Sector Heterogeneity and Credit Market Imperfections in Emerging Markets

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Abstract

Interest rate shocks have a large impact on economic activities in emerging markets. This paper argues that this finding can be associated with credit market imperfections affecting principally non-tradable activities. Using a new database on sectoral output and credit markets in emerging economies, I present novel evidence documenting that tradable and non-tradable sectors respond asymmetrically to changes in credit conditions. In particular, I show that local credit conditions explain a significant proportion of the variation in output growth in non-tradable activities, but little of the variation in output growth in the tradable sector. Accordingly, interest rate shocks are amplified solely through non-tradable activities. Importantly, I demonstrate that these distinctive features of emerging markets are absent in developed small open economies. To rationalize these findings, I introduce a simple small open economy model in which tradable and non-trabable sectors differ in their access to external finance. The model illustrates that credit market imperfections can reverse the predictions of the standard small open economy model, in which interest rate shocks affect the capital-intensive tradable sector most. In presence of financial frictions, these shocks can affect the labor-intensive non-tradable sector more.

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1 Introduction

External shocks have a large impact on aggregate activities in emerging markets. Changes in international terms of trade, *sudden stops* of capital inflows, and foreign interest rate shocks have been at the center of downturns in these economies over the last decades.[1] In particular, several studies provide substantial evidence that foreign interest rate shocks explain a non-negligible part of economic recessions. Using econometric techniques, Uribe and Yue (2006) and Canova (2005) estimate that US interest rate shocks explain about 20% of movements in aggregate activities in emerging markets. Recently, Chang and Fernández (2010) with a quantitative exercise confirm that interest rate shocks coupled with financial frictions can have a substantial impact on main economic aggregates.

This paper illustrates that increases in the cost of borrowing propagate asymmetrically in emerging markets. In particular, I present novel evidence of how interest rate shocks are negatively correlated with output in the non-tradable sector, whilst showing no significant relationship in the tradable sector. However, this major countercyclical co-movement between non-tradable output and the interest rate is at odds with the standard small open economy model. In a frictionless setting, increases in the cost of borrowing should affect the tradable capital-intensive sector the most. This paper argues that heterogeneous access to external finance can account for the asymmetric and *a priori* counterintuitive response of tradable and non-tradable outputs to interest rate shocks. More precisely, it sustains that the low development of the domestic credit market affects more those firms relying particularly on local credits, i.e. non-tradable firms.[2]

A well-documented fact is that the interest rate is countercyclical in emerging markets, but a-cyclical in developed small open economies (SOE) (for example Uribe and Yue, 2006; and Neumeyer and Perri, 2005). Table 1 presents these relationships for a group of ten emerging markets and nine developed SOE, over the period between 1994 and 2008 at a quarterly frequency. It confirms that increases in the cost of borrowing are associated with declines in emerging markets' aggregate activities, but they are unrelated with output fluctuations in small open economies. The decomposition between tradable and non-tradable sectors is revealing. In emerging markets, the observed declines are solely driven by downturns in the non-tradable sector. In contrast, tradable activities are

[1] For instance, Calvo, Leiderman, and Reinhart (1993) illustrate that the US interest rate was a major determinant of the economic expansion of Latin American countries in the early 1990s. Calvo, Izquierdo, and Mejía (2004) show that *sudden stops* are associated with financial disruptions, exchange rate depreciations, and economic recessions. Several studies point out that changes in the terms of trade explain a non-negligible part of output drops in developing economies (for example, Mendoza, 1995; Kose, 2002; and Broda, 2004).

[2] I will review the related literature on this topic below.

Table 1: Panel VAR: Interest Rate and Output Growth

	Output Growth		
	GDP	Tradable	Non-Tradable
Interest rate	(1)	(2)	(3)
Small Open Economies	-0.0006	0.0017	-0.0009
	(0.0006)	(0.0019)	(0.0007)
Emerging Markets	-0.0900**	0.1055	-0.1265***
	(0.0445)	(0.1320)	(0.0494)

Notes: Real Output Growth Rate. Real Interest Rate: Short-term 3-month, MEI, OECD for SOEs; and r US Tbill + EMBI GLOBAL for EMs. standard erros in parenthesis. *,**,*** significant at 10%, 5%, 1%, respectively. Period: 1994q1: 2008q2. SOEs: Australia, Belgium, Canada, Denmark, Italy, Netherlands, Norway, Spain and Sweden. EMs: Argentina, Bulgaria, Chile, Hungary, Indonesia, Korea, Mexico, Peru, Thailand and Turkey.

unaltered by changes in the domestic cost of borrowing. Remarkably, this salient response of the non-tradable activities is only characteristic of emerging markets. Table 1 shows that the negative correlation between output and the interest rate vanishes in developed SOE.

The major impact of the rise in the cost of borrowing on the labor-intensive sector is somehow puzzling. This paper sustains that the larger exposure of non-tradable firms to domestic credit market imperfections can account for this feature. To rationalize this argument, I develop a standard small open economy model with international borrowing (as in Eaton and Gersovitz, 1981; Kletzer and Bardhan, 1987; and Arellano, Bai, and Zhang, 2009). In my framework, agents face heterogeneous access to credit markets depending on the enforceability of debt contracts. Tradable firms enjoy broad access to credit, as foreign lenders find it easier to enforce their contracts by submitting them to foreign courts. Unlike tradable firms, as there is no international authority guaranteeing that non-tradable firms will fulfill their debt contracts, foreign lenders face the risk of debt repudiation. In the model, non-tradable firms pay a risk premium endogenously determined by their probability of debt default. Then, an upsurge in the foreign interest rate induces a larger increase of the borrowing cost for non-tradable firms and, thus, a deeper downturn of their activities. Hence, the model predicts that interest rate shocks should be particularly correlated with non-tradable output. In addition, it states that the larger fall in non-tradable output induces an upsurge in its price, and hence an exchange rate appreciation.

