International Competitiveness and Monetary Policy:
Strategic Policy and Coordination with a Production Relocation Externality

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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 maintain their exchange rate at a competitively low level. While lowering manufacturing prices, optimal pro-competitive monetary rules actually improve the 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.

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

JEL classification: F41

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1. Introduction

This paper reconsiders how monetary and exchange rate policy can raise welfare by promoting a country’s international competitiveness. In recent open-economy monetary literature, the trade-offs between output gap and exchange rate stabilization are typically modeled in terms of the same mechanism underlying the ‘optimal tariff’ argument in international trade. Namely, when domestic goods and imports are substitutes, policymakers can improve national welfare by engineering a systematic appreciation of the terms of trade, relative to the flex price allocation. At the margin, such policy lowers the disutility of work required to achieve a given level of utility from consumption --- a point stressed by Obstfeld and Rogoff (1996) and Corsetti and Pesenti (2001,2005), and elaborated by Benigno and Benigno (2003), Canzoneri et al. (2005), and Corsetti et al. (2010), among others. The emphasis the current literature places on terms of trade appreciation, however, has long been at odds with the terms of policy debates, dominated by concerns over the continuation of firms and jobs in sectors with deteriorating ‘competitiveness.’

The tension between the optimal tariff argument and competitiveness is also at the core of the debate on trade theory and policy. Indeed, Ossa (2011) has recently revisited this debate based on the notion of a ‘production relocation externality.’ In the presence of such externality, a country can gain at the expense of others by attracting a larger share of world production of manufacturing goods associated with high trade costs, essentially by enjoying savings on these costs. While highly stylized, this simple mechanism is interpreted as a proxy for (more complex) factors potentially shaping the national policymakers’ incentives to procure manufacturing jobs for domestic residents.

In this paper, we take a similar perspective and show that modeling a production relocation externality can bring the open-economy macro literature much closer to the ongoing policy debate, reconciling early theoretical results with concerns about competitiveness.

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1 This idea is related to the home market effect, studied broadly in the trade literature (Krugman 1980). Ossa (2008) makes the point that the benefits of the ‘home market effect’ can be engineered by strategic use of tariff policy. We make the point here that these gains can also be engineered using monetary and exchange rate policy.

2 Ossa argues that discussion of manufacturing jobs clearly play a more prominent role in “real-world trade policy debates” (p124) than do academic debates over terms of trade, and modeling it provides a new motivation for tariff reciprocity.
Namely, we will show that national monetary policymakers optimally trade off output gap stabilization with the international competitiveness of domestic manufactures. By keeping the international price of domestic manufacturing goods competitively low, optimal monetary stabilization thus contributes to shape the country’s comparative advantage, affecting the composition of production and trade. Because of these composition effects, the country ultimately benefits from an overall improvement in its average terms of trade.

Our theoretical argument is constructed upon a combination of market features which on their own are entirely standard within their respective trade or macro literatures. The main building block of our model is a two-sector market structure that is common in trade theory, which we embed in a two-country stochastic macroeconomic environment with sticky prices. The first sector consists of monopolistically competitive firms producing differentiated goods, that, as customary in trade theory, we identify with manufacturing. 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. 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 choose prices. Following trade theory, this sector is subject to iceberg trade costs. A second sector produces a homogeneous good under perfect competition, implying price flexibility, without entry and trade costs. For simplicity, but without loss of generality, the production of homogenous goods is not subject to shocks.

Because the monopolistically competitive (manufacturing) sector must invest in the creation of new differentiated products ahead of production, pricing and entry decisions are quite sensitive to uncertainty about and anticipation of future macroeconomic shocks. As shown in previous work (such as Bergin and Corsetti (2008) and Bilbiie, Ghironi and Melitz

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3 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).
(2008)), uncertainty tends to raise preset prices and discourage entry. Hence this sector reaps most benefits from government policies that actively manage macroeconomic shocks. Other things equal, a well-designed domestic stabilization policy can spur entry of manufacturing firms into the country, at the expense of the foreign country, which in turn rebalances the composition of its production in favor of the homogeneous good. Domestic stabilization policy can contribute to shape the comparative advantages of a country in the production of high-marginal utility goods.

Our main results are as follows. First, despite the added complexity of a market structure including two types of tradables, our assumption that the homogeneous good sector operates under flexible prices vastly simplifies monetary analysis. As in the baseline New Open Economy Macroeconomics (NOEM) model, a simple monetary policy rule followed in both countries can replicate the allocation of a flexible-price equilibrium, which is the constrained efficient allocation.\(^4\) When a productivity shock generates productive capacity in excess of current demand in a country, that country’s policy maker should implement a monetary expansion to generate the extra demand. With nominal rigidities, endogenous currency depreciation is an integral part of this policy, as the exchange rate efficiently realigns the international relative price of the country’s exports, to the new, higher level of productivity.

Yet, the production relocation externality creates a strong incentive to defect from the simple rule above, with significant beggar-thy-neighbor effects. In each country, policymakers can improve national welfare by unilaterally muting their monetary policy response to domestic productivity shocks, and undercut the response of the foreign country to its own shocks. Everything else equal, a self-oriented, optimal stabilization policy induces domestic manufacturing firms to optimally preset lower prices, i.e. there is a fall in the ‘premium’ built into manufacturing prices set ahead of time. As a result, the domestic manufacturing goods are on average more competitive, and acquire a larger share of world demand. There is more entry of home firms in the differentiated good sector. The foreign country correspondingly expands the relative weight of the perfectly competitive sector.

