staiger, Robert W. and Alan O. Sykes, 2010. “’Currency Manipulation’ and World Trade,” *World Trade Review* 9(04), 583-627.

Shambaugh, Jay C., 2004. “The Effect of Fixed Exchange Rates on Monetary Policy,” The *Quarterly Journal of Economics* 119, 301-352.

Sutherland, Alan, 2004. “International Monetary Policy Coordination and Financial Market Integration,” manuscript.

Appendix:

1. **Entry condition**:

Substituting (12) into (15) and simplifying:

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

Under producer currency pricing of exports:

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

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

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

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

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

Under log utility, where $W_t = \kappa\mu_t$ and $P_tC_t = \mu_t$, this becomes equation (27).

2. Entry under full stabilization

Substitute prices, $p_{t+1}(h) = p^*{}_{t+1}(f)\left(\phi/(\phi-1)\right)\kappa$, and policy rules ($\mu = \alpha,\quad \mu^* = \alpha^*$) into (27) and simplify:

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

Impose symmetry across countries:

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

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

Which is the same as for the flexible price case.

To compare to the no stabilization case, write this as

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

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

Note that $n_{t+1}^{stab} > n_{t+1}^{no\,stab}$ 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. Consider case of fixed exchange rate rule:</u>

Substitute prices and policy rules ($\mu = \alpha_*, \mu^* = \mu = \alpha \quad (\text{so } e = 1)$) into (27):

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

Pass through expectations and simplify

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

Do the same for the foreign entry condition:

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

Rewrite the home and foreign conditions as fractions:

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

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

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. Explaining how monetary policy affects optimal pricing

Normalizing the monetary policy parameters such that $\gamma_1+\gamma_2=1$ and $\gamma_1^*+\gamma_2^*=1$, we can rewrite the price-setting equation (13) as:

$$p_{t+1}(h)=\frac{\phi}{\phi-1}\kappa\left(E_t\left[\left(\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right)^{\gamma_1-1}\right]+\text{cov}_t\left[\Omega_{t+1},\left(\frac{\alpha_{t+1}}{\alpha^*_{t+1}}\right)^{\gamma_1-1}\right]\Big/E_t\left[\Omega_{t+1}\right]\right).$$

A primary determinant of the price setting equation is the covariance between labor production costs (W/α) and demand (a negative function of the Ω from above). Using the fact that under this policy $e_t=(\alpha_t/\alpha_t^*)^{\gamma_1+\gamma_1^*-1}$, Ω can be written as

$$\Omega_{t+1}=\left(n_{t+1}p_{t+1}(h)^{1-\phi}+n^*_{t+1}(1+\tau)^{1-\phi}\left(\frac{\alpha_t}{\alpha_t^*}\right)^{(\gamma_1+\gamma_1^*-1)(1-\phi)}p^*_{t+1}(f)^{1-\phi}\right)^{-1}$$
$$+\left((1+\tau)^{\phi-1}n^*_{t+1}\left(\frac{\alpha_t}{\alpha_t^*}\right)^{(\gamma_1+\gamma_1^*-1)(1-\phi)}p^*_{t+1}(h)^{1-\phi}+n_{t+1}p_{t+1}(f)^{1-\phi}\right)^{-1}$$

establishing that that the only time-varying term in the covariance above is α_t / α_t^*. We will now discuss how the sign and magnitude of the covariance term crucially depends on the configuration of policy parameters.

Consider first the case in which home policymakers focus on domestic stabilization. In general, the home monetary stance will respond to a domestic shock more than the foreign one: $\gamma_1 > \gamma_2^* = 1 - \gamma_1^*$ --- consistent with the fact the it is always optimal for home policymakers to devalue the home currency so to stimulate demand for domestically produced goods, both at home and abroad. Such condition is indeed verified in our characterization of optimal policies. In this case, it is apparent that a positive shock to the home productivity (a rise in α_t / α_t^*) will increase the 'demand' term Ω_{t+1} in the covariance above. Conversely, the cost term: $\left(\alpha_t / \alpha_t^*\right)^{\gamma-1}$ may either rise or fall, depending on whether γ is smaller or greater than one, that is, whether the home policy 'over' or 'under-stabilize the output gap. If the home policy over-responds to the shock (γ_1 >1), it will drive nominal wage growth above productivity growth, increasing marginal costs: --- see the term $\frac{W_{t+1}}{\alpha_{t+1}} = \kappa \frac{\mu_{t+1}}{\alpha_{t+1}} = \kappa \left(\frac{\alpha_{t+1}}{\alpha_{t+1}^*} \right)^{\gamma-1}$. The cost term in the covariance will rise.