In the empirical section, I apply this model's predictions to the data. First, I compute a panel VAR, the impulse response functions, and the variance decomposition for output

growth to domestic and foreign interest rate shocks for a set of 19 economies (nine small open economies and ten emerging markets) at a quarterly frequency. The figures suggest that country interest rate shocks explain approximately 12% of non-tradable output growth variations, but only 1% of the variation in the tradable sector. Next, in line with the model's predictions, I show that aggregate fluctuations are associated with exchange rate appreciations in emerging economies, while they are unrelated in developed SOE. This highlights the mechanism implied by the model: a higher borrowing cost depresses non-tradable activities, which raises their relative price and appreciates the currency. Finally, I show that non-tradable activities are more reliant on the domestic credit market in emerging economies. I construct a database on local credit and output at a quarterly frequency, and estimate a dynamic heterogeneous panel for both sectors. Estimation results suggest that in these economies, domestic credit is significantly more associated with output growth in the non-tradable sector.

This paper adds to a long literature on the causes of economic downturns in emerging markets. In particular, studies on business cycles highlight the role of interest rate shocks on economic downturns (Calvo, Leiderman, and Reinhart, 1993; Neumeyer and Perri, 2005; Canova, 2005; Oviedo, 2005; Uribe and Yue, 2006; Chang and Fernández, 2010). These papers show that interest rate shocks represent a significant part of business-cycle movements in emerging markets. I advance this literature by analyzing the propagation mechanism of these shocks. I demonstrate for the first time that the negative correlation between the interest rate and output growth observed in previous studies is only explained by the fall in output of non-tradable firms.

The higher dependence of non-tradable activities on the domestic credit market is supported by micro-level studies demonstrating that non-tradable firms face more financial frictions than tradable firms. For example, for middle-income countries, Tornell and Westermann (2003) note the existence of asymmetries of financing opportunities between tradable and non-tradable firms. Tradable firms enjoy easier access to external finance because they can pledge export receivables as collateral, or can receive guarantees from closely links firms. By contrast, non-tradable firms are smaller and face tighter borrowing constraints.[3] This paper is complementary to Tornell and Westermann (2003) insofar as I provide a more comprehensive analysis of the relationship between domestic credit conditions and sectoral output growth.

The remainder of the paper is structured as follows. Section 2 develops a standard small open economy model with international borrowing. In Section 3, I test the model's predictions. First, I document the sectoral output responses to changes in the domestic

[3]In this line, The Global Development Finance (The World Bank, 2004) reports that firms involved in international trade enjoy better access to the international capital market.

and foreign interest rates, the impulse response functions, and the variance decomposition analysis for emerging markets. Next, I study GDP and exchange rate correlations. In parallel, I carry out the same analysis for developed SOE. Finally, I estimate a dynamic heterogeneous panel of sectoral credit and output growth in emerging markets, and test whether non-tradable activities are more reliant on domestic credit. The last section concludes.

2 A SOE Model with Heterogeneous Access to External Finance

A standard small open economy (SOE) model states that increases in the cost of borrowing affects the capital-intensive tradable sector the most. However, this view is at odds with the empirical regularities presented above. As shown in table 1, in emerging markets, interest rate shocks are negatively correlated solely with the labor-intensive non-tradable output. In this section, I develop a two-periods SOE model with international borrowing to illustrate that the presence of heterogeneous access to external finance can explain the empirical patterns observed in the data. This section proceeds as follows. First, I briefly discuss the implications of changes in the cost of capital in the standard SOE model. Next, I introduce asymmetric access to external finance, and study how sectoral outputs respond to interest rate shocks. Then, I derive the predictions that I take to the data in the next section.

2.1 The Standard SOE Model

Consider a SOE model with two goods: tradable and non-tradable, and two factors of production: capital and labour. Assume as well that capital is perfectly mobile across countries and sectors. In this standard setting, labour is international immobile, but workers can migrate instantaneously within the country. For expositional simplicity, let consider a two periods model. Further, let the economy be composed by a representative agent who consumes in both periods, but works only in the first period and supplies inelastically one unit of labour. The household gets utility only from consumption in a log form.

Assume that there are two perfectly competitive sectors: tradable and non-tradable,

which produce using a Cobb-Douglas function:

$$Y_t^i = K_t^{i\alpha_i} L_t^{i1-\alpha_i}$$

where i=T, N, the tradable and non-tradable, respectively. Set $\alpha_T > \alpha_N$, i.e. the tradable sector is capital-intensive and the non-tradable sector is labor-intensive. In the model with perfect capital mobility and capital markets, rates of return equalize across countries and sectors. Moreover, since the country is price-taker, capital in both sectors adjusts until their marginal productivity equalizes the foreign interest rate.

In a frictionless setting, the model predicts that a shock in the foreign interest rate reduces the tradable output the most. Following the shock, the domestic interest rate adjusts instantaneously to the new international level. However, the effect of the increase in the cost of borrowing is heterogenous and affects more the sector using intensively that factor, i.e. the tradable sector. To see this, consider the elasticity of tradable and non-tradable output to changes in the foreign interest rate,

$$\epsilon_{y_t^T, R_t^*} = -\frac{\alpha^T}{1-\alpha^T} \quad \text{and} \quad \epsilon_{y_t^N, R_t^*} = -\frac{\alpha^N}{1-\alpha^T} \tag{1}$$

since $\alpha^T > \alpha^N$, an unexpected shock in the foreign interest rate leads to a larger decrease in the tradable output. The asymmetric decline of sectoral outputs entails a change in the relative prices. Since the price of the tradable good is determined in foreign markets, the adjustment process takes place only through the price of the non-tradable good. More precisely, after the shock the non-tradable output becomes abundant, which leads to a decline in its price. This can be seen from the negative elasticity of the price of the non-tradable output to the foreign interest rate given by,

$$\epsilon_{p_t^N, R_t^*} = -\left(\frac{\alpha^T - \alpha^N}{1-\alpha^T}\right)$$

Recall that in this model, the exchange rate is determined by the relative price of the tradable and non-tradable goods: $er_t = P_t^T / P_t^N$. In the SOE model, the decline of the price of the non-tradable good induces the depreciation of the domestic currency.