\(^4\) See e.g. Corsetti and Pesenti 2005 and Obstfeld and Rogoff (2002). The allocation is first best when appropriate production subsidies eliminate the distortions due to imperfect competition.
Second, as a country gains competitiveness by keeping its real exchange rate and the price of its manufacturing goods low, it actually benefits from an improvement in its overall terms of trade. This is due to the shift in the composition of output and exports induced by monetary policy: in the country pursuing pro-competitive stabilization policies, there is more domestic production and export of manufacturing goods; less production and more import of homogenous goods. Specifically, when a country deviates from the (constrained) efficient global monetary rule, the real exchange rate and international price of domestic manufacturing falls, but so does the price of the basket of imports in terms of the basket of exports. Domestic residents enjoy more consumption utils per unit of labor.

Third, the strong unilateral incentive to deviate from the social planner allocation corresponds to a significant welfare gain from international policy coordination, relative to a Nash equilibrium among policymakers. In our quantitative exercises, the gains from coordination over Nash are as high as 2/3 of the gains from optimal stabilization, relative to the case of no monetary stabilization at all. This result contrasts sharply with the conclusions from standard open-economy macro models, stressing that gains from coordination are at best a tiny fraction of the benefits from inward-looking optimizing policy, when not precisely equal to zero (see Obstfeld and Rogoff (2002) or Devereux and Engel (2003), among others).

The paper concludes with an empirical exploration. We focus on a key testable implication of the model: countries where monetary policy is directed to domestic macro stabilization will have greater specialization of production and export in differentiated products, relative to countries where monetary policy is driven by the objective of maintaining a fixed exchange rate. Panel estimates using industry-level data as well as country aggregates find a significant, positive relationship between monetary stabilization and specialization of exports in differentiated goods, consistent with the theory.

The difference between our argument and the standard NOEM literature (see e.g. Benigno and Benigno 2003, Corsetti and Pesenti 2005, Corsetti et al. 2010, Obstfeld and

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5 As in most of the literature, however, the overall gains from stabilization are quite small
Rogoff 2002 and Sutherland 2004) is apparent. Not only are the gains from coordination larger, but the mechanism driving these gains is different. In the existing literature, 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. In our model, the production relocation externality implies that higher entry of domestic firms in the high-transportation cost sector produces welfare gains via a reduction in the trade costs borne out by domestic consumers, corresponding to a drop in the overall consumer price index. For this reason, the sign of optimal policy is reversed: under elastic demand for exports and imports, domestic policy makers can raise welfare by lowering the relative price of manufacturing, in order to gain competitiveness, rather than appreciating this relative price.

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. Our work is more closely 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 considering the implications of price stickiness and monetary policy, as well as introducing a homogeneous non-manufacturing good.

The next section describes the model, and section 3 discusses the effects of monetary policy in the model, providing analytical results where possible. Section 4 uses simulations to find optimal policy rules, and discuss the implications of international coordination. Section 5 presents empirical evidence.

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6 Corsetti and Pesenti (2001) found gains from coordination in an extension of the basic model to partial indexation of prices to exchange rates.

7 There are a number of contributions studying the effects of monetary policy regimes on entry, see, e.g., Arespa (2011) and 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 a production relocation.
2. Model

Consider a model of two countries, home and foreign. In each country there are 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, 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 \( (C_D) \):

\[
C_t = C_{M,t}^{\phi} C_{D,t}^{1-\phi}
\]

where

\[
C_{M,t} = \left( \int_0^{n_h} c(h)^\phi \, dh + \int_0^{n_f} c(f)^\phi \, df \right)^{\frac{1}{\phi}}
\]

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

\[
P_t = \frac{P_{M,t}^{\phi} P_{D,t}^{1-\phi}}{\theta^\phi (1-\theta)^{1-\phi}}
\]

where

\[
P_{M,t} = \left( n_h p_h (h)^{1-\phi} + n_f^* p_f (f)^{1-\phi} \right)^{\frac{1}{1-\phi}}
\]
is the index over the prices of all varieties of home and foreign manufacturing goods.

These definitions imply relative demand functions for domestic residents:

\[
c_t(h) = (p_t(h)/P_{Mt})^{-\phi} C_{Mt} \quad (3)
\]
\[
c_t(f) = (p_t(f)/P_{Mb})^{-\phi} C_{Mb} \quad . \quad (4)
\]
\[
P_{Mt} C_{Mt} = \theta P_t C_t \quad . \quad (5)
\]
\[
P_{Dt} C_{Dt} = (1 - \theta) P_t C_t \quad . \quad (6)
\]

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 \((\pi(h))\) 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:

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

subject to the budget constraint:

\[
P_t C_t = W_l l_t + \int_0^h \pi_t(h) dh - W_q + M_t - M_{t-1} + B_t - (1 + i_{t-1}) B_{t-1} - T_t
\]

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:

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

a labor supply condition:
\[ W_i = \kappa \mu_i \]  

(8)

and a money demand condition:

\[ M_i = \chi \mu_i \left( \frac{1+i}{i} \right). \]  

(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:

\[ y_i (h) = \alpha l_i (h), \]  

(10)

where \( l(h) \) is the labor employed by firm \( h \), and where \( \alpha \) 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, \( \tau \), so that

\[ y(h) = c_i (h) + (1 + \tau_i) c_i^* (h). \]  

(11)

Firm profits are computed as:

\[ \pi_i (h) = p_i (h)c_i (h) + e_i \cdot p_i^* (h)c_i^* (h) - W_i y_i (h)/\alpha_i \]  

(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. Firms choose their price by maximizing the expected discounted value of their profits

\[ \max_{p_i (h)} E_i \left[ \beta \frac{\mu_i}{\mu_{i+1}} \pi_{i+1} (h) \right]. \]

This implies the price setting function for domestic sales:
\[ p_{t+1} \left( h \right) = \frac{\phi}{\phi - 1} E_t \left[ \Omega_{t+1} \left( \frac{k \mu_{t+1}}{\alpha_{t+1}} \right) \right] \]

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:

\[ p^*_{t+1} \left( h \right) = \left( 1 + \tau \right) p_{t+1} \left( h \right) / e_{t+1} \]

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:

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

Production in the homogeneous sector is specified:

\[ y_{D,t} = \alpha_D l_{D,t} . \]

Where \( \alpha_D \) is a non-stochastic productivity level, which is assumed to be the same across countries. Price setting in this perfectly competitive sector follows:

\[ p_{D,t} = W_t / \alpha_D . \]

### 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:

\[ M_t - M_{t-1} + T_t = 0 . \]

Monetary policy will be defined as a rule setting \( \mu \) as a function of productivity levels:

\[ \mu_t = \mu \left( \alpha_t, \alpha^* \right) . \]
2.5 Market clearing

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

\[ l_{M,t} = \int_{0}^{n} l(h) dh = n l_t(h), \quad (20) \]

and

\[ l_{M,t} + l_{D,t} + n \pi q = l_t. \quad (21) \]

Bond market clearing requires:

\[ B = 0. \quad (22) \]

Market clearing in the homogenous sector requires:

\[ C_{D,t} + C_{D,t}^* = y_{D,t} + y_{D,t}^*. \quad (23) \]

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

\[ P_{D,t} = e_t P_{D,t}^*. \quad (24) \]

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

\[ \int_{0}^{n} p^*_t(h) c^*_t(h) dh - \int_{0}^{n} p_t(f) c_t(f) df - P_{D,t} (C_{D,t} - y_{D,t}) = 0. \quad (25) \]

2.6 Equilibrium definition and dynamic stability:

Equilibrium is a sequence of the following 47 variables: \( C, P, c(h), c^*(h), p(h), p^*(h), C_M, C_D, P_M, P_D, W, l, l(h), l_{D,t}, l_{M,t}, y(h), y_{D,t}, \pi(h), n, M, i, T, B \) and foreign counterparts for each of these, along with \( e \). Of the 47 equilibrium conditions needed, 44 are: equations (1)-(22) and foreign counterpart, as well as equations (23)-(25).

2.7 Risk sharing and exchange rate determination

Analytical results for the exchange rate are greatly facilitated by the presence of a perfectly competitive homogeneous good with identical technology across borders. Note that equations (8) and (17) imply that the exchange rate may be expressed as:
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, then, the exchange rate is a function of relative nominal demands, and hence is the ratio of the monetary policy stance variables.

A second 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. Since \( \mu_i = P_iC_i \), the equation above can be rewritten as:

\[
\frac{e_iP^*_i}{P_i} = \frac{C_i}{C^*_i}
\]

which is the usual risk sharing condition implied by complete asset markets for the case of log utility. See the appendix for a more general discussion of the conditions under which the perfectly competitive good provides risk sharing. Note that the left-hand side of the risk sharing equation above defines the real exchange rate, which represents the relative price of consumption between the two countries: \( rer_i \equiv \frac{e_iP^*_i}{P_i} \).

We also report two versions of the terms of trade. Following the trade literature, we compute a first version of 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: \( TOTM_i \equiv \frac{p_i(h)}{\left( e_iP^*_i(f) \right)} \). This measure ignores the homogeneous good, which in equilibrium may be either imported or exported. In our second version, instead, the terms of trade take 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,

\[
TOTSi \equiv p(h), \left[ \omega e_iP^*_i(f) \left( 1 - \omega \right) pD_i \right],
\]

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\[ e_i = \frac{p_{Di}}{p_{Di}^*} = \frac{W_i}{W_i^*} = \frac{\mu_i}{\mu_i^*}. \] (26)

---

8 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).
where the weight is an expenditure share:

$$\omega_i = e_i p_i (f) n_{i,t}^* c_i (f) / [e_i p_i (f) n_{i,t}^* c_i (f) + p_{Dt_i} (c_{rDi} - y_{Di})]$$.

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

$$\frac{\kappa q}{\beta \theta} = E \left[ \left( p_{r+1} (h) - \frac{\kappa \mu}{\alpha} \right) p_{r+1} (h)^{-\phi} \Omega_{t+1} \right]$$ (27)

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

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

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

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: $\phi$ =6 among differentiated goods (implying a price markup of 20%), and $\beta$ =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 $\tau$ =0.1, and the fixed cost is $q$=0.1.

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 $\alpha_o = 1$. 

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Parameters are set the same across countries to imply a symmetric steady state 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. Stabilization policies and ‘competitiveness’

In this section, 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 will start with a characterization of the flex-price allocation.

3.1 Flexible prices

As a reference allocation, it is appropriate to characterize the flexible-price equilibrium, where firms set prices after observing (productivity) shocks. With constant demand elasticity, firms charge a constant markup over marginal costs, which in our case coincide with unit labor costs:

\[
p^\text{flex}_t(h) = \frac{\phi}{\phi - 1} \frac{\mu_t}{\alpha_t}, \quad p^\text{flex}_t(f) = \frac{\phi}{\phi - 1} \frac{\mu^*_t}{\alpha^*_t}.
\]

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

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

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.\(^9\) The latter

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\(^9\) Even in a case where monetary policy endogenously responds to shocks, changing the value of \(\mu_t\), the number of firms is not time-varying in response to shocks. While a change in \(\mu_t\) will affect wage level...
assumption clearly facilitates many of our analytical results below. With no monetary policy response to shocks ($\mu_i = \mu_i^* = 1$, 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, let, as before, $\mu_i = \mu_i^* = 1$, 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 analytically. Prices are optimally preset charging the constant, equilibrium markup over expected marginal costs:

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

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

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

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 and hence entry costs on the left side of equation (15), the wage is directly proportional to $\mu_t$, which exactly cancels the appearance of $\mu_t$ on the right hand side as part of the discount factor.
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.