Under the above policy configuration $\gamma_1 > 1 > \gamma_2^* = 1 - \gamma_1^*$, the covariance between demand and costs is positive, causing firms to preset higher prices. To gain insight on the mechanism, note that when monetary policy overstabilizes the output gap with γ_1 >1, it tends to squeeze markups in high productivity states of the world, and expand them in low productivity states. In high productivity states, as a domestic monetary expansion causes a demand boom for home goods, it raises marginal costs even faster. Conversely when productivity and thus demand are particularly low, marginal costs fall even more, raising markups. The fact that markups are squeezed when demand is high, and boosted when demand is low, is bad for expected discounted profits. By presetting higher prices, however, the firms can optimally react to monetary over-stabilization. At the margin, higher average prices allow the firm to rebalance markups across states of nature, raising revenues and profits in good times. This is essentially the mechanism underlying the (risk) premium in the optimal pricing formula.

In the case of under-stabilization, $1 > \gamma_1 > \gamma_2^* = 1 - \gamma_1^* \gamma_1$ <1, the $\left(\alpha_t / \alpha_t^*\right)^{\gamma-1}$ term falls with a rise in relative home productivity: the covariance term in the optimal pricing expression above turns negative. The logic of the argument is the same. If policy under-responds to shocks, markups are too high in good times, and excessively low in bad times. It is then optimal for firms to adjust their preset prices downward, again to transfer demand and revenues across states of the world, and ultimately raise expected discounted profits.

Monetary policy is optimally designed taking into account the trade-offs implied these effects, as to move the equilibrium allocation away from the natural rate when accounting for the production relocation externality. As shown in the text, the minimum level of prices (and thus of the premium in the above formula) corresponds to a γ_1 for which the rise in wage is small but there is still sufficient rise in demand. Note that the effect of policy is linear on wages, but nonlinear (for our demand elasticity greater than 1) on demand.