2.2 Credit Market Imperfections in the Domestic Market

There is a broad consensus that credit markets are subject to non-negligible financial frictions in emerging markets. To model these frictions, many economists have focused on enforcement problems to debt contracts (see for example Eaton and Gersovitz, 1981;

Kletzer and Bardhan, 1987; and Arellano, Bai, and Zhang, 2009). This paper follows this approach and assumes that borrowers face differential access to credit markets depending on how debt contracts can be enforced. Since tradable firms' activity is oriented to foreign markets, lenders may find easier to enforce debt contracts with these firms by submitting them to foreign courts. Conversely, as there is no external authority that guarantees that non-tradable firms fulfill their debt obligations, foreign creditors face the risk of debt repudiation from non-tradable firms.

To microfound this view, I follow Eaton and Gersovitz (1981) and let the risk neutral foreign lenders to impose a penalty that the non-tradable firm suffers if she defaults on her debt obligation. The penalty, θk_{t+1}^N, is a fraction of capital in the non-tradable sector, where θ is stochastic and follows an exponential distribution supported on the interval $[0, \infty)$, i.e. θ Exp(λ). The borrower repays its obligation whenever the penalty is higher than the amount of debt times the interest she has to pay, $\theta k_{t+1}^N \geq R_t d_{t+1}^N$, and defaults in the opposite case. The probability of default is then defined as follows:

$$\Gamma_t = Pr(\theta k_{t+1}^N < R_t \, d_{t+1}^N) = F\left(\theta < \frac{R_t d_{t+1}^N}{k_{t+1}^N}\right)$$

where R denotes the domestic interest rate, and the probability of default is endogenously determined and increasing in the level of debt repayment ($F'() > 0$). The equilibrium in the financial market imposes the following arbitrage condition for the foreign investor:

$$R_t = \frac{1}{1 - \Gamma_t} \, R_t^*$$

This defines the supply curve for new capital for the non-tradable sector. Remark that this supply curve is upward sloping and depends on the level of indebtedness of the non-tradable firm. As more indebted is the non-tradable firm, higher is the opportunity cost of default, and higher is the risk-premium. Conversely, the supply curve is perfectly elastic for the tradable firm and horizontal at the world level interest rate.

In the presence of financial frictions, the impact of the foreign interest rate shock differs substantially than in the frictionless case. To see this, consider their elasticity to the foreign interest rate:

$$\epsilon_{y_t^T, R_t^*} = -\frac{\alpha^T}{1 - \alpha^T} \quad \text{and} \quad \epsilon_{y_t^N, R_t^*} = -\left[\frac{\alpha^N \alpha^T}{1 - \alpha^T} + \alpha^N \epsilon_{R, R_t^*}\right] \tag{2}$$

where ϵ_{R, R_t^*} denotes the elasticity of domestic to the foreign interest rate and, it can be shown that, is bigger than 1. Notice that the output elasticity in the tradable sector

remains unchanged, whilst the elasticity in the non-tradable sector is augmented by the impact of the initial shock on the domestic interest rate. In particular, the increase in the international cost of borrowing raises the debt burden, and with it the default probability and the interest rate perceived by the non-tradable firm. In this model, domestic financial imperfections amplify the initial shock only to the non-tradable sector. Then, as stated in proposition 1, heterogeneous access to external finance implies different co-movements between sectoral outputs and the domestic interest rate.

Proposition 1: *In presence of credit market imperfections, non-tradable output is negatively correlated with the domestic interest rate, whilst tradable output is uncorrelated. It is the increase in the domestic risk premium affecting solely non-tradable firms what accounts for this asymmetric response across sectors.*
Proof: this follows directly from equation (2).

In addition, equations in (2) imply that the elasticity of non-tradable output to the foreign interest rate is higher in absolute terms than that of the tradable output if the following condition holds:

$$\epsilon_{R,R_t^*} - \left(\frac{\alpha^T/(1-\alpha^T)}{\alpha^N/(1-\alpha^N)} \right) > 0 \tag{3}$$

where both terms are higher than one. Condition (3) establishes that the elasticity of non-tradable output is larger in absolute terms than the elasticity of tradable output, if the elasticity of the domestic to the foreign interest rate exceeds the difference in capital-intensities across sectors. Put it differently, if capital-intensities across sectors do not differ much, small domestic financial frictions can lead to higher declines of the non-tradable output.[4] Furthermore, the larger downturn of the non-tradable output raises its relative price. Hence, conversely to the frictionless case where the initial shock reduces the price of the non-tradable good, in a model with heterogenous access to external finance, a foreign interest rate shock raises it. To see this, consider the elasticity of the non-tradable good price to the foreign interest rate:

[4]The assumption about the similar capital-intensities for tradable and non-tradable sectors in emerging markets is supported by empirical studies. For example, Kátay and Wolf (2008) estimate the production function for all economic activities for Hungary between 1994 and 2002. They find alike capital intensities for tradable and non-tradable activities. More precisely, their estimates indicate an elasticity of capital of 0.4 in the tradable sector, and of 0.34 in the non-tradable sector.

$$\epsilon_{p_t^N, R_t^*} = \alpha^N \epsilon_{R_t, R_t^*} - \frac{\alpha^T(1-\alpha^N)}{1-\alpha^T} > 0 \tag{4}$$

which is positive if condition 3 holds. Contrary to the SOE model where a foreign interest rate shocks induce exchange rate depreciations, in presence of domestic financial frictions, foreign interest rate shocks lead to exchange rate appreciations.

Proposition 2: *In presence of credit market imperfections, if condition (3) holds, output downturns caused by upsurges in the cost of borrowing lead to exchange rate appreciations.* Proof: this follows directly from equation (4).

In sum, conversely to the traditional view, the model illustrates that credit market imperfections can amplify downturns through their impact in the non-tradable sector. An interest rate shock raises the debt burden, which increases the country risk. The increase in the risk premium mostly affects non-tradable firms that have access only to the domestic credit market. The larger downturn of the non-tradable output turns into exchange rate appreciations. In the next section, I take propositions 1 and 2 to the data, and present suggestive evidence of this mechanism.

3 Empirical Analysis

In this section, I take the model's predictions to the data, and study how credit market conditions affect tradable and non-tradable sectors. In particular, in the first part, I test proposition 1 and analyze sectoral output responses to interest rate shocks. In addition, I investigate whether the observed sectoral output and interest rate correlations originate from foreign interest rate or country risk shocks. Next, I test proposition 2 and study the correlation between the exchange rate and the output growth. To explore whether the mechanism presented above is specific of emerging markets or a more general pattern of small open economies, in parallel, I perform the same analysis for a group of small open economies. In the second part, I analyze sectoral output and domestic sectoral credit relationships for emerging markets.

