Trade Relationships, Bargaining and Export Dynamics*

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Abstract

Data from emerging market economies reflect that, following large devaluations, export revenue growth is low and delayed. We examine this fact by introducing long-term trade relationships and bargaining into a standard small open economy model. The long-term nature of trade relationships reduces the expenditure-switching effect of exchange rate fluctuations and the allocative role of intermediate export prices. These elements improve the ability of the model to explain export growth following large devaluations and other second moments. Our analysis suggests that higher exporters' bargaining power or lower trade adjustment costs would increase resilience to interest rate shocks.

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1 Introduction

International trade is comprised almost exclusively of transactions between firms and involves a two-sided search between exporters and importers (Eaton et al., 2015; Bernard et al., 2018; Bernard and Moxnes, 2018). Many-to-many matches, i.e. firm connections where both importers and exporters have multiple trade relationships, make up around two thirds of aggregate trade (see, e.g., Eaton et al. (2015), Bernard et al. (2018), Bernard and Moxnes (2018)). Once a trade relationship is formed, the transaction's price and quantity are usually set by bargaining. For example, Friberg and Wilander (2008) report that the invoicing currency for exports is predominantly set through a negotiation between the exporter and importer.

Bargaining and the long-term nature of the relationships can also change the standard characterization of sales, which features imperfect substitutability between goods and, often, price rigidity. Indeed, Zbaracki et al. (2004) find that price negotiation costs account for almost 75 percent of the total price adjustment cost and are 20 times bigger than the size of the menu costs. Fabiani et al. (2006) find, based on surveys conducted by nine Eurosystem national central banks, that the existence of implicit and explicit contracts with customers is considered as the most important explanation for rigid prices. More generally, the evidence on firm-to-firm relationships and the dynamics of sales are consistent with the large empirical literature documenting incomplete exchange rate pass-through to import prices, suggesting that it mostly occurs at the firm-to-firm level.[1]

The repeated nature of the interactions between exporters and importers has an important implication: export prices may have a limited effect on export quantities and, thus, may not be allocative.[2] For example, when export prices decline, exporters may be willing not to adjust production if they expect foreign importers to compensate them in the future for the reduced profits incurred in the current period. The policy implications of this behavior are potentially large because the reaction of exporters and importers would affect the expenditure-switching effect of export prices and, as a result, the ability of authorities to affect aggregate trade dynamics.

This paper aims to analyze the role of long-term trade relationships and bargaining for export and business cycle dynamics. The central element of the model is the presence of two-sided search and matching frictions between domestic exporters and foreign importers. To sell in the foreign market, exporters and importers face convex costs for establishing firm-to-firm relationships. Resulting matches lead to contracts for the exchange of intermediate goods. Export prices and quantities are set in a bilateral Nash bargain, where exporters and importers share the surplus from each contract according to their relative bargaining power. The total

[1] See, e.g., Gopinath and Itskhoki (2011) and Burstein and Gopinath (2014) for an extensive review of the open economy literature on pass-through.

[2] See the seminal paper of Barro (1977) for an application to the labor market.

volume of exports depends on two margins of adjustment: an intensive margin, defined as the units sold in each match, and an extensive margin, defined as the number of trade relationships. We show that these simple modifications alter the transmission mechanism of exchange rate shocks substantially and allow the model to explain incomplete exchange rate pass-through to export and import prices, sluggish export dynamics following large devaluation episodes, and dynamic adjustment following large interest rate shocks.

To motivate and discipline the model, we revisit some empirical regularities about export dynamics and macroeconomic adjustment in emerging market economies.[3] Following Alessandria et al. (2018), we collect quarterly data for 11 emerging markets that have suffered a large devaluation episode, and describe business cycle facts along four dimensions: (i) second moments; (ii) dynamic cross-correlations between real exchange rates and aggregate trade data at different lags; (iii) the average dynamics of selected variables following large devaluation episodes, and (iv) impulse responses to risk premium shocks using panel local projection techniques. All these analyses reveal one robust finding: export growth is surprisingly low and delayed. Even after large devaluations, export growth is initially negative and only expands after approximately four quarters. This explains the large negative contemporaneous correlation between export growth and the real exchange rate, and the import-driven current account reversal. The lack of export adjustment amplifies the recessionary effects of devaluations with output remaining below potential for almost two years.

To inspect the model's transmission mechanism, we first consider it in partial equilibrium and analyze the effects of an exchange rate shock on the domestic export sector. Three results stand out. First, search frictions and bargaining endogenously generate incomplete and delayed exchange rate pass-through to export prices. Second, search frictions create a disconnect between export prices, and export quantities and foreign prices. In line with the argument by Barro (1977), the long-term nature of trade relationships reduces the allocative role of export prices and the expenditure-switching effect of exchange rate fluctuations. Third, we show that, despite the limited effect of export prices on export quantities, exchange rates still have an impact on export dynamics. In fact, exchange rates directly affect both the incentives to search for new partners (extensive margin) and the total surplus of any trade relationship (intensive margin), regardless of the evolution of export prices. Therefore, export dynamics depend more on the costs of adjusting production along the intensive and extensive margins, than on export price dynamics.

We then embed the model in a general equilibrium framework and analyze the response of the model economy to two shocks: an interest rate shock and a technology shock. The calibration

[3] Researchers and policymakers have for long paid attention to the reaction of exports to real exchange rate depreciation. Studies based on aggregate data tend to find a low elasticity of trade to exchange rate fluctuations ("elasticity pessimism"). Moreover, the relationship between exchange rates and economic fundamentals is generally weak ("exchange rate disconnect puzzle"). See, e.g., Obstfeld and Rogoff (2001), Obstfeld (2002) and Freund and Pierola (2012) for a discussion and alternative views.

strategy aims to capture the structural features revealed in our empirical exercises. Our model, despite its simplicity, matches quite well both the second moments of the data and the salient features of devaluation episodes in emerging market economies. Notably, the search model outperforms a model with no frictions in explaining the relative volatility of the real exchange rate, exports and imports, and the countercyclicality of the trade balance. Moreover, the presence of search frictions helps explain why, after a large devaluation, export growth is low and delayed, and the current account reversal is driven almost entirely by a sharp decrease in imports. These features are impossible to reproduce in a model with no frictions.

Two parameters are unique to this setting: the exporter's bargaining power and the trade cost parameter determining the cost of adjusting production along the intensive margin. We analyze the robustness of our results to different values of these parameters. Different values of the bargaining power greatly influence export price dynamics, which are vital in determining profits in the export sector and, thus, affect the economy's ability to absorb negative shocks. Lower trade adjustment costs allow for higher flexibility during times of crisis. Therefore, the economy's resilience to shocks improves when exporters have higher bargaining power and face lower trade costs.

This paper relates to the flourishing literature on firm-to-firm connections and international trade that repeatedly finds that network structure matters for firm-level and aggregate outcomes.[4] Egan and Mody (1992) show that long-term trade relationships can be of strategic importance for the performance of an emerging economy because its exporters can find them convenient to gain access not only to foreign markets but also to foreign technologies and quality and delivery standards. Rauch and Watson (2003) introduce one-sided search and information frictions in a setting where long-term relationships age to explain export dynamics. Chaney (2014) develops a search model to account for the geographical distribution of exports. Eaton et al. (2016) develop a model where exporters search for potential importers and learn from their interactions with other firms and discuss the welfare gains of reduced search costs. Krolikowski and McCallum (2017) analyze the welfare implications of a model with a mass of unmatched exporters resulting from search frictions. To allow for analytical tractability, they forgo many-to-many matches and endogenous search intensity.

From a modeling perspective, our paper builds on the work of Matha and Pierrard (2011) and Abbritti and Trani (2020). Matha and Pierrard (2011) introduce product market frictions into a closed economy model to study the effects of long-term relationships on business cycle dynamics, while Abbritti and Trani (2020) show that firm-to-firm relationships and bargaining can justify both low pass-through of cost shocks to prices and low allocative power of wholesale price changes. Our paper extends these analyses by including search and matching frictions

[4] See Bernard and Moxnes (2018) for a review of the related literature. Our paper also relates to previous work on the effects of sunk costs on trade dynamics and the sluggish export response to exchange rate changes (Baldwin, 1988; Baldwin and Krugman, 1989; Dixit, 1989; Cook and Devereux, 2006; Alessandria and Choi, 2007; Kohn et al., 2020, 2016; Alessandria et al., 2018).

between firms in a small open economy model. This allows us to study the effects of long-term relationships and bargaining on the degree of expenditure switching, exchange rate pass-through and export dynamics.

Our model is similar to the theoretical frameworks proposed by Drozd and Nosal (2012) and Alessandria et al. (2018). Drozd and Nosal (2012) introduce one-sided search frictions into a two-country real business cycle model and show that the combination of these frictions and bargaining helps account for several pricing puzzles in international macroeconomics. This paper differs from Drozd and Nosal (2012) in three key aspects. First, it develops a small open economy model, arguably a more flexible framework to describe emerging markets' dynamics. Second, it assumes that firm-to-firm relationships result from a two-sided search between large importers and exporters. Third, it endogenizes the intensive margin of trade, which is crucial to match the short-run response of export prices and quantities to shocks. Alessandria et al. (2018) explain sluggish export dynamics by introducing a dynamic model of export participation into a standard small open economy model. The main difference of this paper from Alessandria et al. (2018) consists in the fact that we consider a conceptually different type of dynamic friction: two-sided search and matching between exporters and importers. This setting allows to consider both exporters and importers as important for trade decisions, and analyze the crucial role of bargaining for export dynamics.

The rest of the paper is structured as follows. Section 2 revisits empirical regularities present in devaluation episodes and business cycles in emerging market economies. Section 3 describes the model and provides details on its main features: search frictions and bargaining. Section 4 explains our calibration strategy. Section 5 presents dynamics in partial equilibrium and describes the transmission mechanism of the model. Section 6 embeds our model in a general equilibrium framework and discusses aggregate dynamics after an interest rate shock. Section 7 concludes.

2 A look at the data

This section documents a set of empirical facts about business cycles in emerging market economies. Following Alessandria et al. (2018), we collect quarterly data for 11 emerging market economies that experienced a significant devaluation episode. The countries and dates for each episode are Argentina (2001m12), Brazil (1998m12), Colombia (1998m6), Indonesia (1997m7), Korea (1997m10), Malaysia (1997m7), Mexico (1994m12), Russia (1998m7), Thailand (1997m6), Turkey (2001m1) and Uruguay (2002m12). The final dataset ranges from 1990:1 to 2016:3. The starting date for each country varies depending on data availability. Appendix A.1 provides details on data sources and the construction of the series.

2.1 Large devaluations episodes

Following Alessandria et al. (2018), we begin by documenting the key relationships between macroeconomic variables during large devaluation episodes. Figure 1 presents the average evolution of selected macroeconomic indicators for a 24 quarter period around devaluation episodes. Output is detrended using an HP(1600) filter. The real interest rate is in levels. All other variables are measured as the cumulative percentage change from their pre-crisis levels.

The devaluation episodes included in our sample are violent events. On average, the real exchange rate depreciates 50 percent on impact and remains below its pre-crisis level for more than four years. A spike in international borrowing costs usually precedes these episodes. A year before, interest rates increase to 8 percent, and a quarter after, they peak at 20 percent. Despite considerable improvements in international competitiveness, export growth measured in dollars is initially negative and only expands after approximately four quarters. The large real exchange rate depreciation leads to a strong reversal of the trade balance, but this reversal is almost entirely due, at least on impact, to the collapse of imports. The lack of export adjustment exacerbates the recessionary effects of devaluation episodes, and output still remains 8 percent below trend three quarters after the shock.[5]

2.2 Dynamic cross-correlations

Analyzing dynamic cross-correlations between aggregate variables and the real exchange rate at different lags further confirms sluggish export dynamics. Figure 2 presents the dynamic cross-correlations between different lags of the real exchange rate and exports, imports, the trade balance and output for each of the 11 countries in our sample. All variables are logged, HP-filtered and measured in constant US dollars with the exception of GDP that is measured in constant local currency.