Table 1: Unconditional Means from Stochastic Simulations

policy	(1) none	(2) symmet-ric	(3) asym-metric	(4) fixed exch rate	(5) flex price	(6) Nash	(7) Unilateral defection	(8) (7) with exog entry	(9) (8) with no iceberg	(10) (9) with *n* from (7)
	$\mu=1, \mu^*=1$	$\mu=\alpha, \mu^*=\alpha^*$	$\mu=\alpha, \mu^*=1$	$\mu=\alpha, \mu^*=\alpha$		$\gamma_1=\gamma_1^*=.66$	$\gamma_1=.66, \gamma_1^*=1$	$\gamma_1=.66, \gamma_1^*=1$	$\gamma_1=.66, \gamma_1^*=1$	$\gamma_1=.66, \gamma_1^*=1$
n	0.8000	0.8000	0.8050	0.8100	0.8000	0.8000	0.8095	0.8000	0.8000	0.8095
*n**	0.8000	0.8000	0.7950	0.7900	0.8000	0.8000	0.7906	0.8000	0.8000	0.7906
p	1.0674	1.0672	1.0672	1.0671	1.0672	1.0673	1.0669	1.0672	1.0450	1.0450
*p**	1.0674	1.0672	1.0675	1.0678	1.0672	1.0673	1.0676	1.0673	1.0451	1.0451
c	0.9368	0.9371	0.9371	0.9372	0.9371	0.9370	0.9373	0.9371	0.9570	0.9570
*c**	0.9368	0.9371	0.9368	0.9366	0.9371	0.9370	0.9368	0.9370	0.9570	0.9570
l	0.9967	0.9967	0.9966	0.9966	0.9967	0.9967	0.9966	0.9966	0.9966	0.9966
*l**	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	0.9968
y_m	0.4166	0.4170	0.4196	0.4219	0.4170	0.4168	0.4218	0.4171	0.4172	0.4221
y_d	0.5000	0.5000	0.4969	0.4938	0.5000	0.5000	0.4941	0.4997	0.4996	0.4937
y_m^*	0.4166	0.4170	0.4140	0.4114	0.4170	0.4168	0.4120	0.4166	0.4166	0.4117
y_d^*	0.5000	0.5000	0.5031	0.5062	0.5000	0.5000	0.5059	0.5003	0.5004	0.5063
p(h)	1.2002	1.2000	1.2000	1.2000	1.2000	1.1999	1.1997	1.1997	1.1997	1.1997
p(f)*	1.2002	1.2000	1.2002	1.2004	1.2000	1.1999	1.2000	1.2000	1.2000	1.2000
e	1.0000	1.0003	1.0001	1.0000	1.0003	1.0000	1.0001	1.0001	1.0001	1.0001
rer	1.0000	1.0000	1.0003	1.0006	1.0000	1.0000	1.0006	1.0000	1.0000	1.0000
TOTM	1.0000	1.0003	1.0000	0.9997	1.0003	1.0000	0.9999	0.9999	0.9998	0.9998
TOTS	1.0000	1.0003	1.0018	1.0051	1.0003	1.0000	1.0052	1.0003	1.0003	1.0042
c/l	0.9400	0.9402	0.9403	0.9403	0.9402	0.9401	0.9405	0.9403	0.9602	0.9603
c/l**	0.9400	0.9402	0.9399	0.9397	0.9402	0.9401	0.9399	0.9401	0.9601	0.9601
(c/l)/(c/l*)*	1.0000	1.0000	1.0004	1.0007	1.0000	1.0000	1.0007	1.0001	1.0001	1.0002
log(utility)	-1.0619	-1.0617	-1.0616	-1.0616	-1.0617	-1.0618	-1.0614	-1.0616	-1.0406	-1.0406
*log(utility)**	-1.0619	-1.0617	-1.0620	-1.0623	-1.0617	-1.0618	-1.0620	-1.0618	-1.0407	-1.0408
utility gain		0.0242	0.0296	0.0349	0.0242	0.0146	0.0545	0.0283	--	--
*util gain**		0.0242	-0.0055	-0.0352	0.0242	0.0146	-0.0118	0.0144	--	--

Unconditional means generated from a stochastic simulation of a second order approximation of the model. Utility gain is for the home country, computed in steady state consumption units, in percentage terms.

Table 2: Pooled Regression

	(1) Benchmark	(2) Non-oil countries	(3) >$2000 countries	(4) >$5000 countries	(5) >$10,000 countries	(6) Manufac goods	(7) No energy goods	(8) Shambaugh peg
PEG x DIF	-0.198***	-0.0861***	-0.0557***	-0.0472***	-0.0310**	-0.0744***	-0.0466***	-0.194***
	(0.0520)	(0.0111)	(0.0107)	(0.0114)	(0.0117)	(0.0223)	(0.0105)	(0.0531)
PEG	0.0986*	0.111***	0.0334	0.0422*	-0.0104	0.0490	0.0497*	0.217***
	(0.0411)	(0.0253)	(0.0223)	(0.0215)	(0.0207)	(0.0514)	(0.0224)	(0.0432)
Obs.	719603	556025	607247	551963	503393	633979	634009	800054
R-sq	0.390	0.372	0.380	0.392	0.398	0.478	0.390	0.384
adj. R-sq	0.389	0.371	0.379	0.391	0.397	0.477	0.389	0.383
Country Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
Year Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes
Sector Fixed Effect	yes	yes	yes	yes	yes	yes	yes	yes

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

Heteroskedasticity robust standard errors in parentheses:

* significance at 5%; ** significance at 1%; ***significance at 0.1%

Table 3: Pooled Regressions with Interaction Effects

	(1) Benchmark	(2) Non-oil countries	(3) >$2000 countries	(4) >$5000 countries	(5) >$10,000 countries	(6) Manufac goods	(7) No energy goods	(8) Shambaugh peg
PEG x DIF	-0.318***	-0.184**	-0.164**	-0.172**	-0.142**	-0.208***	-0.196***	-0.194***
	(0.0961)	-0.0547	(0.0519)	(0.0553)	-0.0518	-0.0191	(0.0107)	-0.0531
PEG	-0.0991	0.0915	-0.0724	-0.0321	-0.0727	-0.0245	-0.0471**	0.217***
	(0.0707)	-0.166	(0.163)	(0.172)	-0.18	-0.055	(0.0179)	-0.0432
Obs.	719603	556025	607247	551963	503393	633979	634009	800054
R-sq	0.367	0.342	0.343	0.346	0.339	0.434	0.364	0.384
adj. R-sq	0.363	0.338	0.341	0.343	0.337	0.432	0.360	0.383
Country-Sector FE	yes	yes	yes	yes	yes	yes	yes	yes
Country-Year FE	yes	yes	yes	yes	yes	yes	yes	yes