3.1 Output Responses to Interest Rate Shocks

To test proposition 1, I first analyze sectoral output and interest rate relationships for a group of emerging markets, and compare them with small open economies. I then turn to study of the impulse response functions of sectoral to domestic and foreign interest rate shocks. Finally, to identify the contribution of the different shocks in each sector, I perform a variance decomposition analysis.

The sample consist in nineteen countries: nine small open economies (Australia, Belgium, Canada, Denmark, Italy, Netherlands, Norway, Spain and Sweden) and ten emerging markets (Argentina, Bulgaria, Chile, Hungary, Indonesia, Korea, Mexico, Peru, Thailand, and Turkey) during the period 1994q1:2007q4. The choice of countries and sample period is guided by data availability. I use a broad definition of these sectors: I consider agriculture, manufacturing and mining as tradable, and let all other economic activities constitute the non-tradable sector.[5] For small open economies, I use the 3-month interest rate reported by OECD Stats. For emerging markets, I follow the standard literate and build the country interest rate as the sum of the risk free interest rate (US T-bill) and the risk premium (EMBI Global) (as for example in Uribe and Yue, 2006; and Neumeyer and Perri, 2005). Output values at producer prices are in US dollars, and real terms are obtained by deflating series with the US GDP deflator.

Panel VAR

In this section, I examine sectoral output responds to changes in cost of borrowing. More precisely, based on equations in (2), I estimate a panel var of sectoral output on changes in the domestic and foreign interest rate. The empirical model is then:

$$y_{(i,t)} = \alpha_0 + \sum_{m=1}^{p-1} \alpha_m \, y_{(i,t-m)} + f_{(i)} + d_{(t)} + \epsilon_{(t)} \tag{5}$$

where and i denotes the country. The vector y is composed by $\{R, R_{US}, \text{Output}\}$ denoting country interest rate, US interest rate, and output. Following specifications in (2), I estimate a different panel VAR for GDP, and tradable and non-tradable outputs. Notice that, by construction, a country interest rate shock can be equivalently interpreted as a country spread shock ($R = R_{US}+$ Spread). As the US interest rate appears as a regressor of the VAR system, the estimated coefficient is already considering the effect of the US interest rate on output. In this way, the implied relationships for country risk shocks are

[5] See Calvo, Izquierdo, and Mejía (2004) for a similar treatment of sectors.

Table 2: Panel VAR: Interest Rate and Output Growth

	Small Open Economies			Emerging Markets		
	GDP	Tradable	Non-Tradable	GDP	Tradable	Non-Tradable
	(1)	(2)	(3)	(4)	(5)	(6)
Interest rate (-1)	-0.0006	0.0017	-0.0009	-0.0900**	0.1055	-0.1265***
	(0.0006)	(0.0019)	(0.0007)	(0 .0445)	(0.1329)	(0.0494)
Interest rate US (-1)	0.2149**	0.2625***	0.2333**	-0.0868	-0.3194	-0.0907
	(0.0888)	(0.0741)	(0.1081)	(0.1206)	(0.2122)	(0.1108)

Notes: Real Output Growth Rate. Real Interest Rate: r Short-term 3-month, MEI, OECD; r^N US Tbill + EMBI GLOBAL. standard erros in parenthesis. *,**,*** significant at 10%, 5%, 1%, respectively. Period: 1994q1: 2007q4. SOEs: Australia, Belgium, Canada, Denmark, Italy, Netherlands, Norway, Spain and Sweden. EMs: Argentina, Bulgaria, Chile, Hungary, Indonesia, Korea, Mexico, Peru, Thailand and Turkey.

identical to those associated to domestic interest rate shocks. Then, in the rest of the section, I will treat them indifferently.[6]

Similar to Douglas Holtz-Eakin and Rosen (1988) and Love and Zicchino (2006), my empirical model allows for country individual heterogeneity using a forward mean-differencing, also referred as the *Helmert procedure*. This methodology removes the mean of all future observations for each group. By preserving the orthogonality between the transformed variables and the lagged regressors, the procedure allows to use the lagged regressors as instruments, and to estimate the coefficients by GMM. To account for country specific characteristics and unobserved shocks, the model also includes country fixed effects, $f_{(i)}$, and time dummies $d_{(t)}$. Finally, m represents the number of lags that are determined following the AIC and BIC criteria. Both criteria report four lags for the output of small open economies and one lag for the emerging markets.

The response of output to changes in the domestic interest rate is reported in table 2.[7] Column 4 confirms previous studies, showing that aggregate output responds negatively to changes in the country interest rate. Albeit smaller than in Uribe and Yue (2006), the estimated coefficient reports a decline of 9% of GDP growth within a quarter following an increase of 1 percentage point of the country interest rate.

As stated in proposition 1, in presence of financial frictions, sectors depict asymmetric responses to changes in the interest rate. In line with equation (2), the tradable sector is not affected by changes in the domestic interest rate. The estimated coefficient for the tradable sector is not only statistically non-significant, but also presents the opposite sign (column 5). Instead, country interest rate shocks have a large impact on the output of the

[6]See Uribe and Yue (2006) for a further discussion on this type of specification.

[7]For expositional simplicity, I only present the main results in this section. See the appendix for the complete tables.

non-tradable sector (column 6). A one percentage point increase in the domestic interest rate decreases growth in the non-tradable sector by 12.6%. Remarkably, the decline in the aggregate output is solely driven by the downturn of non-tradable firms.

Interesting, increases in the US interest rate produce larger downturns in the tradable sector. This is in line with the predictions of the SOE model. As suggested by equations in (1), in a frictionless setting, the capital-intensive tradable sector is more affected by increases in the cost of borrowing. In presence of financial frictions, it is the rise in the default probability perceived by non-tradable firms what amplifies the initial shock and causes the larger downturns in this sector. Finally, observe that the negative response of non-tradable output to changes in the domestic interest rate is not significant in small open economies (columns 1-3).