The results are notably robust across all countries. Contemporaneous correlations of the real exchange rate with imports and output growth are consistently negative. For all countries besides Colombia, the correlation between the real exchange rate and the trade balance peaks approximately one quarter after the crisis begins. More importantly, for all countries in our sample, the real exchange rate presents a negative contemporaneous correlation with export growth, stressing once more that the dollar value of exports generally decreases when devaluation episodes take place.

[5] Average dynamics mask significant cross-country heterogeneity. The size of devaluation episodes ranges from 18 percent in Colombia to 313 percent in Indonesia. Output loss on impact varies from 0 percent in Mexico to 19 percent in Indonesia. These results suggest that there are idiosyncratic characteristics that determine how countries fare during these crises. Detailed results are available upon request.

2.3 Panel local projections

Evidence reported in Figures 1 and 2 is unconditional. We compute panel local projections to provide more rigorous evidence on causality and identify dynamic adjustment of aggregate macroeconomic data to interest rate shocks. An upside of this approach is that it does not require making assumptions about the starting date of crises or the data generating process, while also being robust to misspecification (Jordà, 2005).

We estimate the following fixed effects panel specification for a k-variable system:

$$\Delta y_{it+h}^{k} = \alpha_h^k + r_{it}\beta_h^k + \sum_{l=0}^{p} \gamma_l^k Y_{it-l} + \theta_i^k + v_{it+h}^k \tag{1}$$

where Δy_{it+h}^{k} denotes the cumulative change h periods ahead of y^k in country i. α_h is an intercept parameter, θ_i^k are country fixed effects, and v_{it+h}^k is the error term. A history of p lags of control variables Y are associated with coefficients γ_l^k. β_h^k captures the effect of a one percentage point increase in a country's risk spread. The treatment variable is an exogenous interest rate shock which we identify as the residual of an $AR(4)$ model of the country risk spread. This is equivalent to setting r_{it} equal to the country risk spread and including its lags in Y.

We consider a 4-variable system that contains detrended real GDP, real exports and imports in US dollars, and the real exchange rate. The control matrix Y does not include contemporaneous controls for two reasons: reverse causality is a concern, and, as Figure 1 shows, the spike in the interest rate precedes the response of the remaining variables in the system. Because the real exchange rate is intimately related to the country risk spread during these devaluation episodes, we only include it as a control when it is the outcome variable.[6]

Figure 3 presents the impulse responses to the interest rate shock. After borrowing costs increase, the real exchange rate sharply depreciates and peaks one quarter after the shock. While these dynamics lead to a significant and persistent decline in import growth, the response of export growth is low and delayed: it is initially negative and only expands after four quarters. As a consequence, detrended output decreases in a hump-shaped pattern and only reverts to its pre-crisis trend after almost 2 years. Interestingly, emerging markets' dynamic responses to an increase in borrowing costs are qualitatively similar to the ones of large devaluation episodes (see Figure 1), thus, confirming the importance of interest rate shocks for the dynamics of real exchange rates, exports, imports, and the trade balance.

[6]Robustness checks include contemporaneous controls, the real exchange rate as a control for all specifications, the growth of the spread as the treatment variable, and domestic real GDP as part of the system. All these robustness exercises reveal similar patterns relative to our preferred specification and are available upon request.

2.4 Second moments

Second moments in emerging market economies reflect the brutality of devaluation episodes. Table 1 shows selected second moments for several macroeconomic indicators in our selected countries. All variables, except net exports, are in constant prices in units of the domestic currency, logged, and HP-filtered. Net exports are in levels.[7] As discussed in Neumeyer and Perri (2005), Aguiar (2005) and Uribe and Schmitt-Grohe (2017), emerging markets' business cycles are highly volatile with an average output volatility of 2.91, which more than duplicates the average output volatility of industrialized countries during the same sample period. The volatility of consumption exceeds the volatility of output in all countries barring Thailand, a result that is at odds with the assumption of consumption smoothing usually embedded in macroeconomic models. Similarly, the volatility of exports, imports and the real exchange rate triple that of output.

Regarding cross-correlations with output, three facts stand out. First, imports are strongly procyclical, while exports are acyclical, suggesting that exports adjust gradually to changes in economic conditions. Second, the trade balance is strongly countercyclical, such that net exports are positive in recessions and negative in expansions. Third, real exchange rate fluctuations are negatively correlated with output, suggesting that the real exchange rate tends to appreciate in expansions and depreciate in recessions.

In sum, our empirical analyses reveal a robust result: export growth is low and delayed. The latter is true not only following large devaluations but also during normal circumstances. Large devaluations are usually preceded by a massive increase in interest rate spreads, and lead to significant current account reversals that occur almost entirely through an adjustment in imports. The lack of export adjustment amplifies the recessionary effects of devaluations, and, two years after the shock, output remains below trend. As a result, second moments, cross-correlations, and impulse responses to interest rate shocks are strongly affected.

In the following sections, we show that search and matching frictions and bargaining could help small open economy models account for these features of the data, while also being consistent with the incomplete exchange rate pass-through to import prices.

3 The Model

To study the role of long-term relationships and bargaining on export dynamics and account for patterns found in the data, we introduce search and matching frictions within the export sector of a small open economy model. Domestic exporters and foreign importers spend time

[7] Note that the cross-correlations of exports, imports and the trade balance with the real exchange rate in Table 1 differ from the ones in Figure 2. Exports, imports and the trade balance in Table 1 are expressed in terms of constant local currencies while the corresponding series in Figure 2 are in constant US dollars.

and resources to establish long-term relationships between them. Once matched, domestic exporters and foreign importers bargain for quantities and prices to maximize the total surplus, which is then shared in proportion to their relative bargaining power. Thus, two margins of adjustment determine the total volume of exports: the quantity traded per match (intensive margin) and the number of matches (extensive margin).

There are three productive sectors in the domestic economy: an intermediate goods sector, a final goods sector, and an export sector[8]. The intermediate goods sector produces a nontradable homogeneous good under perfect competition. The final goods sector aggregates the domestic intermediate good and a foreign intermediate good to produce a nontradable good that domestic households consume. The export sector produces a tradable good that foreign importers buy and then sell to foreign households. Imports are financed with revenues from the export sector and households' net positions in internationally traded one period non-contingent bonds denominated in foreign goods.

3.1 Consumer's Problem

Domestic households choose consumption, hours of work, and asset position to maximize lifetime utility:

$$\max E_t \left\{ \sum_{t=0}^{\infty} \beta^t U(C_t, L_t) \right\}$$

C_t denotes household consumption and $L_t = l_{dt} + l_{xt}$ total hours of work in the domestic (l_{dt}) and export (l_{xt}) sector. Households face a sequence of flow budget constraints:

$$P_t C_t = W_t L_t + \Pi_t - P_{mt} B_t + \frac{P_{mt} B_{t+1}}{1 + R_t}$$

B_t is the stock of debt, P_t is the price of the final consumption good, W_t is the wage, Π_t are total profits from all productive sectors in the domestic economy, and P_{mt} is the price of the intermediate foreign good. The domestic economy pays a premium above the world interest rate that is increasing in its debt level, $R_t = R^w + \Psi(e^{(B_{t+1} - \overline{B})} - 1) + \mu_t^R$, where μ_t^R is an exogenous risk premium shock (Uribe and Schmitt-Grohe, 2017).

Households have Greenwood-Hercowitz-Huffman (GHH) preferences:

$$U(C_t, L_t) = \frac{(C_t - \lambda L_t^{v})^{1-\phi}}{1 - \phi}$$

GHH preferences are used extensively in the international business cycle literature. This utility

[8]The structure of the model follows Alessandria et al. (2018).

specification, by shutting down wealth effects on labor supply, assures that persistent productivity shocks do not result in lower employment and, thus, allows matching empirical output dynamics following productivity shocks. Moreover, this specification is supported empirically by Schmitt-Grohé and Uribe (2012), who estimate the wealth effect to be near zero.

The solution to the maximization problem gives a standard set of first order conditions:

$$\lambda \upsilon L_t^{\upsilon-1} = w_t \tag{2}$$

$$(C_t - \lambda L_t^{\upsilon})^{-\phi} = \beta E_t \left\{ \left(C_{t+1} - \lambda L_{t+1}^{\upsilon}\right)^{-\phi} \frac{\sigma_{t+1}}{\sigma_t}(1+R_t) \right\} \tag{3}$$

where the real wage and real exchange rate are defined as $w_t = \frac{W_t}{P_t}$ and $\sigma_t = \frac{P_{mt}}{P_t}$, respectively. The stochastic discount factor is defined as $\beta_{t,t+1} = \beta \frac{U_{c_{t+1}}}{U_{c_t}} \frac{P_t}{P_{t+1}}$.

3.2 Final and Intermediate Nontradable Goods Sectors

Firms in the final goods sector aggregate a domestic intermediate good, D_t, and a foreign intermediate good, M_t, to produce the final consumption good, C_t:

$$C_t = \left(D_t^{\frac{\gamma-1}{\gamma}} + \omega^{\frac{1}{\gamma}} M_t^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}}$$

where γ is the elasticity of substitution between domestic and foreign goods, and ω is the Armington weight associated to the foreign intermediate good. P_{dt} and P_{mt} are the prices of the domestic and foreign intermediate goods, respectively. The price of the final good is:

$$P_t = \left(P_{dt}^{1-\gamma} + \omega P_{mt}^{(1-\gamma)} \right)^{\frac{1}{1-\gamma}} \tag{4}$$

The optimal allocation satisfies:

$$\frac{P_{dt}}{P_{mt}} = \left(\frac{M_t}{\omega D_t} \right)^{\frac{1}{\gamma}} \tag{5}$$

The domestic intermediate good is produced in a perfectly competitive market with a production function that is linear in labor: $D_t = z_t l_{dt}$, where z_t is an exogenous technology shock. It follows that the optimality condition is:

$$\frac{P_{dt}}{P_{mt}} = \frac{w_t}{\sigma_t z_t} \tag{6}$$

An increase in σ_t–a real exchange rate depreciation–lowers production costs in terms of the foreign good and shifts production towards the domestic intermediate good.

In the remainder of the paper, the price of the imported intermediate good, P_{mt}, is assumed to be the numeraire and lowercase notation denotes the relative price of goods in terms of the import price, for example, $p_{dt} = \frac{P_{dt}}{P_{mt}}$.

3.3 Export Sector

The main novelty of the model is the introduction of search and matching frictions in the relationship between exporters and importers. This section describes the export sector's business environment, the maximization problem faced by exporters and importers, and the solution of bilateral bargaining over the prices and quantities of international trade.

3.3.1 Search and Matching

Domestic exporters establish long-term relationships with foreign importers to access the foreign market and sell their goods. The aggregate number of these relationships, T_t, evolves according to:

$$T_{t+1} = (1-\delta)(T_t + h_t) \tag{7}$$

where δ is the exogenous rate at which relationships are terminated. The number of new long-term relationships, h_t, is a constant returns to scale function of a domestic exporter's search effort, a_t, and foreign importer's search effort, d_t:

$$h_t = \overline{h} a_t^{\xi} d_t^{1-\xi} \tag{8}$$

where $\overline{h} > 0$, and $\xi \in (0, 1)$ is the elasticity of matching with respect to the exporter's search effort.

