

# The Business Cycle Volatility Puzzle

Emerging vs Developed Economies \*

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## Abstract

We study the drivers of business cycle volatility differences between emerging and developed economies. We develop a multisector small open economy framework with heterogeneous firms and production linkages in which firms are subject to sectoral and firm-level TFP shocks and international prices shocks. Using sector-level data, firm-level micro data, and international trade data from various developed and emerging economies, we quantify the relevant model-based sufficient statistics. We find that differences in the sectoral composition and the distribution of firms explain roughly half of the excessive business cycle volatility in emerging economies. Finally, we find that the contribution of international prices is sensitive to the households' preferences.

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# 1 Introduction

Emerging economies are characterized by higher business cycle volatility compared with developed ones (Acemoglu and Zilibotti, 1997). This higher output volatility is mirrored by even greater private consumption volatility (Neumeyer and Perri, 2005; Aguiar and Gopinath, 2007), which affects households' welfare in emerging economies. Identifying the sources of this excessive volatility is crucial in determining whether policy interventions can mitigate it or if it is an inherent aspect of the development process. In this paper, we study the drivers of differences in aggregate output volatility between emerging and developed economies.

Extending Hulten's theorem (Hulten, 1978) to a multisector small open economy with heterogeneous firms and production linkages, we show that aggregate output volatility can be decomposed into four channels: aggregate, sectoral, firm-level, and international prices. Our findings reveal that disparities in the economic structure, such as the distribution of sectors and firms, can account for nearly half of the excessive volatility observed in emerging economies. On the other hand, the contribution of the international prices channel ranges from 0.2% to 16.2%, depending on the responsiveness of labor supply to changes in households' real income.

In our model, there is a set of goods that can be traded internationally (tradables) and a set of goods that are only consumed and produced domestically (nontradables). Both sets of goods can be used for production (intermediates) and final consumption. Since the economy is small, the prices of tradable goods are assumed to be exogenous. Within each sector, firms produce a homogeneous good with a decreasing returns to scale technology that combines labor and intermediate inputs produced by other firms. Thus, there is an endogenous distribution of firms and production across sectors is linked through firms' use of intermediate inputs. Firms' productivity is exogenous and has three components: economy-wide (aggregate), sectoral, and firm-specific. Last, there is a representative household that owns all of the firms in the economy, supplies labor, and consumes tradable and nontradable goods.

We first show that the *fundamental* volatility (i.e., the volatility of aggregate output when aggregate labor supply is fixed), up to a first-order approximation, can be explained only by aggregate, sectoral, and firm-level TFP shocks, as in a closed economy.<sup>1</sup> Furthermore, the relevance of each channel is determined by sufficient statistics. The aggregate channel depends on the volatility of economy-wide TFP shocks and total sales over GDP (aggregate Domar weight). The sectoral channel depends on the volatility of sector-level TFP shocks and the distribution of sectoral sales shares

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<sup>1</sup>Our definition of fundamental volatility is similar to that of Carvalho and Gabaix (2013).

(sectoral Domar weights). Finally, the firm-level channel depends on the volatility of firm-specific TFP shocks and the concentration of firms' sales shares (firm-level Domar weights).

Next, we show that the volatility of aggregate output can also be explained by international prices shocks when households' labor supply is elastic. The relevance of the international prices channel depends on sufficient statistics—i.e., the volatility of international prices and the distribution of sectoral trade imbalances—and the parameters of households' preferences that govern the strength of the substitution and income effects. Intuitively, if, for example, the economy is a net exporter of tradable goods and their price increases, the real income of households rises. This, in turn, leads to a change in the aggregate labor supply if the income and substitution effects do not cancel each other out, and consequently affects aggregate output.

In our quantitative exercises, we first study how much of the differences in GDP volatility between emerging and developed economies can be explained by differences in the *fundamental* volatility. We compute model-induced sufficient statistics using sectoral data and firm-level data for 10 emerging and 19 developed economies. To isolate the contribution of the micro-composition of the economy, we assume that the volatility of sectoral and idiosyncratic TFP shocks is the same across emerging and developed economies. Therefore, the contribution of sectoral and firm-level channels is solely determined by differences in the distribution of sales shares across sectors and firms. In our baseline estimates, we find that differences in the sectoral distribution of the economy explain as much as 43% of the excessive volatility in emerging economies, and the firm-level channel explains 5%.