Impulse Response Functions

I now turn to study of the impulse response functions of sectoral output to interest rate shocks. The identifying assumption is that interest rate shocks affect sectoral output contemporaneously, as well as with a lag, while sectoral output affects interest rate only with a lag. Put differently, I assume that interest rate is the exogenous variable and sectoral output is the endogenous variable. This assumption is based on the hypothesis that in a small open economy the interest rate is driven exogenously by changes in external markets.[8] Furthermore, it finds support on Neumeyer and Perri (2005), who show that the domestic interest rate leads output by one quarter in emerging markets. In a similar vein, I consider that changes in the US interest rate lead emerging economies' output.

Figure 1 displays the impulse response functions implied in the VAR system (5) to one standard deviation shock in the domestic and US interest rates for aggregate and sectoral output in emerging markets. Dash lines represent the 5% errors bands generated by Monte Carlo simulations with 1000 repetitions. Confirming proposition 1, figure 1 depicts asymmetric responses of tradable and non-tradable output to unanticipated interest rate shocks. Furthermore, it suggests significant declines in non-tradable output, and non significant changes in the tradable sector. As in table 2, the decline in GDP growth following the shocks is explained by the largest downturn of the non-tradable output. The response of sectoral output to US interest rate shocks follow similar patterns, albeit they are no significant. Finally, notice that the asymmetric response of tradable and non-tradable sectors is characteristic of emerging makers. Figure 2 suggests that domestic interest rate

[8]See Uribe and Yue (2006) for a further discussion on the identification strategy of foreign interest rate shocks.

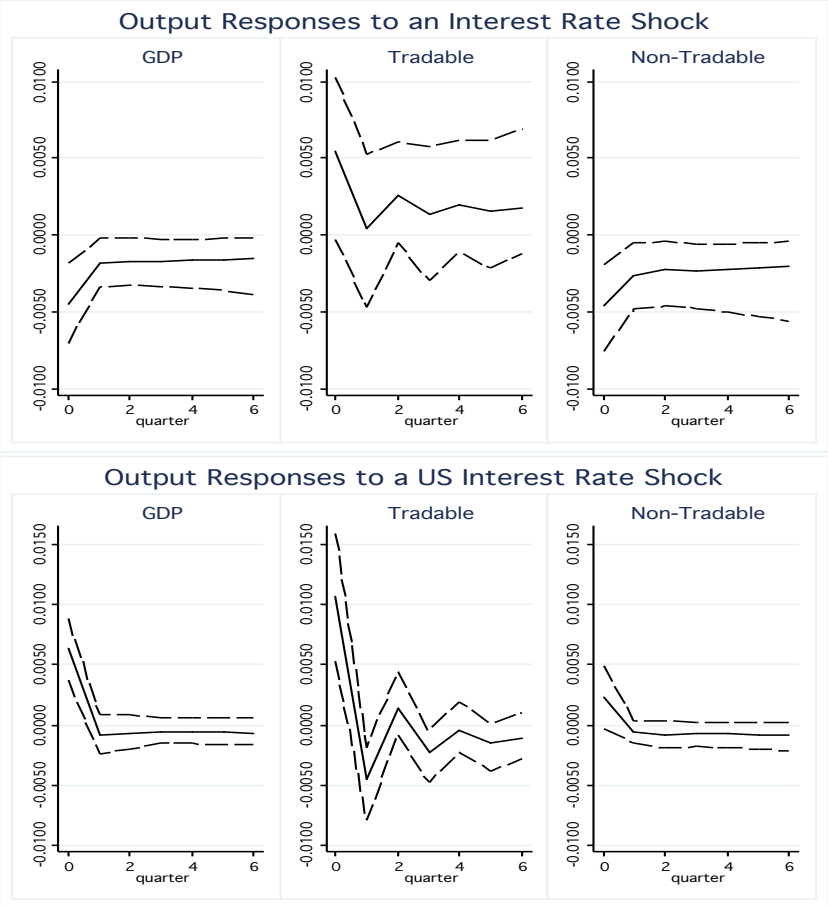

Figure 1: EMs: Model 1, Impulse Response Functions

shocks do not have any significant impact on sectoral outputs in small open economies.

Variance Decomposition

To understand the contribution of the different shocks in each sector, I perform a variance decomposition analysis. The orthogonalization of the VAR residuals above discussed allows to account for the change in output growth due to each of the shocks. The variance decomposition analysis, presented in table 3, suggests that country interest rate shocks account for 7% of GDP fluctuations in emerging markets within a business cycle frequency (20 quarters). Remarkably, the fluctuation of GDP is basically explained by changes in the non-tradable sector. Interest rate shocks account for 8% of the output variation in the non-tradable sector, and only 1.8% of its variation in the tradable sector. In line with