Total international trade, y_{xt}, depends on two margins of adjustments: the number of trade relationships or extensive margin, T_t, and the units sold in each of these relationships or intensive margin, q_t:

$$y_{xt} = q_t T_t$$

Market tightness in the export sector is defined as $\theta_t = a_t/d_t$. The exporter and importer's matching rates are $k^x(\theta_t) = \frac{h_t}{a_t} = \overline{h}\theta_t^{-(1-\xi)}$ and $k^I(\theta_t) = \frac{h_t}{d_t} = \overline{h}\theta_t^{\xi}$, respectively. As it is standard in the search and matching literature, exporters and importers take these rates as given in their maximization problem. This assumption introduces two externalities working in opposite directions. First, individual traders, either exporters or importers, ignore the negative congestion externalities they impose on their peers as they search. Second, they do not internalize the positive thickness externalities they create on each other as they search. These externalities may lead to choices that are suboptimal at the aggregate level and, in turn, to an inefficient matching process.

As discussed in Matha and Pierrard (2011) and Abbritti and Trani (2020), the decentralized equilibrium is constrained efficient only if the Hosios (1990) condition holds, which happens when the exporters' bargaining power, $1-\eta$, equals the exporters' elasticity of matching, ξ. As we move away from this condition, negative congestion externalities dominate either from the exporters' side, when $1-\eta>\xi$, or from the importer's side, when $1-\eta<\xi$. Of course, this implies that establishing international trade relationships becomes costlier, and the matching process, more sclerotic.

3.3.2 Exporter's Problem

There is a continuum of exporters, each indexed by $j \in [0,1]$, who employ domestic labor and produce a final exportable good that is consumed exclusively by foreign consumers. The exporters' production function is linear in labor:

$$y_{xt}\left(j\right) = z_t l_{xt}\left(j\right) = q_t(j)T_t(j)$$

Exporters spend time and resources to match with foreign importers. Search costs are convex and increasing in exporters' search intensity, defined as $x_{xt}\left(j\right) = \frac{a_t(j)}{T_t(j)}$:

$$\frac{\gamma^f}{2}(x_{xt}(j))^2 T_t(j)$$

where $\gamma^f > 0$. Convexity plays a significant role as it allows the model to capture realistically slow adjustment along the extensive margin.[9]

Exporters choose their optimal search effort, $a_t(j)$, and ideal number of matches, $T_t(j)$, to maximize the expected value of current and future profits:

$$E_0\left\{\sum_{t=0}^{\infty}\beta_{0,t}\left(p_{xt}(j)q_t(j)T_t(j)-\frac{w_t}{\sigma_t}l_{x_t}(j)-\frac{\gamma^f}{2}(x_{xt}(j))^2T_t(j)-\Gamma\left(q_t(j)\right)T_t(j)\right)\right\} \tag{9}$$

subject to the law of motion of trade relationships $T_{t+1}(j) = (1-\delta)(T_t(j)+a_t(j)k^x(\theta_t))$. $\Gamma\left(q_t(j)\right)$ is a convex cost of adjusting quantities along the intensive margin. As discussed in Abbritti and Trani (2020), this cost is crucial to disentangle both margins of trade and define the maximization problem correctly. In fact, if changing $q_t(j)$ were costless, there would be no incentive to search for new long-term relationships. We assume a quadratic cost function:

$$\Gamma\left(q_t(j)\right) = \frac{c^f}{2}(q_t(j)-\overline{q})^2.$$

[9]See Gourio and Rudanko (2014), Drozd and Nosal (2012) and Matha and Pierrard (2011) for similar assumptions and a detailed discussion.

This functional form assumes that there is an optimal amount, $\overline{q}$, of units sold per match that minimizes trade costs in each match. Deviations from this optimal quantity are possible but expensive. This specification is useful because of its analytical tractability. As $c^f \to 0$, adjustment along the intensive margin becomes costless and international trade takes place through changes in q_t. Conversely, as $c^f \to \infty$, it must be that $q_t(j) = \overline{q}$ at all t, the intensive margin is closed and international trade only expands through the extensive margin.

The exporter's optimality conditions are:

$$\frac{\gamma^f x_{xt}(j)}{k^x(\theta_t)} = (1-\delta)E_t\left\{\beta_{t,t+1}V_{t+1}(j)\right\} \tag{10}$$

$$V_t(j) = \left(p_{xt}(j) - \frac{w_t}{\sigma_t z_t}\right)q_t(j) - \Gamma\left(q_t(j)\right) + \frac{\gamma^f}{2}(x_{xt}(j))^2 + (1-\delta)E_t\left\{\beta_{t,t+1}V_{t+1}(j)\right\} \tag{11}$$

Equation (10) equates the expected search cost of an additional match to its expected benefit. Equation (11) defines the marginal value of a trade relationship. This is the sum of two terms: profits from sales net of quantity adjustment costs, $\left(p_{xt}(j) - \frac{w_t}{\sigma_t z_t}\right)q_t(j) - \Gamma\left(q_t(j)\right)$, and gains from an additional match, which is a function of savings in the cost of establishing new matches, $\frac{\gamma^f}{2}(x_{xt}(j))^2$, and the expected continuation value, $(1-\delta)E_t\left\{\beta_{t,t+1}V_{t+1}(j)\right\}$.

The real exchange rate directly enters the exporter's valuation function. A depreciation increases V_t by lowering labor costs in terms of foreign goods and creates an incentive to boost the exporter's search intensity. Its impact will depend on the size of search costs and the persistence of the shock.

3.3.3 Foreign Importer's Problem

In the foreign economy, there is a continuum of importing firms, each indexed by $r \in [0,1]$. The foreign importer's problem is symmetrical to the domestic exporter's, except for quantity adjustment costs which are only faced by domestic exporters. Importers optimally choose their search effort, $d_t(r)$, and the number of matches, $T_t(r)$, to maximize the following stream of profits:

$$E_0\left\{\sum_{t=0}^{\infty}\beta^*_{0,t}\left((p_{It}(r) - p_{xt}(r))y_t(r) - \frac{\gamma^f}{2}(x_{It}(r))^2 T_t(r)\right)\right\} \tag{12}$$

subject to the law of motion of the stock of trade relationships and the production function:

$$T_{t+1}(r) = (1-\delta)(T_t(r) + d_t(r)k^I(\theta_t))$$

$$y_t(r) = q_t(r)T_t(r)$$

where $x_{It}(j) = \frac{d_t(j)}{T_t(j)}$ is foreign importer's search intensity and $p_{It}(r)$ is the price charged to foreign consumers, which is taken as given by each importer. $\beta^*_{t,t+1} \equiv \beta \frac{U^*_{ct+1}}{U^*_{ct}} \frac{P_{mt}}{P_{mt+1}}$ is the foreign stochastic discount factor. Because foreign dynamics are exogenous in our analysis, it follows that $\beta^*_{t,t+1} = \beta$.

First-order conditions for the foreign importer are analogous to the domestic exporter's:

$$\frac{\gamma^f x_{It}(r)}{k^I(\theta_t)} = \beta(1-\delta)E_t\left\{J_{t+1}(r)\right\} \tag{13}$$

$$J_t(r) = \left(p_{It}(r) - p_{xt}(r)\right) q_t(r) + \frac{\gamma^f}{2}(x_{It}(r))^2 + \beta(1-\delta)E_t\left\{J_{t+1}(r)\right\} \tag{14}$$

3.3.4 Nash Bargaining

The presence of search frictions implies that there is a surplus associated with each existing long-term relationship and many bargained prices and quantities are consistent with equilibrium. In fact, any price schedule that satisfies $V > 0$ and $J > 0$ for all t could be an equilibrium in the model, as it generates a positive surplus for both parties. This feature has interesting implications, because it opens up the possibility of *equilibrium sticky prices* (Hall, 2007; Arseneau and Chugh, 2007), which we discuss later in the paper.

We assume that exporters and importers share the surplus according to a Nash bargaining protocol. They simultaneously choose the export price, p_{xt}, and quantity traded per match, q_t, to maximize the following product:

$$S_t = \left[J_t^\eta V_t^{1-\eta}\right]$$

where $\eta \in [0,1]$ is the importer's bargaining power. To simplify notation and because we focus on a symmetric equilibrium, match-specific indexes are dropped.

The solution for the bargained export price yields the optimal sharing rule:

$$(1-\eta)J_t = \eta V_t$$

The export price splits the total surplus of a long-term relationship according to the relative bargaining power of each party. Solving for the bargained price:

$$p_{xt} = \eta\left\{\frac{w_t}{z_t\sigma_t} + \frac{\Gamma(q_t)}{q_t} - \Omega_{xt}\right\} + (1-\eta)\left\{p_{It} + \Omega_{It}\right\} \tag{15}$$

where $\Omega_{xt} = \frac{\gamma^f}{2}\frac{(x_{xt})^2}{q_t} + \frac{\gamma^f x_{xt}}{q_t k^x(\theta_t)}$ and $\Omega_{It} = \frac{\gamma^f}{2}\frac{(x_{It})^2}{q_t} + \frac{\gamma^f x_{It}}{q_t k^I(\theta_t)}$. The bargained price is a weighted average of two terms. The first term is the exporter's reservation price: the minimum price at which the exporter is willing to sell. It is a function of domestic marginal costs, quantity adjustment costs, and savings in search costs, Ω_{xt}. The second term is the importer's reservation price: the highest price at which the importer is willing to buy. It is a function of the price the importer charges to foreign consumers, p_{It}, and savings in search costs, Ω_{It}. The weight of each term directly depends on their relative bargaining power, η.

The quantity sold per match, q_t, is chosen to maximize the total surplus obtained from an export relationship:

$$q_t = \overline{q} + \frac{1}{c^f}\left(p_{It} - \frac{w_t}{\sigma_t z_t}\right) \tag{16}$$

The number of units sold per match is an increasing function of the total profit margin shared by exporters and importers, μ_t, defined as the difference between the final price in the foreign economy, p_{It}, and the exporters' marginal cost of production, $\mu_t = p_{It} - \frac{w_t}{\sigma_t z_t}$. More importantly, notice that, because exporters and importers choose q_t to maximize the total surplus of a match, the units traded in each match depend directly on the foreign import price, p_{It}, but are set independently from the export price, p_{xt}. Therefore, the export price has no direct effect on the intensive margin of trade, q. This raises the important question of whether export prices play a role in the allocation of resources in the economy; a question to which we will return later.

3.3.5 External Demand

To close the model, we assume that foreign consumers' demand for the exported good is:

$$EX_t = (p_{It})^{-\varepsilon} C_t^*$$

where ε captures the elasticity between exports and domestic goods in the foreign country, and C_t^* denotes foreign consumption expenditures.

3.4 Equilibrium

In the symmetric equilibrium, firms on either side of the market are identical. Thus, they trade at equal prices and quantities with the same number of long-term relationships.

The market-clearing condition for the export sector requires:

$$y_{xt} = q_t T_t = z_t l_{x_t} = (p_{It})^{-\varepsilon} C_t^*$$

Total imports, IM_t, are defined as follows

$$IM_t = \left[M_t + \left(\frac{\gamma^f}{2}(x_{xt})^2 + \Gamma(q_t)\right)T_t\right]$$

which involves both the imported good and the resources absorbed by the trade costs associated with export relationships.

From the budget constraint, it follows that the relationship between net exports and debt accumulation is:

$$\frac{B_{t+1}}{1+R_t} = B_t + EXR_t - IM_t$$

where $EXR_t = p_{xt}EX_t$ denote aggregate export revenues. Real output is defined as:

$$Y_t = D_t + \frac{p_{xt}}{p_{dt}}y_{xt}$$

Total profits in the domestic economy equal profits from the export sector because the remainder of domestic firms are perfectly competitive:

$$\Pi_t = \pi_{xt} = p_{xt}q_tT_t - \frac{w_t}{\sigma_t}l_{x_t} - \left(\frac{\gamma^f}{2}(x_{xt})^2 + \Gamma(q_t)\right)T_t$$

3.5 A Benchmark Model

Comparing our baseline model with a nested model with no frictions is a useful exercise to understand the role of long-term relationships and bargaining for exports and business cycle dynamics. In the benchmark model with no frictions, hereafter referred to as *No Frictions Model*, we assume that the export sector is perfectly competitive, which implies:

$$p_{It} = p_{xt} = \frac{w_t}{\sigma_t z_t}$$

It follows that in the *No Frictions Model* there is complete exchange rate pass-through to export prices, and complete pass-through of export prices to foreign import prices.