The relevance of the sectoral channel is explained by the significant contrast in the sectoral distribution between emerging and developed economies. Emerging economies concentrate 47% of their sales in sectors with high volatility of TFP, such as manufacturing and primary sectors, while developed economies concentrate only 30% of their sales in those sectors. This pattern is closely tied to the structural transformation process, which posits that as economies develop, economic activity shifts away from agriculture and manufacturing (which have high TFP volatility) toward services (which have low TFP volatility).<sup>2</sup> This suggests that almost half of the disparities in aggregate output volatility can be intrinsic to the development process.

In the firm-level channel, the relevant model-based sufficient statistic is the concentration of firm sales among top firms ([Gabaix, 2011](#)). Using firm-level data from several countries, we observe that sales by the largest firms in the economy are 41% more con-

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<sup>2</sup>See [Herrendorf, Rogerson and Ákos Valentinyi \(2014\)](#) for a review of the literature.

concentrated in emerging economies.<sup>3</sup> Despite this observation, differences in the distribution of firms can explain a small fraction (5%) of the excessive volatility in emerging economies. However, if we allow for firm-level TFP shocks to be moderately more volatile in emerging economies, we find that the contribution of this channel could be substantially higher.

Finally, we focus on the international transmission of shocks. When disparities exist between the consumption basket and production structure, shocks to the prices of tradable goods can affect households' real income. These disparities manifest as trade imbalances at the level of individual goods or sectors. Crucially, any shifts in real income translate into changes in aggregate output only if labor supply is responsive. Using disaggregated international trade data, we document that emerging economies have higher sectoral trade imbalances than developed. Then, we estimate the contribution of the international prices channel for a range of preferences parameters that are commonly used in the literature, and find that it can explain from 0.2% to 16.2% of the differences in GDP volatility between emerging and developed economies.

**Related Literature and Contributions.** The observation that emerging economies have higher business cycle volatility than developed economies [see, for example, [Lucas \(1988\)](#) and [Acemoglu and Zilibotti \(1997\)](#)] ignited a large body of work that studies potential explanations. First, many papers have focused on aggregate explanations, such as more frequent or larger financial shocks [[Neumeyer and Perri \(2005\)](#); [Uribe and Yue \(2006\)](#); [Calvo, Izquierdo and Talvi \(2006\)](#); and others]; more persistent TFP processes [[Aguar and Gopinath \(2007\)](#)]; procyclical fiscal and monetary policy [[Vegh and Vuletin \(2014\)](#)]; more institutional instability [[Mobarak \(2005\)](#)]; and higher exposure to commodity prices shocks [see, for example, [Kohn, Leibovici and Tretvoll \(2021\)](#)]. Second, a smaller set of papers have focused on the role of sector-level shocks and sectoral differences across emerging and developed economies [see, for example, [Da-Rocha and Restuccia \(2006\)](#) and [Koren and Tenreyro \(2007\)](#)].<sup>4</sup> In our paper, we combine these different views—aggregate and micro explanations—in a unique theoretical framework. Our empirical contribution is to document that in emerging economies, sectoral sales tend to be more concentrated in the most volatile sectors, firms' sales tend to be more concentrated in the largest firms, and disaggregated trade imbalances are larger.

Unlike previous studies on the excessive business volatility in emerging economies,

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<sup>3</sup>Concentration is measured as the square of the sum of the Domar weights (HHI index) of the 70 largest firms in the economy.

<sup>4</sup>Although they don't focus on differences between emerging and developed economies, [Carvalho and Gabaix \(2013\)](#) study the role of sectoral composition in changes in volatility across time for the US and other developed economies.

we use model-induced sufficient statistics to quantify the contribution of each channel.<sup>5</sup> These statistics can be computed using sectoral data, firm-level micro data, and international trade data from several emerging and developed economies. To derive the sufficient statistics, we extend Hulten’s theorem (Hulten, 1978) to a small open economy framework. Our analytical results are related to those of Baqaee and Farhi (2021). While they focus on a multiple economy setup, we focus on a small open economy setup with tradable (no market clearing, and thus exogenous prices) and nontradable (only domestic market clearing) sectors, a non-degenerate distribution of firms within a sector, and elastic labor supply.