3.3. Efficient stabilization policy

Since in our model we have posited 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: \( \mu_i = \alpha_i, \ \mu_i' = \alpha_i' \). The exchange rate in this case
is not constant, but is also contingent on productivity differentials: the home currency
depreciates in response to an asymmetric rise in home productivity:

\[ e_i = \frac{\alpha_i}{\alpha_i'} \]

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). The endogenous exchange rate movement contributes 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:

\[ p_{r+1}(h) = \frac{\phi}{\phi-1} \kappa < p_{r+1}^{no\text{ stab}}(h), \]

given that, by Jensen’s inequality, \( E_i \left[ \frac{1}{\alpha_{r+1}} \right] > \frac{1}{E_i[\alpha_{r+1}]} = 1 \). However, as shown in the
appendix, the number of manufacturing firms is the same as the flexible price case.
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 illustrates the analytical results above. Yet, the effects of policy are very 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 rise in the consumption index. The effects regarding the manufacturing sector coincide with those found in Bergin and Corsetti (2008).

3.4 The consequences of asymmetric policies: the cases of a currency peg and a deterministic money growth rule

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 post that the home government fully stabilizes its output gap, while the foreign country maintains its exchange rate fixed against the home currency: \( \mu_e = \alpha_e \), \( e^* = 1 \) so \( \mu_e = \mu_e = \alpha_e \). As a related exercise, we will also extend the analysis to the

\[ n_{rel}^{stab} = n_{rel}^{flex}. \]

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.
case in which the foreign country keeps its money growth constant \((\mu_t = 1)\) while home carries out stabilization policy as above.

Under a currency peg the optimally preset prices are:

\[
p_{r+1}^*(h) = \frac{\phi}{\phi - 1} \kappa, \quad p_{r+1}^*(f) = \frac{\phi}{\phi - 1} \kappa E_t \left[ \frac{\alpha_{r+1}}{\alpha_{r+1}^*} \right].
\]

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

\[
\frac{1}{n_{r+1} + An_{r+1}} + \frac{1}{n_{r+1} + Bn_{r+1}^*} = \frac{\kappa q \phi}{\beta \theta},
\]

\[
\frac{A}{n_{r+1} + An_{r+1}^*} + \frac{B}{n_{r+1} + Bn_{r+1}^*} = \frac{\kappa q \phi}{\beta \theta}
\]

where

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

While it is not possible to solve in closed form for the number of firms, the system does allow one to prove that \(n > n^*\) (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 the full stabilization case in the home economy, hence raising the overall demand for home manufactures. Lower prices set by home firms drives the worsening of the ex-factory terms of trade reported in the table \((tot \equiv p(h)l(ep^*(f)))\). 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 \( \frac{\text{rer} \equiv eP^*}{P} \) 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, we also have a key result 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. This result reconciles the stress placed by the existing literature, on the welfare benefits from improving a country’s terms of trade, with widespread concerns among policy makers, about making their economies more competitive. There is no contradiction among the two. There could be differences in which policy strategy and instruments may be appropriate under different trade and production structures.

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. This prediction of the model is in line with the evidence emphasized by Obstfeld and Rogoff 2000, in their critique of the local currency pricing assumption (but see the generalization in Corsetti, Dedola and Leduc 2008). 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.

As a final observation, comparing columns 3 and 4 in the table suggests that 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 \( \mu_i = \alpha, \mu_i = 1 \). 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).

4. Policy coordination versus Nash

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

\[
\mu_t = \alpha_t \gamma_1 \alpha_t^{\gamma_2}
\]

\[
\mu_t^* = \alpha_t^* \gamma_1^{*} \alpha_t^{\gamma_2^*}.
\]

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:

\[
\max_{\gamma_1, \gamma_2} E_0 \left[ (\ln C_t - L_t) + (\ln C_t^* - L_t^*) \right].
\]

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 a 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:

\[
\max_{\gamma_1, \gamma_2} E_0 [\ln C_t - L_t]
\]

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 \( \gamma_1 \) holding \( \gamma_2 \) constant at 0. This means that when the home country experiences a rise in productivity, it responds with a smaller monetary expansion than in the symmetric, efficient stabilization case. A similar conclusion applies to the parameter \( \gamma_2 \) when studied in isolation, holding \( \gamma_1 \) 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 shocks. The effect is clearly that of preventing the exchange rate to move in favor of the Foreign manufacturing sector.

The figures also show that 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.

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, the policymakers’ incentives to deviate from the globally efficient rules are 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 $n^*$ at the level of 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 global equilibrium is inefficient.
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. Firms prefer production costs to be low at times that demand is high. In the case of a positive productivity shock, a monetary expansion is helpful in raising demand by depreciating the exchange rate. However, in this sticky price monetary model a monetary expansion also raises the wage. If money supply rises too much (\( \gamma_1 > 1 \)), wage will rise more than productivity, and labor costs will actually rise during a period of high demand. The optimal degree of policy response \( 0 < \gamma_1 < 1 \) balances the rise in demand and rise in wage, where the former rises nonlinearly (depending on the demand elasticity) and the latter linearly in money supply. This positive but muted policy leads to a low ‘premium’ in price setting and a low unconditional expectation of prices for home manufactured goods. As seen in the simulations, the low average terms of trade is associated with high demand for home manufactures. The same logic explains why a muted monetary policy response lowers the riskiness of firm entry and raises the level of firm entry above that of full stabilization.

Because the social planner optimum is not a Nash equilibrium, there is an opportunity to benefit from international policy coordination 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 \((x)\):

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

and compare the gains from the social planner optimum and the Nash equilibrium, we find that the gain from 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 benefit from coordination contrasts sharply with early results from micro-founded macro models to study gains from policy coordination, which find the gain from coordination
to be exceedingly small, when not nil. By way of example, the model of Corsetti and Pesenti (2005) and Devereux and Engel (2003), with which our model shares many features, indicated that under prices fixed in producer currency units there was no benefit from coordination. Even though our model is also constructed under the specification of producer currency pricing, the introduction of firm entry and the production relocation externality changes this conclusion.