4 Calibration Strategy

The parameters of the baseline calibration are chosen to capture the main structural features of emerging market economies. The empirical moments correspond to the unbalanced panel of 11 emerging market economies described in section 2.

Standard parameters. We calibrate the usual parameters of a small open economy model to be as close as possible to the standard values used in the literature at the quarterly frequency. The discount factor is set to $\beta = 0.99$. The risk aversion coefficient is $\phi = 2$ (Mendoza, 1991). The parameter υ, which determines the Frisch elasticity, is set to 1.6 (Neumeyer and Perri, 2005), while λ is chosen so that total labor supply equals one-third of the time endowment. Following Alessandria et al. (2018), the share of total labor employed in the export sector equals 15 percent, the average debt level over imports, $\overline{B}/IM$, equals 10, and the price elasticity of demand for the exported good, ε, equals 3. The debt sensitivity to the interest rate is $\Psi = 0.18$. It is the median estimate by Uribe and Schmitt-Grohe (2017) across 51 poor and emerging market economies over the period 1980-2011.[10] Finally, the elasticity of substitution between domestic non-traded goods and foreign intermediate goods, γ, equals 0.731 to match the relative volatility of imports relative to the volatility of output. This value is well within the range of values found in other empirical studies.[11]

Trade frictions and bargaining. The calibration of the export sector parameters is challenging because direct evidence is scant. The separation rate is set to $\delta = 0.125$. This value, which implies an average duration of trade relationships of 8 quarters, is consistent with evidence found by Eaton et al. (2015), and it is close to the value of 0.10 set by Drozd and Nosal (2012). The exporter's search effort, x_x, is set such that the probability of finding a match, $k^x(\theta)$, equals 0.20. The latter is in line with Eaton et al. (2015), who find that, on average, only one-fifth of the potential buyers contacted by Colombian exporters are interested in establishing a trade relationship. The direct profit margin of exporters and importers $\mu = p_I - \frac{w}{\sigma z}$ is 0.10, similar to the exporter's mark-up of 12 percent used by Alessandria et al. (2018). The steady state value of the import price p_I and the technically optimal level $\overline{q}$ are normalized to 1. The search costs γ^f, and the matching efficiency parameter $\overline{h}$ are obtained through steady-state relationships.

Two crucial parameters in our model are the importer's bargaining power, η, and the trade cost parameter for the intensive margin, c^f. Following Abbritti and Trani (2020) and Matha and Pierrard (2011), we assume symmetry in the matching process between exporters and importers. Therefore, the elasticity of the matching function, ξ, and the importer's bargaining power, η, equal 0.5. We then carefully explore the robustness of our results to different values of the relative bargaining power η.

To calibrate the trade cost parameter c^f, we use the fact that, on impact, the pass-through of cost shocks to import prices depends entirely on the intensive margin.[12] Specifically, the trade cost parameter is calibrated to match an exchange rate pass-through to import prices of 10 percent, in line with the evidence by Burstein and Gopinath (2014). This results in a value of $c^f = 2.55$.

Shock processes. We consider two shocks: a productivity shock z_t and an interest rate shock

[10] See Uribe and Schmitt-Grohe (2017), chapter 7. An empirically plausible value of Ψ is needed, especially in the *No Frictions Model*, to avoid excessive export volatility. In the *Search Model*, the main results are unaffected by different values of Ψ.

[11] See Akinci (2017) and the references therein. Moreover, it is close to the value of γ = 0.74 that Mendoza (1992) estimates for 13 industrial countries.

[12] In fact, in our model the list of trade partners is a state variable, and new matches are operative after one period.

μ_t^R. Both processes follow an AR(1) process:

$$\log z_t = \rho_z \log z_{t-1} + u_t^z, \ \ \log \mu_t^R = \rho_R \log \mu_{t-1}^R + u_t^R$$

Following Alessandria et al. (2018), the persistence parameters for both shocks are $\rho_z = \rho_R = 0.95$. These values are consistent with the Argentinian business cycle estimations computed by Garcia-Cicco et al. (2010). The standard deviations of the two shocks are chosen to match two targets in the sample of emerging market economies: the average volatility of output and the relative volatility of the real exchange rate with output. This results in $\sigma_z = 0.895\%$ and $\sigma_R = 0.975\%$ for the productivity shock and interest rate shock, respectively.

No Frictions Model. To facilitate comparison, the calibration of the *No Frictions Model* is identical to that of the baseline search model.

Both the *Search Model* and *No Frictions Model* are solved by second-order perturbation methods and apply pruning following Kim and Ruge-Murcia (2009).[13] Each model is simulated 500 times for 100 periods to obtain the simulated moments. We simulate an additional 500 periods as a pre-sample that is not included for the computation of the moments to have different starting points.

5 Exchange rate shocks and industry dynamics

In the data, the exchange rate pass-through to export and foreign consumption prices is surprisingly low. At the aggregate level, Campa et al. (2005) find that, across OECD countries, exchange rate pass-through to import prices is around 45 percent in the short-run and 65 percent in the long-run. In the United States, exchange rate pass-through is even lower: 23 percent in the short-run and 42 percent in the long-run. Pass-through estimates are even lower at the micro-level. For example, in the beer market, Goldberg and Hellerstein (2008) find that the exchange rate pass-through to consumer prices is between 7 and 10 percent. Gopinath and Itskhoki (2011) and Burstein and Gopinath (2014) revise a large amount of empirical literature in different markets and arrive at similar conclusions.

To analyze the model's potential for explaining these facts, we consider the adjustment mechanism of the model to an exchange rate shock in partial equilibrium, where the export sector is in isolation and all other aggregate variables are constant.[14] Specifically, we assume that the

[13] Second order perturbation methods are used to improve the accuracy of the solution in the presence of relatively large shocks. Results using the first-order solution are similar.

[14] While the assumption of an exchange rate shock that has negligible effects on aggregate consumption and prices is probably not realistic, this approach is useful to identify the main channels at work within the model, compare them with the standard framework, and distinguish between the direct and general equilibrium effects of our export structure. Moreover, this approach is closer to the empirical work on exchange rate pass-through. See also Gopinath and Itskhoki (2011); Nakamura and Zerom (2010).

exchange rate follows an AR process of order 1:

$$\hat{\sigma}_t = \lambda_\sigma \hat{\sigma}_{t-1} + \varepsilon_t^\sigma \tag{17}$$

where $\lambda_\sigma \in [0, 1)$ denotes the serial correlation of exchange rates and ε_t^σ is an i.i.d. shock.

Figure 4 presents impulse responses of selected variables following a persistent real exchange rate appreciation. Because exchange rates are usually close to a random walk, the persistence of the exchange rate shock is set to $\lambda_\sigma = 0.95$. We distinguish three versions of the model: the baseline *Search Model*, the benchmark model with no frictions, *No Frictions Model*, and the baseline search model with sticky export prices, *Constant Export Price Model*, where the export price is kept constant and equal to the steady-state level of the bargained price ($p_{xt} = p_x$). Note that a completely sticky bargained price is consistent with equilibrium as long as it falls inside the bargaining set.

In the *No Frictions Model*, a one percent real exchange rate appreciation leads to a one percent increase in export prices and foreign retail prices. Thus, the exchange rate pass-through is complete. Because the degree of expenditure-switching is also significant, export volumes and export revenues decrease sharply.

Dynamics in the *Search Model* are quite different. The presence of search frictions and bargaining can explain incomplete pass-through to export and import prices, as well as sluggish export dynamics documented by empirical studies. Because trade adjustment is costly, the reduction of matches and units sold in each match occurs slowly. On impact, exporters and importers react by reducing the units exchanged in each match. Moreover, because the shock is expected to last for several quarters, international traders have the incentive to reduce their search efforts.

Consequently, starting from the second period, the stock of trade relationships decreases, further decreasing total trade in the export sector. Pass-through to foreign retail prices is around 0.1 on impact and remains low afterward. Pass-through to export prices is almost proportional to the bargaining power of foreign importers on impact and persists longer over time.

To get some intuition on the role of bargaining for the expenditure-switching effect of exchange rates, consider the *Constant Export Price Model*. Following an exchange rate appreciation, a fixed export price is beneficial to foreign importers, who increase their profits and search efforts, but detrimental for exporters, who reduce their search efforts. These reactions tend to offset each other such that different pricing schemes have almost no impact on the quantity exchanged per match or the number of matches. For this reason, the dynamics of the total volume of exports track almost perfectly the *Search Model*. In other words, different export price determinations have almost no effect on total trade volumes or the degree of expenditure-switching resulting from exchange rate fluctuations.

Figure 5 shows how exchange rate pass-through and expenditure-switching change with the structure of the export sector. The degree of pass-through and expenditure-switching are measured as the percentage response of prices and quantities to a one percent change in the exchange rate, respectively. We show the degree of pass-through and expenditure-switching after one year.[15] The first column of Figure 5 shows how pass-through and expenditure-switching change for different values of the importer's bargaining power, η. The second column shows the effect of the trade cost parameter, c^f.

The degree of exchange rate pass-through and expenditure-switching depend crucially on the trade cost parameter. c^f determines the relative costs of adjusting production along the intensive margin. Lower values of c^f make it easier for exporters to adjust their production and distribution structure, and increase the elasticity of export quantities to fluctuations in exchange rates. In turn, a strong reduction in the production of exported goods increases the reaction of export and foreign import prices. Therefore, lower values of c^f lead to higher exchange rate pass-through to prices and an increase in the expenditure-switching effect of exchange rate shocks. The degree of pass-through to both export and foreign prices is complete only when trade costs are null. On the other hand, this feature is reversed relatively fast for higher values of c^f.

The relative bargaining power of importers, η, has a different impact on export prices and foreign import prices. Pass-through to export prices is strongly increasing in η, but the increase in pass-through to p_{xt} has weak consequences for foreign prices and the total volume of trade. This happens because η has virtually no effect on the response of q_t and only a limited effect on the dynamics of long-term relationships, T_t. In particular, the responses of the extensive margin, import prices, and final consumption are non-monotonic in η. They peak when the Hosios (1990) condition is satisfied ($1 - \eta = \xi = 0.5$) and the matching process is efficient. As we move away from this value, they decrease symmetrically.

This analysis suggests that the presence of long-term relationships and bargaining leads to a disconnect between the exchange rate pass-through to export prices, and foreign prices and export quantities. To see this, notice for example that when foreign importers' bargaining power goes from 0.5 to 1, the *increase* in the degree of exchange rate pass-through to export prices is associated with a *reduction*, albeit small, in the degree of exchange rate pass-through to import prices and barely any response of either margin of adjustment. Thus, the response of total exports to fluctuations in the exchange rate is not uniquely determined by the exchange rate pass-through to export prices. In the next section, we further examine the mechanism of the model to shed light on these apparently counterintuitive results.

[15]The expenditure-switching effect of exchange rate fluctuations is generally defined as the adjustment in the relative demand of foreign goods to domestic goods following a real exchange rate change. For simplicity, we adopt a narrower perspective. We define expenditure-switching as the change in the demand for the export good following an exchange rate shock.