Our result, whereby international prices shocks are neutral—i.e., they don’t affect domestic aggregate output—when labor supply is inelastic is related to other results by, for example, Kehoe and Ruhl (2008); Burstein and Cravino (2015); and Baqaee and Farhi (2021). We highlight the importance of households’ preferences, and particularly the responsiveness of labor supply to changes in real income, in quantifying the impact of international prices shocks on excessive output volatility in emerging economies.<sup>6</sup>

Lastly, to our knowledge, this is the first paper that studies how differences in the distribution of firms between emerging and developed economies can account for the excessive volatility of output in emerging economies. Gabaix (2011) and di Giovanni and Levchenko (2012) also study the role of firm-level shocks, but focus on developed economies and the differences between large and small countries, respectively.

**Organization.** The rest of the paper is organized as follows. Section 2 describes the theoretical model and main proposition, Section 3 presents the main quantitative applications and empirical patterns, and Section 4 concludes.

## 2 Theoretical Framework

We develop a multisector small open economy model with heterogeneous firms and production linkages. We use the model to decompose the volatility of GDP in aggregate, sectoral, firm-level, and international prices channel.

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<sup>5</sup>E.g., Koren and Tenreyro (2007) use an atheoretical approach to study the role of the economic structure. In spite of this, our main findings regarding the economic structure are in line with theirs.

<sup>6</sup>Several papers in the literature that study the transmission of commodity prices shocks to domestic output in open economies [see, for example, Shousha (2016); Drechsel and Tenreyro (2018); Kohn *et al.* (2021)] use GHH preferences, which we show could significantly amplify their transmission by muting the income effects. On the other hand, our results are consistent with those of Huo, Levchenko and Pandalai-Nayar (2023), who find that international transmission is low for a relatively low elasticity of labor.

## 2.1 Environment

In the economy, there is a discrete number of sectors  $s \in \mathcal{S}$  where  $\mathcal{S}$  can be partitioned into a subset of nontradable sectors  $\mathcal{S}^{NT}$  that can only be sold domestically and a subset of tradable sectors  $\mathcal{S}^T$  that can be sold domestically and internationally. Then

$$\mathcal{S} = \left\{ \underbrace{1, \dots, S_{NT}}_{\mathcal{S}^{NT}}, \underbrace{S_{NT} + 1, \dots, S_T + S_{NT}}_{\mathcal{S}^T} \right\},$$

where  $S_{NT} + S_T = N$  is the total number of sectors. The economy is relatively small and open, so tradable prices,  $p_s$  with  $s \in \mathcal{S}^T$ , are exogenous. Nontradable prices,  $p_s$  with  $s \in \mathcal{S}^{NT}$ , are determined in general equilibrium. Within each sector  $s \in \mathcal{S}$  there is an arbitrarily finite number of heterogeneous firms  $i \in \mathcal{I}_s$ . The set of all firms in the economy is

$$\mathcal{I} = \left\{ \underbrace{1, 2, \dots, I_1}_{\mathcal{I}_1}, \underbrace{I_1 + 1, \dots, I_2 + I_1}_{\mathcal{I}_2}, \dots, \underbrace{\sum_{s=1}^{N-1} I_s + 1, \dots, \sum_{s=1}^N I_s}_{\mathcal{I}_N} \right\},$$

where  $I = \sum_s^N I_s$  is the total number of firms. Firms are linked through their production—i.e., firms buy intermediate goods from other firms—and act competitively. The economy is also populated by a representative household that owns all the firms, consumes, and supplies labor to firms. We next describe the firm and household problems, market-clearing conditions, and aggregates.

### 2.1.1 Firms

Each firm  $i$  in sector  $s$  produces homogeneous good  $s$  and chooses labor and intermediate inputs to maximize its profits, taking the price of the good produced, wages, and the prices of intermediate inputs as given. Then the problem of firm  $i$  in sector  $s$  is

$$\pi_i = \max_{L_i, \mathbf{X}_i} p_s y_i - w L_i - \mathbf{p} \mathbf{X}_i', \quad (1)$$