The result also contrasts with Obstfeld and Rogoff (2002), which showed 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. Our paper offers a counterexample, where even under log utility there are gains from coordination. 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 production relocation externality. This 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 of production activity. We make the same argument here in a 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). 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 use a mechanism other than

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11 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.
the terms-of-trade externality; the production relocation externality is based on the benefits of firm entry in terms of lower trade costs. Secondly, our 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 the opposite. Under elastic foreign demand, policymakers overstabilize domestic productivity shocks, seeking to drive the manufacturing terms of trade up.\footnote{In a model similar to ours without the competitive sector, Sutherland (2004) shows that the optimal deviations from globally optimal rules prescribes $\gamma > 1$}

5. Empirical evidence

To carry out an empirical exploration of our main argument, we focus on a key testable implication of the model: 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 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.

5.1 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.\footnote{Before taking logs, industries with zero trade value are replaced by a value of 1.}

The final key ingredient is a classification of monetary policy regime. Shambaugh (2004) provides just such a classification, based upon the observed behavior of interest rates. In theory, a fixed exchange rate requires that the interest rates of both countries be linked through an interest rate parity condition, provided capital is mobile between countries. A pegging country does not have freedom to use monetary policy to pursue domestic objectives such as macroeconomic stabilization. Shambaugh identifies countries with monetary policy freedom as those whose interest rates do not systematically follow the interest rate of a base country to which it may peg its exchange rate. The index, denoted here as $PEG_{jt}$, takes a value of 0 for a country $j$ with an independent monetary policy in period $t$, and a 1 when policy is constrained by a fixed exchange rate. It covers 182 countries from 1960 to 2004.

For example, although both Germany and France belonged to the EMS/ERM fixed exchange rate regime during our sample, the de-facto classification methodology identifies Germany as having independent monetary policy for all years after 1968. This reflects Germany’s role as leader of the exchange rate regime, where it retained freedom to set its monetary policy to suit domestic macroeconomic stabilization objectives, and other countries pegged to it. In contrast, France is identified as pegging to Germany in various years (1979-80, 84-85, 87-94, 96-2004), with de-facto flexibility in intervening years. This case illustrates the fact that the de-facto classification exhibits significant variation over time. In addition, the methodology classifies China as retaining monetary policy independence in many years (1972-86, 1992-99), despite having a fixed exchange rate. This reflects the presence of capital controls which break the arbitrage condition restricting monetary policy independence.
The set of countries covered both by the trade data and Shambaugh 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.

5.2 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

\[
\log x_{ijt} = \beta_0 + \beta_1 PEG_{jt} + \beta_2 DIF_{jt} + \beta_3 PEG_{jt} \cdot DIF_{jt} + \epsilon_{ijt}
\]

(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. Comparing magnitudes of coefficients, it appears that when a given country adopts a fixed exchange rate, it leads to a rise in exports in non-differentiated industries, but the direct and interaction effects of a peg nearly cancel out for differentiated industries. So a peg shifts the composition of a country’s exports toward non-differentiated goods.

We conduct robustness checks in Tables 3-5 for various subsamples of countries and goods, and with alternative regressors. One concern is that the result is driven by endogeneity, whereby a country chooses an exchange rate regime due to its specialization in nondifferentiated exports. This concern is especially plausible for oil exporters, who commonly peg their currency to the dollar because the world market denominates the price of their export in dollar terms. We conduct several types of robustness checks for this and other types of endogeneity. One simple way is to exclude Opec members and other large oil exporters from
the data set (see table 5 column 3) and to exclude fuel from the set of export industries (SITC categories beginning with 3, see table 4 columns 1-3).\textsuperscript{14} Both sets of estimations continue to strongly support our claim.

We also conduct estimation instrumenting for fixed exchange rate status in table 3. One instrument for this purpose, proposed by Klein and Shambaugh (2006), consists of the share of neighboring countries that also peg their currency to the same base country. The logic is that if France pegs its currency to the U.S. dollar, in doing so it might be motivated by the goal of stabilizing its currency to its neighbor Germany, which also pegged to the dollar. To the degree these regional ties dictate the choice exchange rate regime, we can conclude that the peg to the dollar was not endogenously driven by the trade relationship with the U.S. A second instrument is to use one lag of the exchange rate regime. Table 3 shows that results using either instrument continue to strongly support our claim, with a statistically significant negative coefficient on the interaction term.

We also provide robustness checks for other subsamples, such as 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 --- some basic manufactures can indeed be considered close to a homogenous good. Results in Table 4 shows that for two of the three specifications of fixed effects, estimates of the coefficient on the interaction term continue to be negative and significant.

Table 5 shows continued support for our model in different subsamples of countries, such as the one limited to OECD countries, or a sample excluding countries with less than 2000 dollars of per capita income. The OECD sample is smaller, which leads to a drop in statistical significance.

\textsuperscript{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.
5.3 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:

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

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, $SDIF_j$ varies both over countries and years due to variation in the trade weights. The regression specification is now

$$SDIF_j = \beta_0 + \beta PEG_j + \epsilon_j,$$  

(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 6 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 3.7 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 various exercises reported in columns (2) through (8) of table 6. Among these, we run the regressions restricting the above index to either non-energy exports or manufacturing goods, as well as using subsamples including only OECD countries, non-oil-exporters and non-poor countries. We also try IV estimation. Observe that the effect of a peg is somewhat less significant in the subsample including manufacturing goods only, than in the other subsamples. While the coefficient for the sample consisting only of OECD countries is the wrong sign, it is not statistically significant.

6. Conclusion

Standard open-economy monetary literature has long stressed national gains from exchange rate appreciation, with monetary policy essentially acting like an optimal tariff in
tilting the terms of trade in favor of the country. This paper revisits instead the classical view, that monetary policy can contribute to national welfare by boosting domestic competitiveness, namely, by fostering the expansion of the domestic manufacturing sectors at the expense of foreign competitors. We build our analysis around the notion of a production relocation externality, recently studied in trade theory, showing that such an externality has a clear macroeconomic dimension. Industries with monopoly power are typically associated with price stickiness and sunk (entry) investment, arguably making them more sensitive to macroeconomic uncertainty than other industries. Monetary stabilization policy can attract such industries, leading to potential welfare gains.