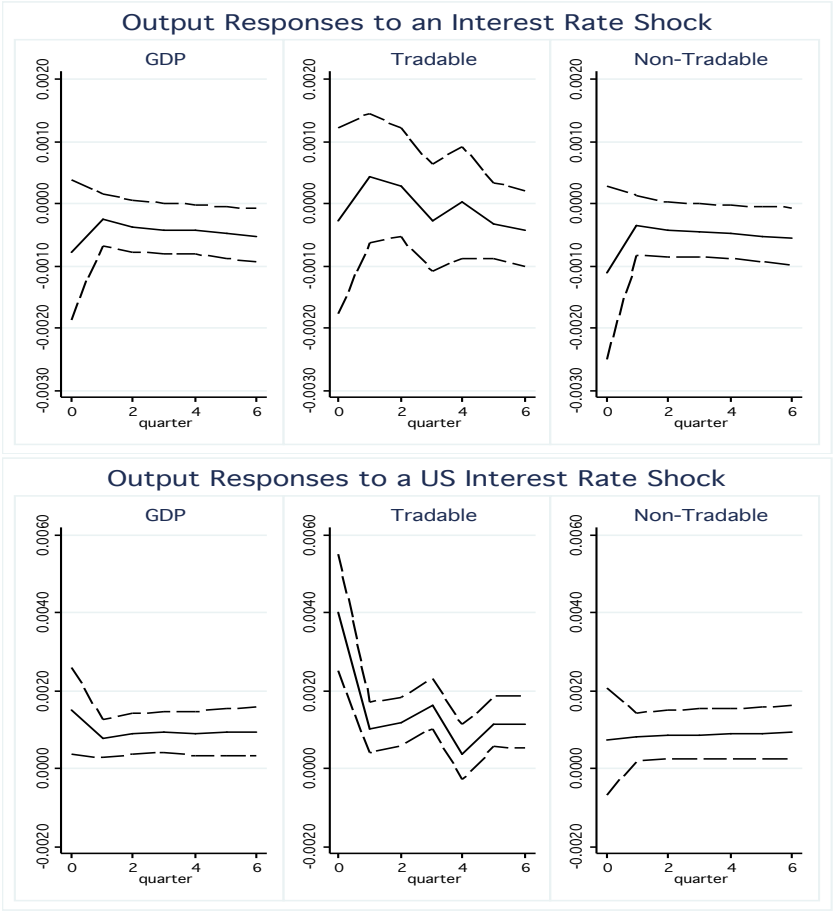

Figure 2: SOEs: Impulse Response Functions

Table 3: Variance Decomposition to Interest Rate Shocks

	Small Open Economies			Emerging Markets		
	GDP	Tradable	Non-Tradable	GDP	Tradable	Non-Tradable
	(1)	(2)	(3)	(4)	(5)	(6)
10Q						
Interest rate	1.7	0.4	1.6	5.7	1.2	6.1
Interest rate US	5.8	6.9	3.5	6.0	3.4	1.0
20Q						
Interest rate	4.8	2.4	4.0	7.1	1.8	8.0
Interest rate US	12.5	13.2	9.0	6.8	4.1	2.7

Notes: Real Output Growth Rate. Real Interest Rate: r Short-term 3-month, MEI, OECD; r^N US Tbill + EMBI GLOBAL. standard erros in parenthesis. *,**,*** significant at 10%, 5%, 1%, respectively. Period: 1994q1: 2007q4. SOEs: Australia, Belgium, Canada, Denmark, Italy, Netherlands, Norway, Spain and Sweden. EMs: Argentina, Bulgaria, Chile, Hungary, Indonesia, Korea, Mexico, Peru, Thailand and Turkey.

the results presented in table 2, US interest rate shocks explain a larger part of disturbances in the tradable than in the non-tradable sector. These results are in line with the model predictions. In a frictionless setting, increases in the cost of borrowing affect the capital-intensive tradable sector the most. It is the domestic financial friction what amplifies the initial shock by raising the country risk premium perceived by the non-tradable labor-intensive sector. This propagation mechanism explains the downturn of aggregate activities in emerging markets following increases in the cost of borrowing.

Exchange Rate

Indicated in proposition 2, in presence of financial frictions, the model predicts that the decline in non-tradable output, caused by the increase in the cost of borrowing, leads to an appreciation of the exchange rate. Recall that after the shock, the non-tradable good becomes scarce, which raises its relative price and decreases the exchange rate. To tackle this prediction, I estimate the relationship of exchange rate, interest rate and aggregate output movements for emerging markets. As in Tornell and Westermann (2003) the real exchange rate is defined as the ratio between the producer and consumer price indexes. For comparison, I also present the results for small open economies. I follow the same empirical strategy as in the previous section, and estimate the panel VAR of {Exchange rate, Interest Rate, GDP}. Since disturbances in the exchange rate are expected to occur lagged, only once the interest rate shock affected the non-tradable output, I include two lags in the VAR system. Table 4 presents the main results. As predicted, exchange rate

Table 4: Panel VAR: Exchange Rate and Output Growth

	Small Open Economies	Emerging Markets
	Exchange rate	Exchange Rate
	(1)	(2)
Interest Rate (-1)	0.0010	0.1761
	(0.0021)	(0.1431)
Interest Rate (-2)	-0.0049**	-0.1527
	(0.0022)	(0.1244)
GDP (-1)	0.0537	-0.0646
	(0.0560)	(0.0527)
GDP (-2)	-0.0155	-0.0772***
	(0.0520)	(0.0302)

Notes: Real Output Growth Rate. Real Interest Rate: r Short-term 3-month, MEI, OECD; r^N US Tbill + EMBI GLOBAL. standard erros in parenthesis. *,**,*** significant at 10%, 5%, 1%, respectively. Period: 1994q1: 2007q4. SOEs: Australia, Belgium, Canada, Denmark, Italy, Netherlands, Norway, Spain and Sweden. EMs: Argentina, Bulgaria, Chile, Hungary, Indonesia, Korea, Mexico, Peru, Thailand and Turkey.

movements are negatively correlated with GDP growth, particularly after two quarters, when the exchange rate appreciate by 7.7%. Interestingly, this correlation is statistically non-significant for small open economies.

With an extended data coverage, the empirical evidence presented in this section confirms previous findings that interest rate have a negative effect on aggregate output growth in emerging markets. I advanced previous literature showing that interest rate shocks are solely amplified through their impact on non-tradable activities. In line with the model's predictions, the propagation mechanism is a rise in the risk premium, which particularly affects firms relying on the domestic credit market, i.e. non-tradable firms. The downturn in the non-tradable good raises its relative prices and leads to an exchange rate appreciation. Throughout this section, I illustrated that this mechanism is present in emerging markets, and absent in small open economies. To complement this analysis, in the next section, I present empirical evidence suggesting that the non-tradable sector is more reliant on domestic credit in emerging countries.

3.2 Domestic Credit and Sectoral Output Growth

The previous section reported that tradable and non-tradable sectors respond asymmetrically to changes in the domestic interest rate. This distinctive fact of emerging markets

suggests that economic activities enjoy heterogeneous access to external finance; and in particular, that non-tradable firms might be more reliant on domestic credit. To assess this hypothesis, I now turn to study how changes in domestic credit affect output growth in tradable and non-tradable sectors. To tackle this question I estimate a heterogenous dynamic panel using two different methodologies: Mean Group and Pool-Mean estimators (see Pesaran, Shin, and Smith, 2004).