where  $y_i$  is the output produced by firm  $i$ ,  $L_i$  is the labor demanded by firm  $i$  at wage  $w$ , and  $\mathbf{X}_i = \begin{bmatrix} X_{i,1} & \cdots & X_{i,s} & \cdots & X_{i,N} \end{bmatrix}$  are the intermediate inputs demanded by firm  $i$  at prices  $\mathbf{p} = \begin{bmatrix} p_1 & \cdots & p_s & \cdots & p_N \end{bmatrix}$ , where  $X_{i,j}$  denotes firm  $i$ 's demand of sector  $j$ 's intermediate good. The production function of firm  $i$  in sector  $s$  is

$$y_i = \mathcal{A}_i F_s(L_i, \mathbf{X}_i),$$

where  $\mathcal{A}_i = \exp(a + \tilde{a}_s + a_i)$  is an exogenous productivity shifter composed of aggregate productivity  $A = e^a$ , sectoral productivity  $\tilde{A}_s = e^{\tilde{a}_s}$ , and firm-level idiosyncratic productivity  $A_i = e^{a_i}$  components. Crucially, the function  $F_s(\cdot)$  exhibits decreasing returns to scale, and thus firms can be heterogeneous within a sector [see [Hopenhayn \(1992\)](#)].

### 2.1.2 Households

The representative household consumes tradable and nontradable goods, supplies labor to firms, and owns all the firms in the economy. The household maximizes its utility

$$\max_{\mathbf{C}, L} \frac{\mathcal{C}(\mathbf{C})^{1-\sigma}}{1-\sigma} - \frac{L^{1+\frac{1}{\psi}}}{1+\frac{1}{\psi}},$$

subject to the budget constraint

$$\mathbf{p}\mathbf{C}' + B^* \leq wL + \sum_{i \in \mathcal{I}} \pi_i, \quad (2)$$

where  $\sigma$  is the relative risk aversion parameter and  $\psi$  the labor-supply elasticity;  $\mathcal{C}(\cdot)$  is a homogeneous degree one aggregator over consumption choices  $\{C_s\}_{s=1}^N$  with  $\mathbf{C} = [C_1 \ \cdots \ C_s \ \cdots \ C_N]$ ;  $L$  is the aggregate labor supply choice,  $\mathbf{p}' \in \mathcal{R}_+^N$  consumption goods' prices, and  $B^*$  is the exogenous net transfers to the rest of the world [similar to [Baqae and Farhi \(2021\)](#)]. The household's earnings are the sum of labor income  $wL$  and firms' profits  $\sum_{i \in \mathcal{I}} \pi_i$ . Since firms have a decreasing returns to scale technology, profits are weakly positive; i.e.,  $\pi_i \geq 0 \ \forall i \in \mathcal{I}$ .

### 2.1.3 Market Clearing and Aggregation

**Market clearing.** First, the total amount of labor demanded by all firms in the economy has to equal the labor supplied by the representative household:

$$\sum_{i \in \mathcal{I}} L_i = L. \quad (3)$$

Next, for each nontradable sector the goods produced by firms within sector  $s$  have to equal household's and all firms' demand of sector  $s$ 's good:

$$\sum_{i \in \mathcal{I}_s} y_i = C_s + \sum_{i \in \mathcal{I}} X_{i,s} \quad \text{if } s \in \mathcal{S}_{NT}. \quad (4)$$

Finally, there is an aggregate external resource constraint such that the sum of production across all tradable sectors net of aggregate consumption of these sectors and

aggregate demand of intermediate inputs from these sectors equals aggregate net exports in the small open economy:

$$\sum_{s \in \mathcal{S}^T} p_s \left( \sum_{i \in \mathcal{I}_s} y_i - C_s - \sum_{i \in \mathcal{I}} X_{i,s} \right) = \sum_{s \in \mathcal{S}^T} b_s = B^*. \quad (5)$$

**Gross domestic product.** GDP in this economy is given by aggregate production net the use of intermediate inputs. Using the nontradable sector's market-clearing conditions (4) and that  $\mathcal{C}(\cdot)$  is homogeneous of degree 1, we can express the economy's GDP ( $\tilde{Y}$ ) as

$$\tilde{Y} = \mathbf{p}\mathbf{C}' + B^* = wL + \sum_{i \in \mathcal{I}} \pi_i = \mathcal{C}(\mathbf{C}) + B^*, \quad (6)$$

which means that, different from a closed economy setup, in our small open economy GDP differs from welfare by the exogenous net exports.<sup>7</sup> Notice that  $\tilde{Y}$  is the GDP deflated by the CPI index  $P = P_C = 1$ , which is the numeraire, and denote GDP deflated by the production price index  $P_Y$  as  $Y = \frac{P_C}{P_Y} \tilde{Y}$ . In Lemma 1, we show analytically what determines the difference between CPI inflation and the production price index.