We have shown that a standard model augmented with a production relocation externality reconciles the main lessons from the existing literature with core concerns shaping the policy debate, regarding the implications of monetary and exchange rate policies for competitiveness. Efficient monetary stabilization rules at the national level will attempt to boost national comparative advantage in manufacturing, by creating conditions for domestic firms to charge low average prices on their exports. However, per effect of a change in the composition of output and exports, the country actually improves its overall terms of trade --- a point on which the macro-literature can contribute to the current debate in trade. Because of the 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 self-oriented conduct of monetary policy.

In a stylized manner, this paper builds a case for a novel modeling approach to classic issues in strategic monetary policy and international coordination. The main idea is to specify models with two or more tradable sectors, with fundamental asymmetries regarding their contribution to national welfare. In our specification, specialization in the monopolistic sector is desirable, insofar as it brings about saving in trade costs. Alternative models could allow for differences in the monopoly power across sectors, (knowledge) externalities or increasing returns.
References


Appendix:

1. **Risk sharing through a perfectly competitive ‘outside’ sector:**

To begin, suppose a one good world, with competitive supply. Labor disutility is linear, and abstract from constraints on labor supply. The law of one price and competitive labor markets imply

\[ e_t P^{*}_{D_t} = p_{D_t} \]

\[ e_t \frac{W_t}{\alpha_{D_t} f^{*}(l_t)} = \frac{W^*_t}{\alpha_{D_t} f^{*}(l^*_t)} \]

\[ e_t \frac{\kappa P_t C_t}{\alpha_{D_t} f^{*}(l_t)} = \frac{\kappa^* P^*_t C^*_t}{\alpha_{D_t} f^{*}(l^*_t)} \]

If the homogeneous good is the only consumption good

\[ \frac{\kappa^* C^*_t}{\alpha^*_{D_t} f^{*}(l^*_t)} = \frac{\kappa C_t}{\alpha_{D_t} f^{*}(l_t)}. \]

Under complete markets, perfect risk sharing ensures \( C_t = C^*_t \), which corresponds to equalization of the marginal disutility of labor of the marginal products of labor across countries:

\[ \frac{\kappa^*}{\alpha^*_{D_t} f^{*}(l^*_t)} = \frac{\kappa}{\alpha_{D_t} f^{*}(l_t)}. \]

Employment is higher where productivity is higher. In this world, a linear production function would imply that only the country with the higher productivity supplies output. We conclude that in general, trade in a homogeneous good cannot ensure risk sharing.

Now consider the model of this paper, in which there is a homogeneous perfectly competitive sector and a monopolistically competitive sector. The homogeneous good has the same production function in both countries.

Again the law of one price implies as above:

\[ e_t \frac{\kappa P_t C_t}{\alpha_{D_t} f^{*}(l_t)} = \frac{\kappa^* P^*_t C^*_t}{\alpha^*_{D_t} f^{*}(l^*_t)} \]

Perfect risk sharing requires \( e_t P^*, C^*_t = \omega P_t C_t \), for some constant of proportionality \( \omega \). This is satisfied as long as the marginal products of labor are equalized across countries. One way to satisfy this requirement is if production in this sector is linear in labor, and shocks to production in this sector are either the same across countries or, as in this paper, such shocks do not exist. Note that risk sharing is not affected by productivity shocks in the other, monopolistic sector.
2. Entry condition:

Substituting (12) into (15) and simplifying:

\[
W_q = E_t \left[ \beta \frac{\mu_t}{\mu_{t+1}} \left( p_{t+1}(h) - \frac{W_{t+1}}{\alpha_{t+1}} c_{t+1}(h) + \left( e_{t+1} p_{t+1}^*(h) - (1 + \tau) \frac{W_{t+1}}{\alpha_{t+1}} c_{t+1}^*(h) \right) \right) \right]
\]

Under producer currency pricing of exports:

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

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

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

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

3. Entry under full stabilization

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

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

Impose symmetry across countries:

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

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

Which is the same as for the flexible price case.

To compare to the no stabilization case, write this as
\[ n_{t+1}^{stab} = n_{t+1}^{stab*} E_t \Omega_{t+1} \]

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

Note that \( n_{t+1}^{stab} > n_{t+1}^{stab*} \) if \( E_t \Omega_{t+1} > 1 \). However \( \Omega_{t+1} \) switches from a concave function of \( \frac{\alpha_{t+1}}{\alpha_{t+1}^*} \) to a convex function near the symmetric steady state value of \( \frac{\alpha_{t+1}}{\alpha_{t+1}^*} = 1 \). 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, even though our analysis will show that the effects of asymmetric stabilization can be large.

**4. Consider case of fixed exchange rate rule:**

Substitute prices and policy rules \( \mu = \alpha, \mu^* = \mu = \alpha \) (so \( e = 1 \)) into (27):

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

Pass through expectations and simplify

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

Do the same for the foreign entry condition:

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

Rewrite the home and foreign conditions as fractions:

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

Home:

\[
\frac{\kappa q \phi}{\beta \theta} = \frac{A}{n_{t+1} + An_{t+1}^*} + \frac{B}{n_{t+1} + Bn_{t+1}^*} \]

Foreign:

Where we define:

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

Equating across countries:
\[
\frac{2n_{t+1} + (A+B)n_{t+1}}{(n_{t+1} + An_{t+1})} = \frac{(A+B)n_{t+1} + 2ABn_{t+1}}{(n_{t+1} + An_{t+1})}
\]

\[
n_{t+1} = \frac{2AB - A - B}{2 - A - B}
\]

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:

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

For shocks independently log normally distributed with standard deviation \(\sigma\) so that

\[
E_i \left[ \frac{\alpha_{t+1}}{\alpha_{t+1}^*} \right] = e^{\frac{1}{2} \sigma^2}
\]

For example, with \(\tau = 0.1\) and \(\phi = 6\), \(\sigma\) must be less than 0.209. Our calibration of \(\sigma\) is 0.017.