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

Heteroskedasticity robust standard errors in parentheses:

* significance at 5%; ** significance at 1%; ***significance at 0.1%

Table 4: Country Level Analysis

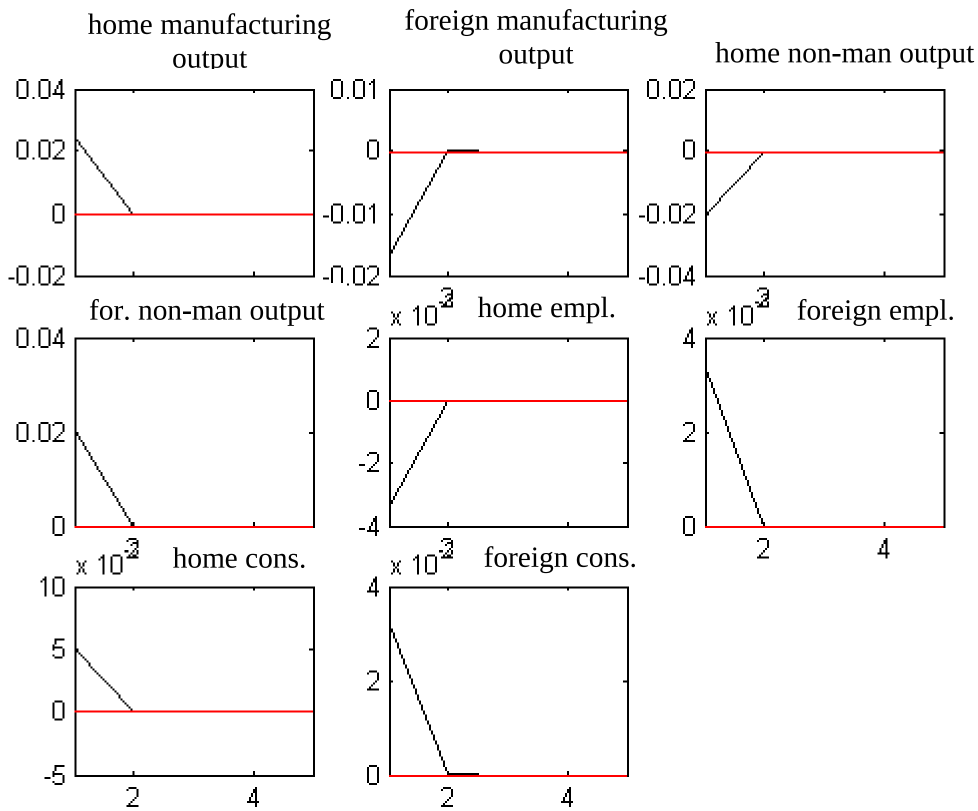
	(1) Benchmark	(2) Non-oil countries	(3) >$2000 countries	(4) >$5000 countries	(5) >$10,000 countries	(6) Manufac goods	(7) No energy goods	(8) Shambaugh peg	(9) Additional controls
PEG	-0.0585***	-0.0625***	-0.0735***	-0.0624**	-0.0628**	-0.0334	-0.0486**	-0.0367*	-0.0546**
	(0.0163)	(0.0166)	(0.0170)	(0.0186)	(0.0218)	(0.0205)	(0.0164)	(0.0162)	(0.0182)
CA/GDP									0.000519
									(0.000615)
Real Exch. Rate									0.00795
									(0.0122)
Currency Crisis									0.00448
									(0.0108)
Banking Crisis									0.00621
									(0.0155)
Obs.	3646	3190	2839	2345	1877	3632	3645	4757	2624
R-sq	0.741	0.721	0.798	0.805	0.815	0.602	0.711	0.718	0.775
adj. R-sq	0.728	0.706	0.786	0.793	0.803	0.581	0.696	0.706	0.759
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes

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

Heteroskedasticity robust standard errors in parentheses:

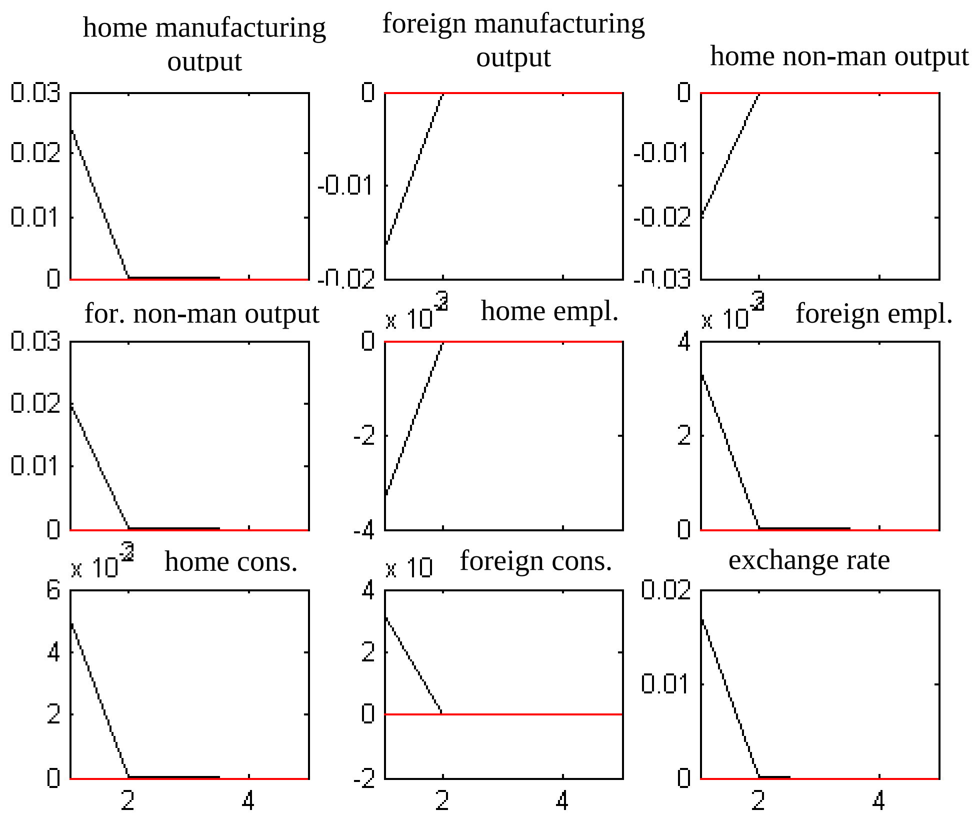
* significance at 5%; ** significance at 1%; ***significance at 0.1%

Fig 1: Responses to a 1 std dev rise in home manufacturing productivity
Under flexible prices and no stabilization policy



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

Fig 2: Responses to a 1 std dev rise in home manufacturing productivity
Under full symmetric stabilization policies



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

Fig. 3a World utility as function of policy parameter 1
(value of 1 is full stabilization case that replicates the flexible price allocation)