To study the relationship between domestic credit and output at sectoral level, I construct a database for a group of nine emerging markets (Argentina, Bulgaria, Chile, Hungary, Korea, Mexico, Peru, Thailand, and Turkey) over the period 1994 and 2007 at quarterly frequency. The dependent variable is sectoral output growth and the explanatory variables is sectoral credit growth. The controls variables are: trade openness (measured as exports plus imports over GDP), and exchange rate (defined as the ratio of PPI/CPI). I also control for country fixed effect to account for country unobserved characteristics, and financial and banking crisis for time-specific shocks. Variables are in real US dollars, and real values are obtained using the GDP deflator.

Mean Group Estimator

To understand how sectoral credit and output relate, I compute a mean group estimator that separately estimates the short- and long-term relationships for each country, and averages the results across them (see Pesaran, Shin, and Smith, 2004 for a further discussion). I consider the mean group estimator to be the best empirical approach to study emerging markets, since it considers individually each country dynamic. Given the heterogenous pattern of growth of emerging markets, jointly estimate their dynamic could induce to measurement error problems and bias the estimators. The empirical model has the following form,

$$\Delta y_{(i,t)} = \sum_{j=1}^{p-1} \gamma_j \Delta y_{(i,t-1)} + \sum_{j=0}^{q-1} \rho_j \Delta x_{(i,t-q)} + \phi \Big[y_{(i,t-1)} - \{\beta_{(0,j)} + \beta_{(1,j)} x_{(i,t-1)}\} \Big] + \epsilon_t \qquad (6)$$

The first term on the RHS of equation (6) accounts for the effect of past output growth on current production (y). The second term is the term under study, and indicates how changes in domestic credit affect production in each sector (x). The term in brackets reports the long-term relationship between sectoral credit and output. The order of lags is determined by the AIC and BIC criteria, and indicate one lag for both variables. I estimate these relationships for GDP, tradable and non-tradable activities separately. Next, to test

whether the dynamic between tradable and non-tradable sectors differs, I use the data jointly and interact sectoral credit with a binary variable indicating the sector. With this purpose, I re-estimate the model as follows,

$$\Delta y_{(i,t)} = \sum_{j=1}^{p-1} \gamma_j \Delta y_{(i,t-1)} + \sum_{j=0}^{q-1} \rho_{(0,j)} \Delta x_{(i,t-q)} + \sum_{j=0}^{q-1} \rho_{(1,j)} NT * \Delta x_{(i,t-q)} + \tag{7}$$
$$\phi \Big[y_{(i,t-1)} - \{\beta_{(0,j)} + \beta_{(1,j)} x_{(i,t-1)} + \beta_{(2,j)} NT * x_{(i,t-1)}\} \Big] + \epsilon_t$$

where NT represents the binary variable for the non-tradable sector. Table 5 reports the main results. Columns 1 and 2 illustrate a strong short-term correlation between domestic credit and output growth: an increase in the growth rate of total credit is associated with an upsurge of the GDP growth rate by 50% within a quarter. This strong relationship suggests that, in emerging markets, domestic economic activities are still highly dependent on local credit market. Columns 3-6 report the credit and output relationships for each sector. Loosely speaking, non-tradable firms seem to rely more than tradable firms on domestic credit. The estimated coefficients are much higher, and closer to those estimated for the aggregate economy. Columns 7 and 8 confirm this hypothesis. The interaction term of equation (7) suggests that an expansion of domestic credit raises output growth 10% more in non-tradable than in tradable firms. Notice, however, that both tradable and non-tradable activities are equivalently affected by the development of the local financial market in longer periods.

Pooled Mean Group

For comparison, I also compute a pooled-mean group, which estimates heterogenous dynamics in the short-term, and a common long-term relationship across countries. More precisely, the pooled mean group proceeds first to calculate the long-term coefficients jointly for all countries using a maximum likelihood procedure, and then to estimate the short-term coefficients, the country-specific intercept, and the country-specific error variances for each country, also through a maximum likelihood procedure and using the estimates of the long-term relationships computed in the first step.[9] In particular, I estimate equations (6) and (7) assuming homogenous dynamic in the long-term relationships ($\beta_{(0,j)} = \beta_{(0)}$, $\beta_{(1,j)} = \beta_{(1)}$, and $\beta_{(2,j)} = \beta_{(2)}$).

The estimated results are reported in table 6. Overall, they confirm results of table 5. An increase in the credit growth raises aggregate economic activity growth by 51%. The

[9]See Pesaran, Shin, and Smith (2004) for a more extensive discussion about this methodology.

Table 5: Emerging Markets: Sectoral Output and Credit Relationship-MG

	Mean Group							
	Output		Tradable		Non-Tradable		Interaction	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short-Term Coeff.								
Δ Credit	0.501***	0.514***	0.310***	0.322***	0.407***	0.418***	0.155**	0.161**
	(0.116)	(0.117)	(0.119)	(0.122)	(0.106)	(0.107)	(0.069)	(0.071)
Δ NT*Credit							0.102***	0.105***
							(0.036)	(0.036)
Δ Credit (-1)	0.074	0.094	0.013	0.036	0.056	0.072	0.007	0.018
	(0.085)	(0.082)	(0.044)	(0.050)	(0.115)	(0.111)	(0.021)	(0.025)
Δ NT*Credit (-1)							0.030	0.038
							(0.063)	(0.062)
Δ Output (-1)	-0.157	-0.184*	-0.093	-0.116	-0.106	-0.135	-0.100	-0.125
	(0.098)	(0.096)	(0.101)	(0.101)	(0.166)	(0.163)	(0.094)	(0.093)
Δ Trade Openness	0.058	0.038	-0.309	-0.328	0.053	0.032	-0.128	-0.148
	(0.097)	(0.105)	(0.260)	(0.260)	(0.074)	(0.081)	(0.138)	(0.139)
Δ Exchange Rate	0.062	0.094	0.072	0.106	-0.296	-0.262	-0.112	-0.078
	(0.201)	(0.209)	(0.366)	(0.369)	(0.210)	(0.226)	(0.210)	(0.214)
Long-term Coeff.								
ECC	-0.218***	-0.228***	-0.347***	-0.358***	-0.282**	-0.288**	-0.314***	-0.323***
	(0.076)	(0.075)	(0.113)	(0.112)	(0.143)	(0.142)	(0.089)	(0.088)
Credit	-0.356	-0.321	1.428**	1.441**	0.119	0.151	0.714**	0.721**
	(1.260)	(1.261)	(0.638)	(0.634)	(0.257)	(0.254)	(0.354)	(0.354)
NT*Credit							0.030	0.038
							(0.063)	(0.062)
Trade Openness	-3.636*	-3.054	-77.586	-77.358	-0.687	0.142	-39.137	-38.608
	(2.195)	(2.232)	(78.045)	(78.074)	(1.117)	(0.637)	(38.993)	(39.021)
Exchange Rate	0.904	0.785	-33.932	-33.970	-0.023	-0.123	-16.978	-17.047
	(1.821)	(1.821)	(33.498)	(33.493)	(0.970)	(0.921)	(16.768)	(16.763)
Crisis		-0.020		-0.020		-0.020		-0.020
		(0.019)		(0.021)		(0.018)		(0.014)
N	322	322	322	322	322	322	644	644