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

For independent log normal distributions of productivity:

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

We can conclude that \(n > n^*\).

5. Explaining Nash Policy

Normalizing the average level of money at unity, so that \(\gamma_1 + \gamma_2 = 1\), we can rewrite the price-setting equation (13) as:

\[
p_{t+1}(h) = \frac{\phi}{\phi - 1} K \left( E_i \left[ \left( \frac{\alpha_{t+1}}{\alpha_{t+1}^*} \right)^{\gamma-1} \right] + \text{cov}_i \left[ \Omega_{t+1}, \left( \frac{\alpha_{t+1}}{\alpha_{t+1}^*} \right)^{\gamma-1} \right] \right) + E_i \left[ \Omega_{t+1} \right]
\]

A primary determinant of the price setting equation is the covariance between labor production costs (\(W/\alpha\)) and demand (a negative function of the \(\Omega\) from above). Using the fact that under this policy \(e_i = \left( \frac{\alpha_i}{\alpha_i^*} \right)^\gamma\), \(\Omega\) can be written as

\[
\Omega_{t+1} = \left( n_{t+1} + n_{t+1}^* \left( 1 + \tau \right)^{\phi-1} \left( \frac{\alpha_i}{\alpha_i^*} \right)^{\gamma(1-\phi)} p_{t+1}(f)^{1-\phi} \right)^{-1} + \left( 1 + \tau \right)^{\phi-1} n_{t+1}^* \left( \frac{\alpha_i}{\alpha_i^*} \right)^{\gamma(1-\phi)} p_{t+1}(h)^{1-\phi} + n_{t+1} p_{t+1}(f)^{1-\phi}
\]

So that the only time-varying term in the covariance now is \(\alpha_i / \alpha_i^*\).
Consider a positive shock to the home productivity (rise in $\alpha_t / \alpha_t^*$). This clearly raises both terms in $\Omega_{t+1}$, regardless of the degree to which the monetary policy responds. This just represents the fact the home policy devalues currency which stimulates demand for home goods, both at home and abroad. Now consider the other term in the covariance: $(\alpha_t / \alpha_t^*)^{-1}$. Whether the positive home productivity shock raises or lowers this depends on whether $\gamma$ is greater or less than one, that is, whether the home policy over or under-responds to the shock.

If the policy over responds ($\gamma > 1$) then the term rises, and the covariance is positive. This means that the risk premium is positive and prices are higher due to risk. This reflects that fact that the monetary policy is raising the wage ratio to productivity (this is the term). Despite the rise in productivity, monetary policy is driving up the wage even more. So at the time that demand for home goods is rising, the marginal cost is also rising. This is bad for expected firm profits, hence raising the risk premium.

On the other hand, if policy under-responds ($\gamma < 1$) then the $(\alpha_t / \alpha_t^*)^{-1}$ term falls with a rise in relative home productivity. Now the covariance above is negative, so the price setting is below the flexible price level. This reflects the fact that firms like it when there is a combination or rise in demand for their goods and a fall in the marginal cost of production. The minimum level of the risk premium is at a gamma where the rise in wage is small but there is still sufficient rise in demand. Recall that while the first of these two effects (wage) is linear in policy, but the second is nonlinear (if the demand elasticity is greater than 1).
Table 1: Unconditional Means from Stochastic Simulations

<table>
<thead>
<tr>
<th>policy</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
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<tbody>
<tr>
<td></td>
<td>none</td>
<td>symmetric</td>
<td>asymmetric</td>
<td>fixed</td>
<td>exch rate</td>
<td>flex price</td>
<td>Nash</td>
<td>Unilateral defection</td>
<td>(7) with exog entry</td>
<td>(8) with no iceberg</td>
</tr>
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<td>$\mu = \underline{1} , \mu^* = \underline{1}$</td>
<td>$\mu = \underline{\alpha} , \mu^* = \underline{\alpha}$</td>
<td>$\mu = \underline{\alpha} , \mu^* = \underline{\alpha}$</td>
<td>$\chi = \chi^* = .66$</td>
<td>$\chi = \chi^* = .66$</td>
<td>$\chi = \chi^* = .66$</td>
<td>$\chi = \chi^* = .66$</td>
<td>$\chi = \chi^* = .66$</td>
<td>$\chi = \chi^* = .66$</td>
<td>$\chi = \chi^* = .66$</td>
<td>$\chi = \chi^* = .66$</td>
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<td>0.9967</td>
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<td>0.9967</td>
<td>0.9966</td>
<td>0.9966</td>
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<td>$l^*$</td>
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<td>0.9967</td>
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<td>util gain*</td>
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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: Baseline Specification

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<tr>
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<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEG x DIF</td>
<td>-0.194***</td>
<td>-0.223***</td>
<td>-0.204***</td>
</tr>
<tr>
<td></td>
<td>(0.0151)</td>
<td>(0.0146)</td>
<td>(0.0146)</td>
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<tr>
<td>PEG</td>
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<td>0.197***</td>
<td>0.285***</td>
</tr>
<tr>
<td></td>
<td>(0.0145)</td>
<td>(0.0142)</td>
<td>(0.0150)</td>
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<td>800054</td>
<td>800054</td>
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<tr>
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<tr>
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<tr>
<td>Country-Sector FE</td>
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</table>

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 Regression: IV Specifications