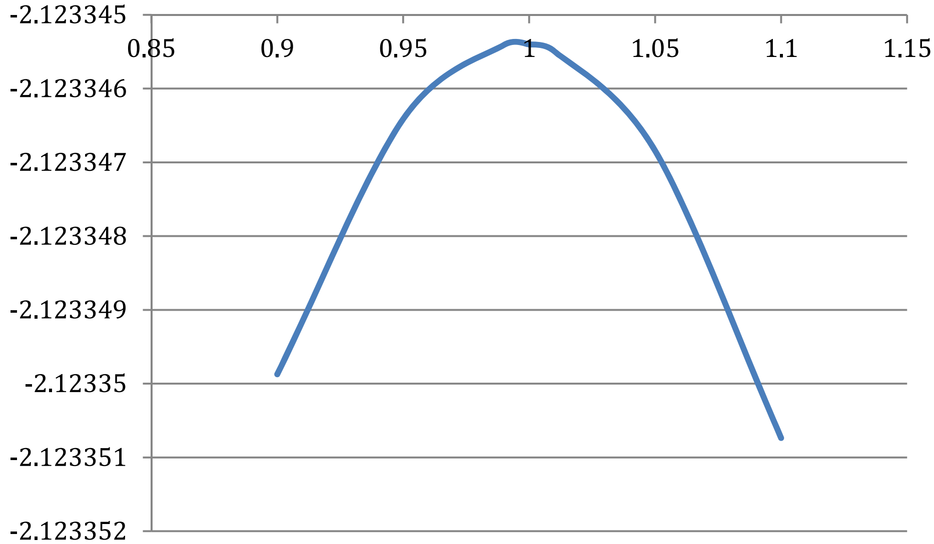


Fig. 3b World utility as function of policy parameter 2
(value of 0 is full stabilization case that replicates the flexible price allocation)

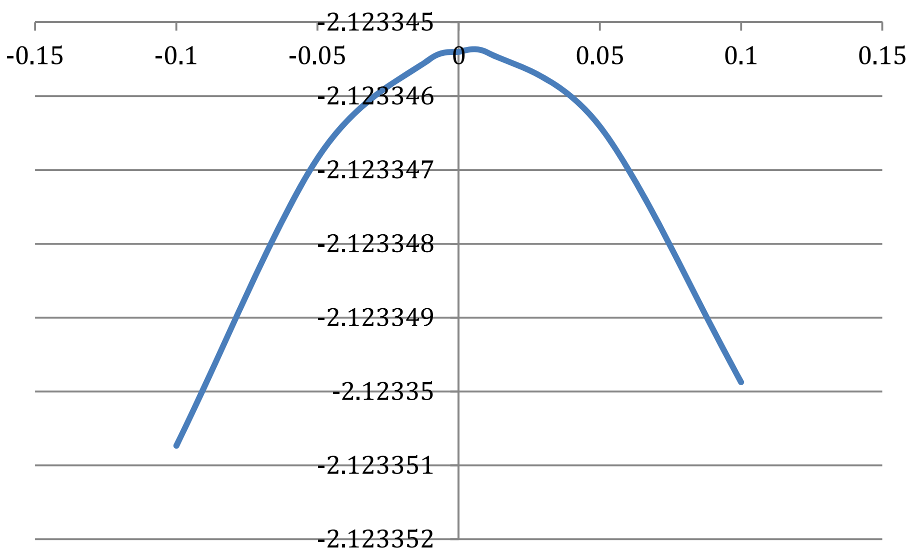


Fig. 4a Home utility as function of policy parameter 1
(value of 1 is full stabilization case that replicates the flexible price allocation)

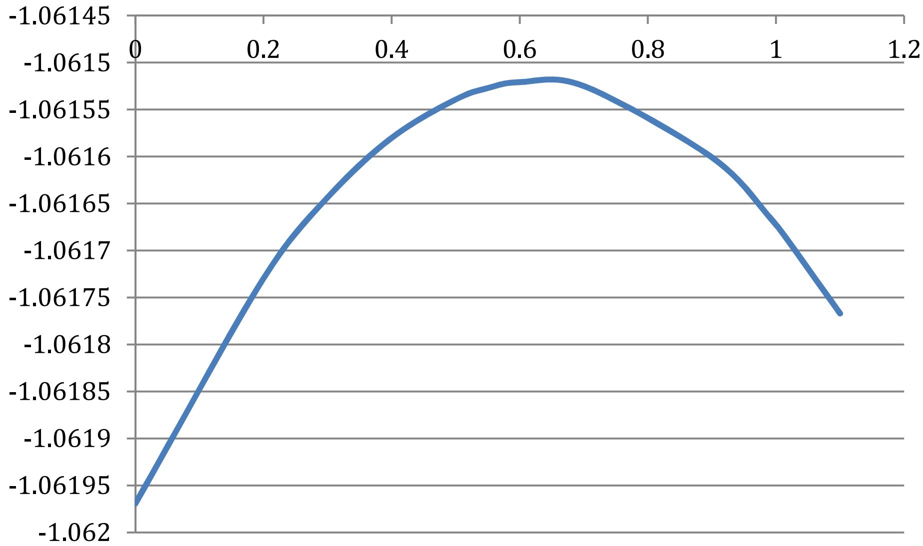


Fig. 4b Home number of firms as function of policy parameter 1
(value of 1 is full stabilization case that replicates the flexible price allocation)