5.1 Inspecting the Mechanism: Exchange Rate Pass-through and Expenditure Switching

The presence of search frictions and bargaining has a profound effect on the transmission mechanism of shocks in the export sector. To understand why this is the case, in this section, we compare the standard framework used in international macroeconomics with our baseline search model.

In standard international macroeconomic models with imperfect competition, there is a strict relationship between the degree of exchange rate pass-through (ERPT) to export prices and the degree of expenditure-switching. Suppose that the demand for the good exported by firm j is $c_t^*(j) = D_c\left(p_{xt}^*(j)/p_t^*\right)C_t^*$, where $p_{xt}^*(j)$ is the border price of good j in the foreign country, C_t^* are total consumption expenditures of foreign consumers, p_t^* is the associated aggregate price level, and $D_c(\cdot)$ is an inverse function of the relative price[16]. In log deviations from the steady state, we have:

$$\hat{c}_t^*(j) = -\varepsilon_i\left(\hat{p}_{x,t}^*(j) - \hat{p}_t^*\right) + \hat{c}_t^*, \tag{18}$$

where $\varepsilon_i \equiv -\frac{dD_c\left(p_{x,t}^*(j)/p_t^*\right)}{d\left(p_{xt}^*(j)/p_t^*\right)}\frac{\left(p_{xt}^*(j)/p_t^*\right)}{D_c\left(p_{xt}^*(j)/p_t^*\right)} > 0$ is the price elasticity of demand. Variables with a hat operator denote log-deviations from the steady state. Equation (18) implies that for any given aggregate price and output dynamic, *exchange rate fluctuations impact the demand for the imported good*, $\hat{c}_t^*(j)$, *only inasmuch as they affect export prices*, $\hat{p}_{xt}^*(j)$. A higher degree of ERPT leads to a larger degree of expenditure-switching. Notice that this channel crucially depends on export prices being allocative, i.e. affecting the demand for the good.

The *Search Model*'s transmission mechanism differs from the standard setup on, at least, two dimensions. First, in the search model, different factors determine export and import prices. Consider the evolution of export prices:

$$p_{xt} = \eta\left\{\frac{w_t}{z_t\sigma_t} + \frac{\Gamma(q_t)}{q_t} - \Omega_{xt}\right\} + (1-\eta)\left\{p_{It} + \Omega_{It}\right\}$$

In the model, export prices distribute the surplus of trade relationships between exporters and importers. As a consequence, p_{xt} is a weighted average of exporters and importers' valuation of the good, where the weight depends on the bargaining power, η. An exchange rate appreciation–a decrease of σ_t–directly affects the first term because it increases the costs of production of the export good once expressed in terms of the foreign good. When exporters have most of the bargaining power–when η is low–they obtain most of the trade surplus and the price is strictly related to the value of exported goods in the foreign market. At the limit, for $\eta \to 0$, there is no *direct* link between exchange rate shocks and export prices. Conversely, when foreign importers have most of the bargaining power–when η is high–the effect of an ex-

[16] See, for example, Burstein and Gopinath (2014) for a similar formulation.

change rate shock on the export price is stronger because export prices are more closely related to the reservation price of exporters. Therefore, exchange rate pass-through to *export prices* is strongly increasing in the *importer's* bargaining power. At the limit, for $\eta \to 1$, pass-through is complete.

Pass-through to foreign import prices, instead, depends on how easy it is to adjust production along the intensive and extensive margin:

$$p_{It} = A_t \left(q_t T_t\right)^{-\frac{1}{\varepsilon}}$$

where $A_t = \left(C_t^*\right)^{\frac{1}{\varepsilon}} > 0$ is exogenous in the model. Following an exchange rate appreciation, the response of p_{It} is proportional to the response of q_t and T_t, and pass-through to foreign prices is strictly related to the costs of changing the production and the distribution infrastructure.

The second main difference of the search model with the standard setup is related to the impact of exchange rates and export prices on export quantities. Total export volume in the model depends on the two margins of adjustment, $y_{xt} = q_t T_t$.

The extensive margin depends on the expected future values of trade relationships that determine the incentives to search:

$$V_t = \left(p_{xt} - \frac{w_t}{\sigma_t z_t}\right) q_t + CV_t^X \tag{19}$$

$$J_t = \left(p_{It} - p_{xt}\right) q_t + CV_t^I \tag{20}$$

where $CV_t^X = \Omega_{xt} q_t - \Gamma\left(q_t\right)$ and $CV_t^I = \Omega_{It} q_t$.

The intensive margin depends on the total direct profit margin of a trade relationship:

$$q_t = \overline{q} + \frac{1}{c^f}\left(p_{It} - \frac{w_t}{\sigma_t z_t}\right) \tag{21}$$

Two facts are worth mentioning. First, contrary to a standard model, the export price has limited allocative power. In fact, p_{xt} does not affect the intensive margin of trade q_t that depends on the total profit margin of a match. Moreover, it is unlikely to have a large impact on the extensive margin of trade, T_t. A higher export price increases the exporter's value of a long-term relationship while decreasing the importer's. In such a context, while exporters increase search efforts, importers reduce it–see equation 19 and equation 20. Because these opposite forces tend to cancel out, export prices have a small effect on T_t. As such, export prices are partially disconnected from export quantities, and different price determination schemes in Figure 4 have limited effects on export dynamics.

Despite the limited role of export prices in changing quantities, the real exchange rate still has an effect on export dynamics but through an entirely different channel. Real exchange rate fluctuations directly affect both exporters' marginal costs and incentives to search–see equation 19–and the total surplus of a match–equation 21. Therefore, the expenditure-switching effect of exchange rates is strictly related to the costs of changing production along the extensive and intensive margins.

In summary, the presence of search frictions and bargaining alters the transmission of exchange rates shocks. In contrast to the standard setup, there is a limited expenditure-switching effect of export prices on export quantities. However, exchange rate fluctuations directly affect export dynamics through their effect on the incentives to search and bargained quantities. Importantly, the size of this effect is a function of the costs of adjusting production along the intensive and extensive margin and is almost independent of the bargained export price.

6 The Model in General Equilibrium: Can Search Frictions and Bargaining Explain Export Dynamics?

To analyze the effects of long-term trade relationships and bargaining on business cycle dynamics, we now incorporate the export sector in a General Equilibrium framework. We first analyze the dynamic responses of different macro variables to interest rate shocks. We then study the effect of search frictions and bargaining on the second moments and cross-correlations of the model. Finally, we perform a sensitivity analysis to understand how different values of η and c^f alter aggregate dynamics.

6.1 Impulse Responses

To study the effects of long-term trade relationships and bargaining on the aggregate economy, Figure 6 compares the dynamic responses to a positive interest rate shock of the *Search Model* to the ones of the *No Frictions Model*.

First, consider the *Search Model*. A spike in interest rates increases the costs of borrowing and incentives to save. Domestic consumption declines, lowering wages and employment in the nontradable production sector. The real exchange rate depreciates. The competitiveness of exports increases and facilitates the reallocation of resources to pay back the outstanding debt to the foreign economy.

Within the export sector, the depreciation increases the profit margin of existing matches and the marginal value of trade relationships. As a result, firms in the export sector adjust production along both margins. They increase the units sold per match and their search intensity to find new matches. Because it is costly for firms to adjust production exclusively along the intensive margin, a significant fraction of trade adjustment occurs through the extensive margin.

Initially, export revenues worsen because the increase in export volume does not offset the decline in the export price. As the shock dissipates and new matches become profitable, export revenues gradually recover. Sluggish export growth reinforces the real exchange rate depreciation and amplifies the drop in imports. As in the data, the current account reversal occurs almost entirely through imports and exacerbates the decline in output.

These results stand in stark contrast to the *No Frictions Model*. In the absence of search frictions, the real exchange rate depreciation substantially increases the volume of exports and export revenues, offsetting the initial decrease in the price of exports. The massive increase in export revenues serves as a buffer for the economy. The resulting fall in output is considerably lower than in the *Search Friction Model*. Similarly, the responses of the real exchange rate, imports, and real wages are less severe.

The *Search Model* tracks remarkably well local projections and salient features of large devaluation episodes presented in Section 2. Following an interest rate shock: (i) export revenues' growth is low and delayed, as it picks up only after three quarters; (ii) imports fall dramatically; (iii) current account reversal is driven almost entirely by a sharp decrease in imports. In the *No Frictions Model*, export revenues' growth is immediate and strong, the current account reversal is driven by exports and imports, and the depreciation is not as severe. Perhaps more importantly, our model suggests that sluggish export dynamics strongly amplify the recessionary effect of interest rate shocks with an output drop in the *Search Model* that is 60 percent larger than in the *No Frictions Model*.[17]

6.2 Model Results: Second Moments and Dynamic Cross-Correlation

Table 2 compares the second moments of the data to those obtained with the *Search Model* and the *No Frictions Model*. The moments are obtained by filtering the actual and simulated data with the HP(1600) filter. The data moments are the averages of the corresponding moments of the 11 emerging market economies in our sample.

Despite its simplicity, the *Search Model* matches various moments of emerging market economies. Our calibration strategy forces the model to match the volatility of output and the relative volatilities of imports and of the real exchange rate. The *Search Model* fits remarkably well the relative volatility of exports and the cross-correlations of several macroeconomic variables to

[17] Search frictions also play a role during a positive productivity shock. When productive capacity increases and domestic marginal costs decrease, the real exchange depreciates. The domestic economy expands as foreign demand increases. In the *Search Model*, the increase in export volume does not offset the decrease in export prices, and export revenues decrease on impact. In the *No Frictions Model*, export revenues increase on impact, and output increases more than in the *Search Model*. The domestic economy's situation is so favorable that it can finance higher imports despite the devaluation. Impulse responses for the productivity shock are available upon request.

output. It predicts the procyclicality of consumption and imports and the countercyclicality of net exports and the real exchange rate. Export dynamics are weakly correlated with output in both the model and the data, even though in the model they have opposite sign.

The *Search Model* outperforms the *No Frictions Model* along several dimensions. In particular, the *No Frictions Model* is unsuccessful in accounting for the relative volatility of exports, imports and the real exchange rate, and the negative correlation of the real exchange rate with output. It also grossly underestimates the negative correlation between the trade balance and output. These results suggest that proper modeling of sluggish export dynamics is crucial not only to replicate the responses to interest rate shocks but also to match emerging market economies' second moments.

Figure 7 shows dynamic cross-correlations of the real exchange rate with exports, imports, output, and the trade balance at different lags. As in Figure 2, both in the data and in the model exports, imports, and the trade balance are measured in US dollars while output is measured in the domestic currency. The *Search Model* approximates dynamic cross-correlations of the data relatively well, capturing both the negative correlations of real exchange rates with output, imports and exports, and the positive correlation of the real exchange rate with net exports. In contrast, the *No Frictions Model* predicts a large positive correlation between export revenues and the real exchange rate and virtually no relationship between the real exchange rate and output, which are clearly at odds with the data.

6.3 Sensitivity Analysis: The Effects of Bargaining Power and Trade Cost

How do different market structures affect export and business cycle dynamics? To answer this question, this section analyzes how export and business cycle dynamics change with different values of the trade cost parameter c^f, and the importer's bargaining power, η.

Figure 8 presents impulse responses to a positive interest rate shock for three different values of c^f: our baseline value of $c^f = 2.55$, $c^f = 0.01$, and $c^f = 8$. As expected, trade costs strongly influence the economy's dynamic adjustment to shocks. For low values of c^f, trade is almost frictionless, and exporters can easily adjust production along the intensive margin. As a result, the increase in total trade, which is initially four times larger than under our baseline calibration, comfortably offsets the reduction in export prices. Export volumes and revenues increase on impact and support economic recovery. The improvement in export revenues allows the economy to adjust its current account with a smaller contraction of imports. Perhaps more importantly, the ensuing output decline and real exchange rate depreciation are halved relative to the baseline *Search Model*. The opposite is true for high values of c^f.