Standard errors reported in parenthesis. All regressions include a constant. ***, **, * significant at the 1, 5, 10 percent level, respectively.

Table 6: Emerging Markets: Sectoral Output and Credit Relationship-PMG

	Pool Mean Group							
	Output		Tradable		Non-Tradable		Interaction	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short-Term Coeff.								
Δ Credit	0.513***	0.522***	0.348***	0.363***	0.379***	0.390***	0.173***	0.177**
	(0.122)	(0.123)	(0.110)	(0.113)	(0.100)	(0.102)	(0.067)	(0.069)
Δ NT*Credit							0.096***	0.099***
							(0.034)	(0.035)
Δ Credit (-1)	-0.014	-0.011	-0.041	-0.034	-0.024	-0.022	-0.026	-0.024
	(0.081)	(0.082)	(0.068)	(0.066)	(0.054)	(0.053)	(0.034)	(0.033)
Δ NT*Credit (-1)							-0.005	-0.003
							(0.014)	(0.014)
Δ Output (-1)	-0.059	-0.087	-0.008	-0.035	0.048	0.013	0.021	-0.011
	(0.128)	(0.127)	(0.132)	(0.134)	(0.121)	(0.122)	(0.088)	(0.089)
Δ Trade Openness	0.066	0.072	0.004	0.008	-0.005	0.001	0.002	0.006
	(0.157)	(0.156)	(0.208)	(0.206)	(0.146)	(0.144)	(0.124)	(0.123)
Δ Exchange Rate	0.056	0.116	0.021	0.074	-0.051	0.008	-0.010	0.038
	(0.305)	(0.320)	(0.417)	(0.423)	(0.245)	(0.262)	(0.234)	(0.240)
Crisis		-0.018		-0.015		-0.019		-0.017
		(0.018)		(0.018)		(0.018)		(0.012)
Long-term Coeff.								
EEC	-0.018	-0.015	-0.048*	-0.037	-0.070	-0.061	-0.061**	-0.049**
	(0.014)	(0.012)	(0.029)	(0.025)	(0.052)	(0.048)	(0.029)	(0.025)
Credit	1.811**	2.000*	1.392***	1.561***	1.101***	1.173***	1.423***	1.635***
	(0.871)	(1.134)	(0.276)	(0.386)	(0.194)	(0.234)	(0.373)	(0.439)
NT*Credit							-0.154	-0.199
							(0.188)	(0.211)
Trade Openness	-9.202	-11.099	-1.606**	-2.208**	-1.161*	-1.329*	-1.277***	-1.636***
	(6.564)	(8.937)	(0.723)	(1.095)	(0.599)	(0.697)	(0.443)	(0.599)
Exchange Rate	-3.466	-3.544	-0.398	-0.572	-0.682**	-0.836**	-0.581**	-0.732***
	(2.293)	(2.702)	(0.354)	(0.373)	(0.336)	(0.347)	(0.252)	(0.260)
N	322	322	322	322	322	322	644	644

Standard errors reported in parenthesis. All regressions include a constant. ***, **, * significant at the 1, 5, 10 percent level, respectively.

short-term credit and output correlations for the non-tradable output are slightly higher than for the tradable sector. Nevertheless, the interaction term reports that non-tradable activities are significant more reliant on domestic credit than tradable. The estimated coefficient suggests that an increase in local credit is associated with output growth 9% higher in the non-tradable sector. As estimated in the model (6) both sectors seems to be equally reliant on domestic credit in the long-term.

Figures in tables 5 and 6 suggest that non-tradable activities are more reliant on local credit conditions. This stronger dependence of non-tradable activities on the domestic financial system highlight the mechanism implied by the model and suggested in the previous section. Domestic financial frictions amplify changes in the international cost of capital, inducing deeper downturns in firms more dependent on the local financial system,

i.e., non-tradable firms. Overall, the decline in non-tradable activities explains the general downturn of aggregate economy following interest rate shocks.

4 Conclusion

Throughout the paper I showed that increases in the cost of borrowing propagate asymmetrically in emerging markets. In particular, I presented evidence that interest rate shocks are amplify solely through their impact on non-tradable activities. I illustrated that this deeper countercyclical co-movement between the non-tradable output and the interest rate is at odds with the standard SOE model, where interest rate shocks are amplified through the tradable sector. Furthermore, I showed that the presence of credit market imperfections can account for the larger downturn of the non-tradable output, and help reconciling the predictions of the standard SOE model with the empirical evidence presented in this paper. Finally, I also presented empirical evidence suggesting that non-tradable firms are more reliant on local credit in emerging markets.

This paper contributes to a growing body of evidence suggesting that the relatively high economic volatility of emerging markets is related to the prevalence of financial frictions in these economies. Given the increasing importance of emerging markets for the global economy as well as the limited scope for their residents to share domestic income risk, the question how to enhance the economic stability of capital-importing countries is of significant interest to policy makers within as well as outside the countries in question. By highlighting that the vulnerability of emerging markets to foreign interest rate shocks derives chiefly from the vulnerability of their non-tradable sectors to such shocks, my paper implies that stability-enhancing policy reforms should aim to increase the access to credit of firms in this sector. Traditionally, development policy has focused on credit access for tradable firms, to aid the growth of a country's exporting sector. Based on my findings, countries with a well developed export sector should also improve credit access to domestically operating firms, so as to stabilize their economies in the face of external shocks.

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