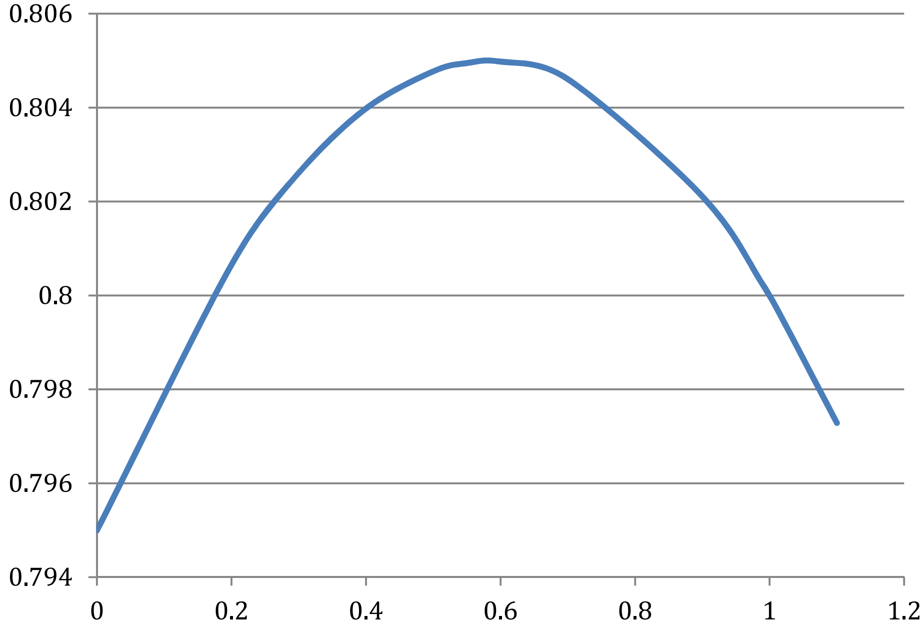


Fig. 5a Home utility as function of policy parameter 2
(value of 0 is full stabilization case that replicates the flexible price allocation)

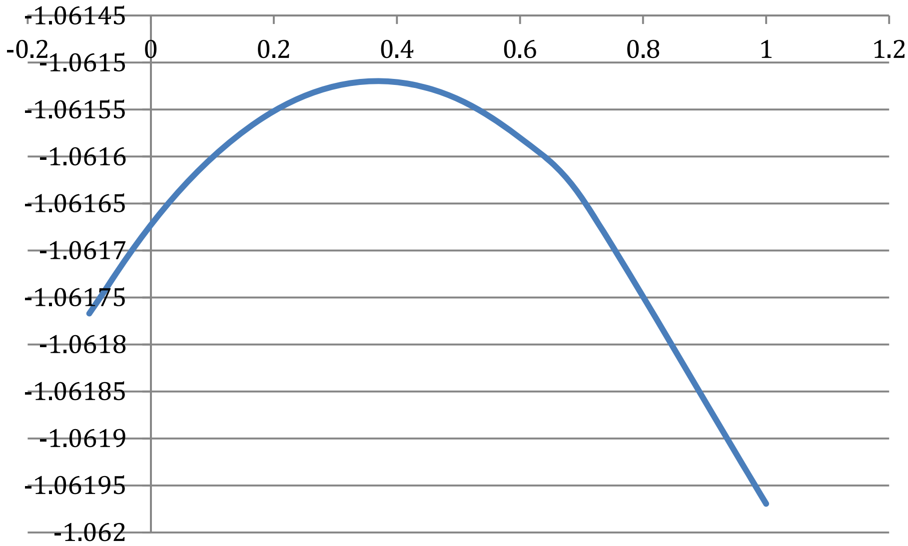


Fig. 5b Home number of firms as function of policy parameter 2
(value of 0 is full stabilization case that replicates the flexible price allocation)