Likewise, Figure 9 shows the role of bargaining power for business cycle dynamics following a positive interest rate shock. Once more, we consider three cases: the baseline case of $\eta = 0.5$, a lower value where domestic exporters are the dominant party ($\eta = 0.1$), and a higher value where foreign importers have most of the bargaining power ($\eta = 0.9$).

In line with the partial equilibrium analysis of Section 5, different values of η have a relatively small effect on the intensive and extensive margins of trade or import prices. Notwithstanding, bargaining power has a significant impact on the gravity of the recession. When foreign retailers have most of the bargaining power ($\eta = 0.9$) output falls by almost 2 percent on impact, whereas in the opposite case ($\eta = 0.1$) output only shrinks 0.5 percent. Despite η's negligible effect on the total volume of trade, it changes export prices and determines profits of exporting firms in the domestic economy. In fact, while export prices fall by almost 5 percent when $\eta = 0.9$, they actually increase when $\eta = 0.1$. For this reason, the economy's resilience to an interest rate shock increases when exporters are able to retain a large fraction of the surplus of each trade relationship.

7 Conclusions

Recent empirical evidence shows that most international transactions involve two-sided search, many-to-many matches, and bargaining over prices and quantities. This paper introduces search and matching frictions and bargaining over prices and quantities into a standard small open economy model to account for these features.

These new elements change the transmission mechanism of the exchange rate and cost shocks. Search frictions allow the model to replicate sluggish export dynamics following devaluation episodes, and bargaining over prices and quantities create a disconnect between export prices and export quantities. Export prices have mainly a distributive role: they determine how the rents of an international trade relationship are split between exporters and importers. Export quantities depend on the costs of adjusting the production and distribution infrastructure to a changing economic environment.

The resulting model explains three aspects that standard small open economy models cannot account for: incomplete exchange rate pass-through to export prices, second moments and cross-correlations of emerging market economies, and business cycle dynamics following interest rate shocks and large devaluation episodes.

The model is still stylized and could be expanded along several dimensions. One fruitful avenue for future research is the introduction of nominal rigidities. By changing the allocative power of export prices and the expenditure-switching effect of exchange rate fluctuations, the presence of long-term relationships and bargaining in international trade is likely to have important implications for the exchange rate and monetary policy. Understanding these mechanisms and their implications could be vital in designing policies for the stabilization of emerging market economies' business cycles.

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A Appendix

A.1 Data sources

This section describes the sources and transformation for each of the macroeconomic indicators used in our data exercises.

1. The panel dataset is unbalanced. We consider the following countries and periods:

   - Argentina: 1993Q1 to 2016Q2
   - Brazil: 1995Q1 to 2016Q3
   - Colombia: 1994Q1 to 2016Q1
   - Indonesia: 1997Q1 to 2016Q4
   - South Korea: 1990Q1 to 2016Q3
   - Malaysia: 1991Q1 to 2016Q3
   - Mexico: 1990Q1 to 2016Q3
   - Russia: 1995Q1 to 2014Q4
   - Thailand: 1993Q1 to 2016Q3
   - Turkey: 1990Q1 to 2016Q3
   - Uruguay: 1997Q1 to 2016Q3

2. **Exchange rates:** We follow Alessandria et al. (2018) and estimate the real exchange rate using the following formula:

$$RER_{it} = e_{it} * \frac{CPI_{US,t}}{CPI_{i,t}}$$

   where e_{it} is the nominal exchange rate of country i at time t of domestic currency to United States dollars. We obtain all series from the International Monetary Fund's International Financial Statistics (IFS) database except for Argentina, Colombia and the United States. Because the Argentinean CPI is otherwise unavailable, we use the estimated series by Cavallo and Bertolotto (2016). For Colombia, we obtain the CPI series published by the official statistics office, DANE, following Uribe and Schmitt-Grohe (2017). We use the United States CPI from the OECD database. All indices have the base year of 2010.

3. Total exports and imports are obtained from the IFS database in current domestic currency. The trade balance is computed as the difference.

4. Gross national product, and final household consumption are downloaded from the IFS database in current national currency. This excludes Uruguay. Its time series are constructed using official figures published by the Central Bank of Uruguay. We estimate a price deflator using their Real GDP and Nominal GDP series, and use it to compute GDP components in current domestic currency. Also, expenditure components are spliced using growth rates obtained from a sample dating from 1983Q1 to 2008Q1.

5. A series for the United States import price deflator is downloaded from the Federal Reserve Bank of St. Louis database and rescaled such that 2010=100.

6. Interest Rates: The United States real interest rate is constructed using the Federal Fund Rate series from the Federal Reserve Bank of St. Louis database and its CPI.

   We use the **JP Morgan EMBI+ Stripped Spread** for Argentina, Brazil, Colombia, Indonesia, and Mexico. For Malaysia, Russia, Turkey, and Uruguay, we use the **JP Morgan EMBI Global Stripped Spread**. The interest rate data for South Korea and Thailand is obtained from the online appendix of chapter 6 in Uribe and Schmitt-Grohe (2017).

Series were deflated with country i's GDP deflator from the IFS database (with the exception of Uruguay), and seasonally adjusted. The series for Colombia, and Mexico were already seasonally adjusted.

Countries	Arg	Bra	Col	Ind	Kor	Mal	Mex	Rus	Tha	Tur	Uru	Mean
Panel A. Standard Deviations												
σ_y	4.54	1.96	1.62	3.13	2.08	2.47	2.67	2.95	3.40	3.70	3.44	2.91
$\frac{\sigma_c}{\sigma_y}$	1.26	1.09	1.23	1.34	1.62	1.53	1.57	1.10	0.92	1.06	1.31	1.28
$\frac{\sigma_x}{\sigma_y}$	2.97	4.62	4.08	3.62	3.21	1.90	3.63	4.17	1.77	2.32	1.91	3.11
$\frac{\sigma_m}{\sigma_y}$	2.64	4.06	4.20	3.74	3.40	2.44	3.01	2.15	2.72	3.00	2.82	3.11
$\sigma_{\frac{tb}{y}}$	2.35	0.87	1.29	2.18	2.39	3.92	1.39	3.40	4.04	2.20	2.24	2.39
$\frac{\sigma_{rer}}{\sigma_y}$	3.10	5.57	4.70	5.02	4.13	2.40	3.36	4.96	1.95	2.47	2.46	3.65
Panel B. Correlations with Output												
c	0.94	0.74	0.61	0.33	0.90	0.63	0.75	-0.05	0.84	0.84	0.91	0.68
x	0.09	0.13	0.16	-0.19	-0.31	0.29	-0.04	0.27	0.22	0.10	0.69	0.13
m	0.75	0.31	0.63	0.12	0.52	0.61	0.38	0.44	0.62	0.57	0.81	0.52
$\frac{tb}{y}$	-0.55	-0.20	-0.38	-0.57	-0.81	-0.57	-0.49	0.06	-0.51	-0.57	-0.38	-0.45
rer	-0.50	-0.28	-0.37	-0.47	-0.50	-0.43	-0.34	-0.35	-0.50	-0.41	-0.73	-0.44
Panel C. Serial Correlations												
y	0.79	0.51	0.82	0.85	0.82	0.80	0.32	0.85	0.72	0.72	0.79	0.73
c	0.78	0.66	0.78	0.56	0.83	0.78	0.20	0.65	0.84	0.63	0.74	0.68
x	0.70	0.54	0.57	0.67	0.69	0.71	0.71	0.79	0.64	0.68	0.59	0.66
m	0.76	0.64	0.67	0.72	0.77	0.74	0.45	0.76	0.76	0.78	0.68	0.70
$\frac{tb}{y}$	0.82	0.75	0.60	0.59	0.64	0.68	0.60	0.79	0.66	0.74	0.42	0.66
rer	0.70	0.66	0.62	0.79	0.61	0.73	0.72	0.66	0.63	0.63	0.79	0.68

Table 1: Second moments of emerging market economies. Panel A presents standard deviations. Panel B presents correlations with output. Panel C presents serial correlations. All series are quarterly level data, HP-filtered with a smoothing coefficient of 1600, and measured in local currency units. The trade balance is the difference between exports and imports.

Statistic	Data	Search Model	No Frictions
Standard Deviation			
σ_y	2.91	2.91	2.82
$\frac{\sigma_c}{\sigma_y}$	1.28	1.87	1.46
$\frac{\sigma_x}{\sigma_y}$	3.11	2.81	5.04
$\frac{\sigma_m}{\sigma_y}$	3.11	3.11	2.04
$\sigma_{\frac{tb}{y}}$	2.39	1.36	1.94
$\frac{\sigma_{rer}}{\sigma_y}$	3.65	3.65	1.30
Correlations with Output			
c	0.68	0.78	0.79
x	0.13	-0.17	-0.01
m	0.52	0.59	0.56
$\frac{tb}{y}$	-0.45	-0.53	-0.26
rer	-0.44	-0.29	-0.01

Table 2: Comparison of the second moments of the data with those obtained with the *Search Model* and the *No Frictions Model*. The moments are obtained by filtering the actual and simulated data using the HP(1600) filter. The empirical moments are the averages of the corresponding moments of the 11 emerging market economies described in Appendix A.1.

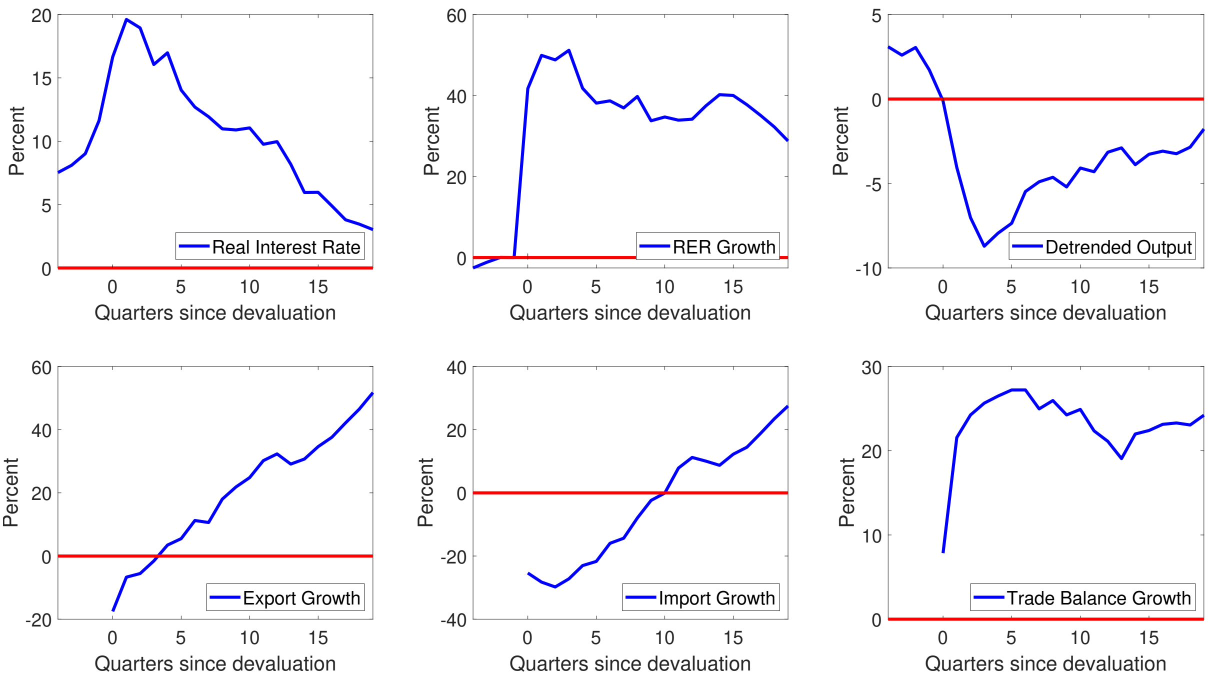

Figure 1: Average dynamics of 11 emerging market economies during a large devaluation episode. The x-axes show the quarters since the start of the devaluation episode at time 0, and the y-axes represent cumulative changes from time 0 in percentage points. Exports, imports, and the trade balance are measured in constant US dollars. Detrended output is in constant local currency units.