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<th>Regional Instrument</th>
<th>Lagged Instrument</th>
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</thead>
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<td>(2)</td>
</tr>
<tr>
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<td>-0.168***</td>
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<tr>
<td></td>
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<tr>
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<td></td>
<td>(0.0181)</td>
<td>(0.0184)</td>
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<tr>
<td>Obs.</td>
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<td>694330</td>
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<tr>
<td>R-sq</td>
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<tr>
<td>adj. R-sq</td>
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<td>0.374</td>
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</table>

Country Fixed Effect: yes, yes
Year Fixed Effect: yes, yes
Sector Fixed Effect: yes
Country-Year FE: yes
Country-Sector FE: 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 4: Pooled Regression: Robustness Checks by Goods Subsample

<table>
<thead>
<tr>
<th></th>
<th>Exclude</th>
<th>Energy</th>
<th>Exports</th>
<th>Only</th>
<th>Manufacturing</th>
<th>Exports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
</tr>
<tr>
<td>PEG x DIF</td>
<td>-0.155***</td>
<td>-0.159***</td>
<td>-0.143***</td>
<td>0.0748***</td>
<td>-0.224***</td>
<td>-0.243***</td>
</tr>
<tr>
<td></td>
<td>(0.0149)</td>
<td>(0.0142)</td>
<td>(0.0143)</td>
<td>(0.0201)</td>
<td>(0.0192)</td>
<td>(0.0193)</td>
</tr>
<tr>
<td>PEG</td>
<td>0.182***</td>
<td>0.145***</td>
<td>0.244***</td>
<td>-0.0390</td>
<td>0.175***</td>
<td>0.370***</td>
</tr>
<tr>
<td></td>
<td>(0.0144)</td>
<td>(0.0139)</td>
<td>(0.0148)</td>
<td>(0.0199)</td>
<td>(0.0192)</td>
<td>(0.0201)</td>
</tr>
<tr>
<td>Obs.</td>
<td>787468</td>
<td>787468</td>
<td>787468</td>
<td>596811</td>
<td>596811</td>
<td>596811</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.390</td>
<td>0.394</td>
<td>0.374</td>
<td>0.465</td>
<td>0.439</td>
<td>0.416</td>
</tr>
<tr>
<td>adj. R-sq</td>
<td>0.389</td>
<td>0.390</td>
<td>0.370</td>
<td>0.465</td>
<td>0.437</td>
<td>0.414</td>
</tr>
<tr>
<td>Country Fixed</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Year Fixed</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sector Fixed</td>
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<td>yes</td>
<td></td>
<td>yes</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Country-Year</td>
<td>yes</td>
<td></td>
<td></td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FE</td>
<td></td>
<td>yes</td>
<td></td>
<td></td>
<td>yes</td>
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</tr>
<tr>
<td>Country-Sector</td>
<td></td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FE</td>
<td></td>
<td>yes</td>
<td></td>
<td></td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

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 5: Pooled Regression: Robustness Checks by Country Subsample

<table>
<thead>
<tr>
<th></th>
<th>(1) OECD countries</th>
<th>(2) EU countries</th>
<th>(3) non-oil countries</th>
<th>(4) non-poor countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEG x DIF</td>
<td>-0.0444* (0.0197)</td>
<td>-0.118*** (0.0213)</td>
<td>-0.177*** (0.0158)</td>
<td>-0.181*** (0.0154)</td>
</tr>
<tr>
<td>PEG</td>
<td>0.0380 (0.0204)</td>
<td>0.122*** (0.0225)</td>
<td>0.276*** (0.0153)</td>
<td>0.181*** (0.0148)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Obs.</th>
<th>R-sq</th>
<th>adj. R-sq</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD countries</td>
<td>299355</td>
<td>0.508</td>
<td>0.506</td>
</tr>
<tr>
<td>EU countries</td>
<td>217423</td>
<td>0.511</td>
<td>0.509</td>
</tr>
<tr>
<td>non-oil countries</td>
<td>701834</td>
<td>0.367</td>
<td>0.366</td>
</tr>
<tr>
<td>non-poor countries</td>
<td>760845</td>
<td>0.382</td>
<td>0.381</td>
</tr>
</tbody>
</table>

Notes: Coefficients on country, year, and sector fixed effects not reported. 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>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>IV Regional</td>
<td>IV Lag</td>
<td>Non-energy</td>
<td>Manufac.</td>
<td>OECD</td>
<td>Non-oil</td>
<td>Non-poor</td>
</tr>
<tr>
<td>PEG</td>
<td>-0.0367***</td>
<td>-0.0429***</td>
<td>-0.0378***</td>
<td>-0.0327***</td>
<td>-0.0185*</td>
<td>0.00317</td>
<td>-0.0387***</td>
<td>-0.0554***</td>
</tr>
<tr>
<td></td>
<td>(0.00793)</td>
<td>(0.0117)</td>
<td>(0.00780)</td>
<td>(0.00795)</td>
<td>(0.00938)</td>
<td>(0.0108)</td>
<td>(0.00842)</td>
<td>(0.00800)</td>
</tr>
<tr>
<td>N</td>
<td>4757</td>
<td>3794</td>
<td>4737</td>
<td>4756</td>
<td>4718</td>
<td>660</td>
<td>4208</td>
<td>3706</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.718</td>
<td>0.734</td>
<td>0.721</td>
<td>0.685</td>
<td>0.601</td>
<td>0.888</td>
<td>0.704</td>
<td>0.758</td>
</tr>
<tr>
<td>adj. R-sq</td>
<td>0.706</td>
<td>0.721</td>
<td>0.709</td>
<td>0.672</td>
<td>0.584</td>
<td>0.879</td>
<td>0.691</td>
<td>0.747</td>
</tr>
</tbody>
</table>

Notes: Coefficients on country and sector fixed effects not reported. 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. Horizontal 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. Horizontal 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 $\theta$
(value of $\theta$ is full stabilization case that replicates the flexible price allocation)

Fig. 4b Home number of firms as function of policy parameter $\theta$
(value of $\theta$ 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).