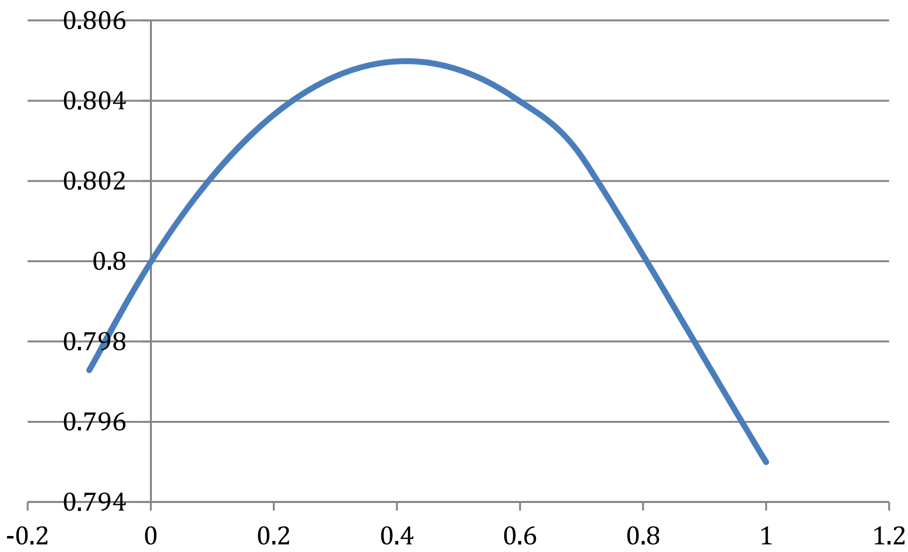
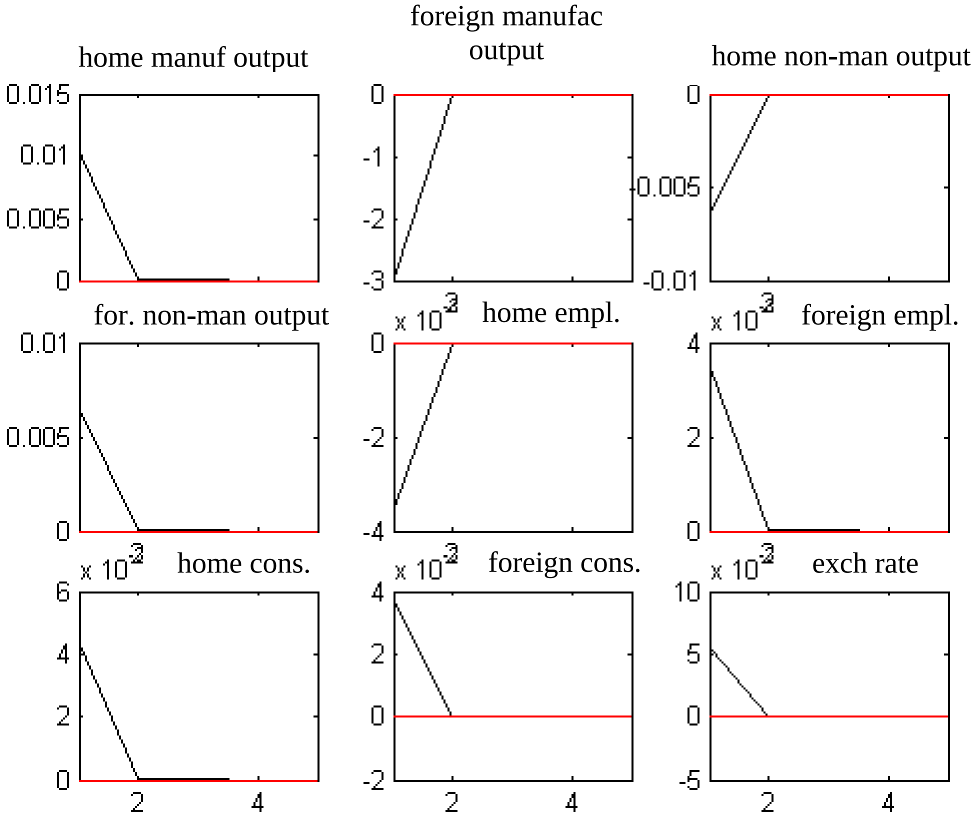


Fig 6: Responses to a 1 std dev rise in home manufacturing productivity
Under policy Nash policy rule (log utility)



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