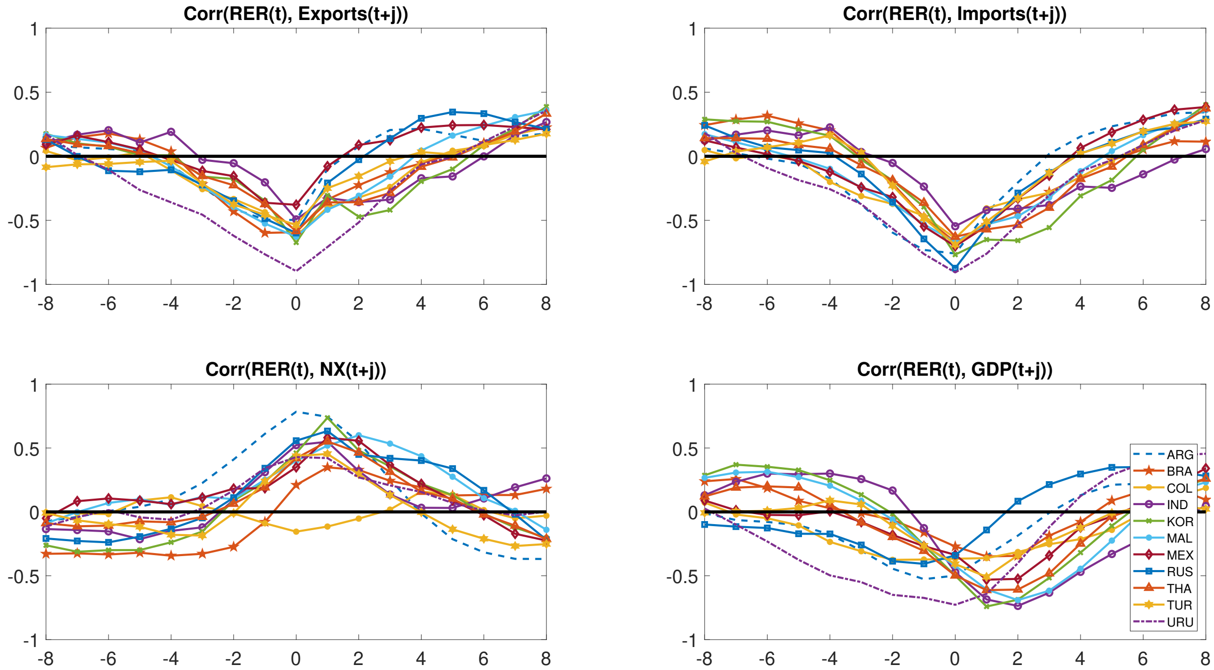

Figure 2: Dynamic cross-correlations between aggregate data and the real exchange rate (RER). All variables are logged, HP-filtered and measured in constant US dollars with the exception of GDP which is measured in constant local currency units.

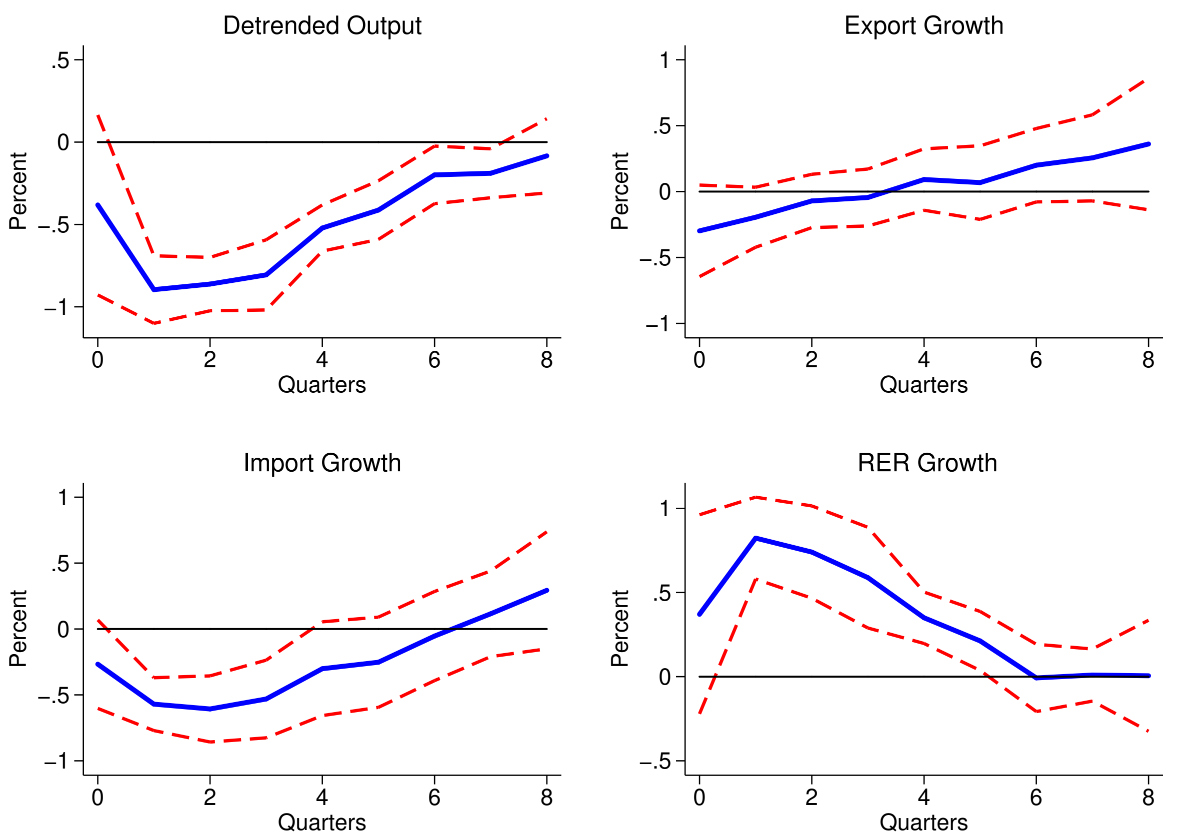

Figure 3: Panel local projections for 11 emerging market economies. The figure presents the marginal effect of a 1 percentage point increase in a country's risk spread. Detrended output, export and import growth are measured in constant US dollars.

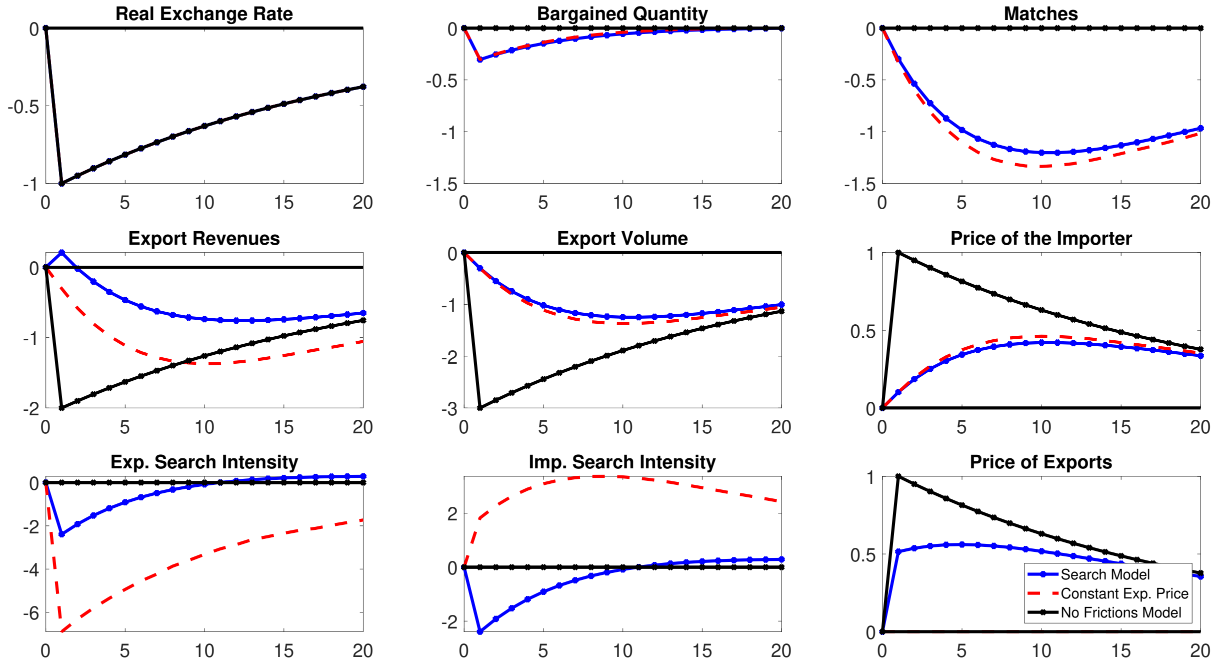

Figure 4: Export industry dynamics following a one-percent real exchange rate appreciation.

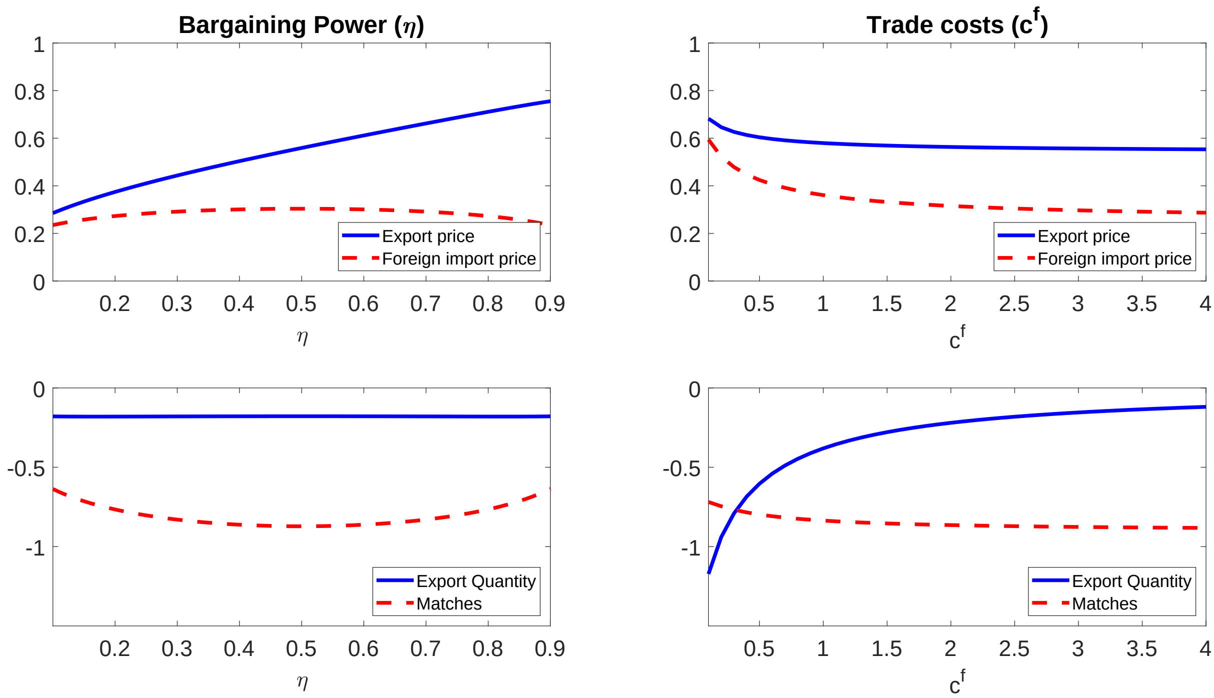

Figure 5: Exchange rate pass-through and expenditure switching-effect one year after the exchange rate shock.

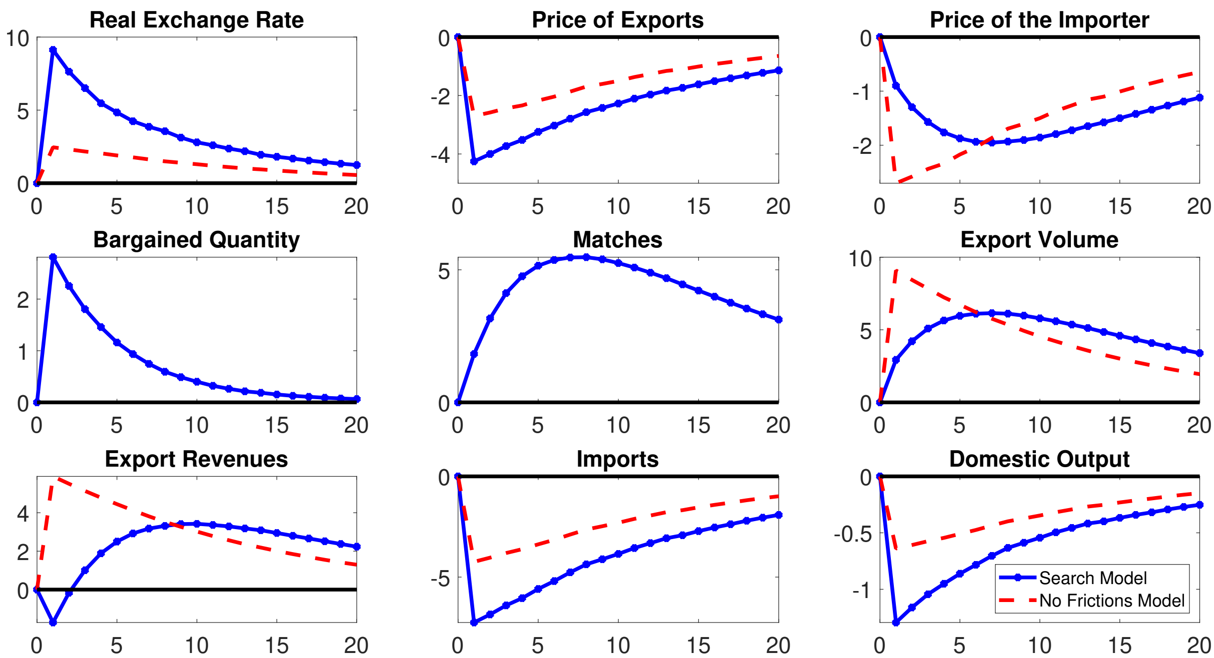

Figure 6: *Search Model* and *No Frictions Model*'s dynamic responses to a positive interest rate shock.

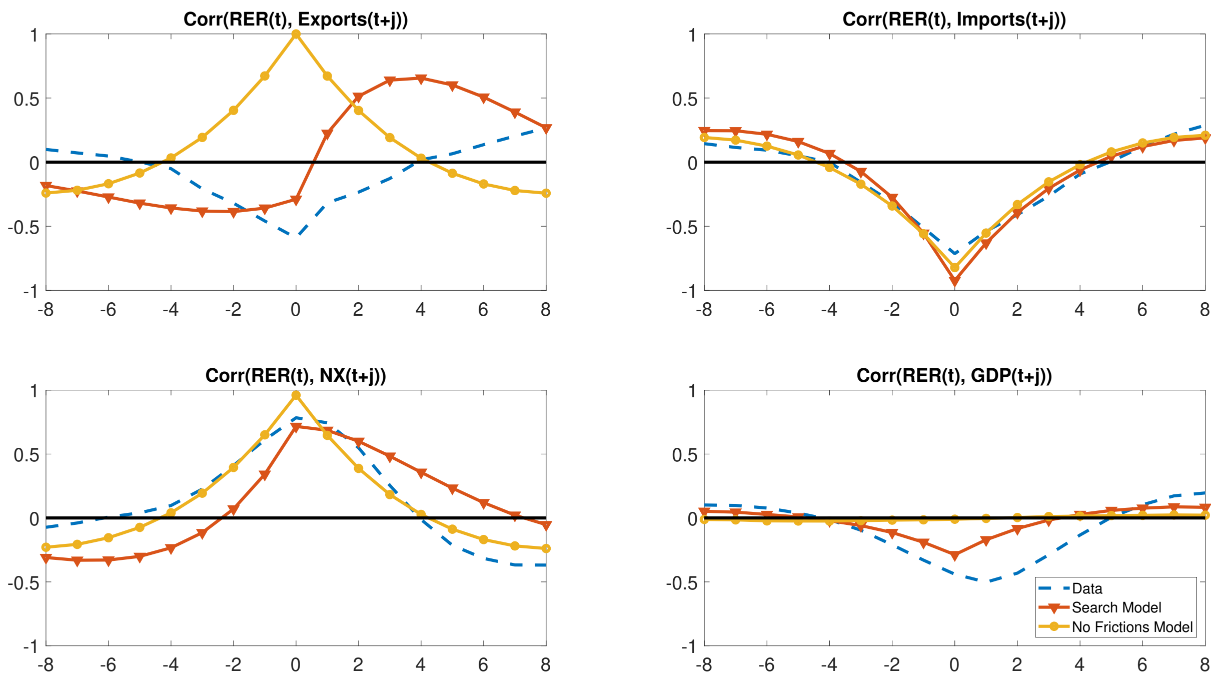

Figure 7: Dynamic cross-correlations with the real exchange rate in the data, in the *Search Model*, and in the *No Frictions Model*. The cross-correlations of the data correspond to a cross-sectional average of the emerging market economies included in our sample. In the data all variables are logged, HP-filtered and measured in constant US dollars with the exception of GDP which is measured in constant local currency units. Exports in constant US dollars in the Search and No Frictions Models correspond to export revenues, EXR(t). For consistency also the models' variables are logged and HP-filtered.

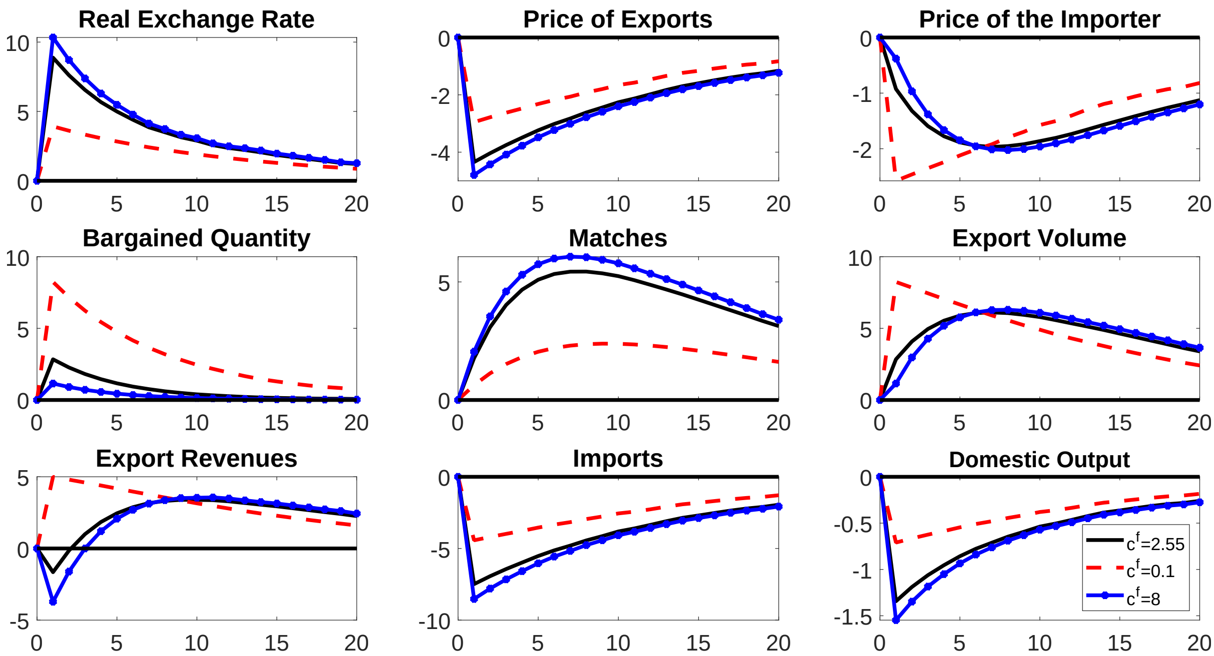

Figure 8: Impulse responses to an interest rate shock for different values of the trade cost parameter c^f.

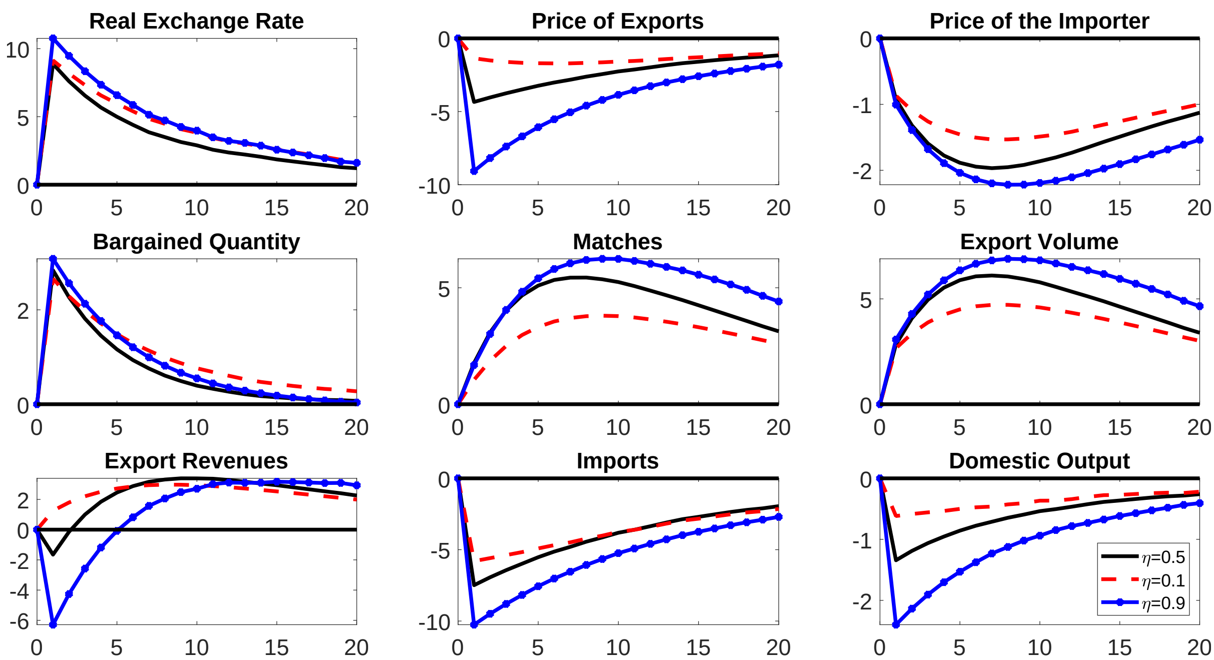

Figure 9: Impulse responses to an interest rate shock for different values of the importer's bargaining power η.