## 2.2 Competitive Equilibrium

**Definition 1.** A competitive equilibrium is an allocation  $\{\{\mathbf{X}_i\}_{i \in \mathcal{I}}, \mathbf{C}, \{L_i\}_{i \in \mathcal{I}}, L\}$  with exogenous productivity shifter  $\mathcal{A}_i = A\tilde{A}_s A_i$ , tradable prices  $\mathbf{p}^T$ , aggregate net exports  $B^*$ , and prices  $\{\mathbf{p}, w\}$  such that

- given prices  $\mathbf{p}$  and  $w$ , firms maximize their profits,
- given  $\mathbf{p}$ ,  $w$  and  $B^*$ , the representative household maximizes its utility,
- nontradable goods markets clear and labor market clears.

Importantly, the economy is efficient, so the competitive equilibrium allocations coincide with the allocations of the planner's problem.

## 2.3 Business Cycle Volatility

Before stating the main proposition, it is useful to define the relevant *Domar weights* in this economy. The Domar weight of firm  $i \in \mathcal{I}_s$  is the sales share of firm  $i$  in GDP ( $\tilde{Y}$ )

<sup>7</sup>Define the expenditure function of the household as  $e(p, \mathcal{C}) = \sum_s p_s C_s$ . Since  $\mathcal{C}$  is homogeneous of degree 1, we have  $e(p, \mathcal{C}) = \mathcal{C}e(p)$ . Normalize the unit cost of consumption  $e(p) = 1$  to obtain  $\sum_i p_s C_s = \mathcal{C}$ , [see, for example, [Baqae and Farhi \(2021\)](#)].



and denoted by  $\lambda_i$ —i.e.,  $\lambda_i \equiv \frac{p_s y_i}{Y}$ . Then, it follows that the sectoral Domar weight for a sector  $s$  is  $\Lambda_s \equiv \sum_{i \in \mathcal{I}_s} \lambda_i$  and the aggregate Domar weight is  $\Lambda \equiv \sum_{i \in \mathcal{I}} \lambda_i$ .

**Proposition 1.** *The first-order response of output  $Y(\cdot)$  to changes in  $\{A, \tilde{A}_s, A_i, \mathbf{p}^T\}$  is*

$$d \log Y = \vartheta \left[ \Lambda da + \sum_{s \in \mathcal{S}} \Lambda_s d\tilde{a}_s + \sum_{i \in \mathcal{I}} \lambda_i da_i \right] + (\vartheta - 1) \sum_{s \in \mathcal{S}^T} b_s d \log p_s, \quad (7)$$

where  $\vartheta = \left( \frac{1+\psi}{1+\psi\sigma(1-b^*)} \right)$  and  $b^* = \frac{B^*}{Y-B^*}$ . Moreover, if firm-level shocks are uncorrelated and their volatility is the same for all firms, sectoral shocks can be correlated across sectors, and international prices shocks can be correlated across tradable goods, then the variance of GDP growth (in log differences) is

$$\text{Var}(d \log Y) = \underbrace{\vartheta^2 \Lambda^2 \sigma_A^2}_{\text{aggregate}} + \underbrace{\vartheta^2 \Lambda' \Omega_{\tilde{A}} \Lambda}_{\text{sectoral}} + \underbrace{\vartheta^2 \lambda' \lambda \sigma_{A_i}^2}_{\text{firm-level}} + \underbrace{(1 - \vartheta)^2 \mathbf{b}' \Omega_{\mathbf{p}^T} \mathbf{b}}_{\text{int. prices}} \quad (8)$$

where  $\sigma_A^2$  is the variance of common (aggregate) TFP shocks,  $\Lambda$  the vector of sector-level Domar weights,  $\Omega_{\tilde{A}}$  the covariance matrix of sectoral TFP shocks,  $\lambda$  the vector of firm-level Domar weights,  $\sigma_{A_i}$  the variance of firm-level shocks,  $\mathbf{b}$  the vector of sectoral trade imbalances, and  $\Omega_{\mathbf{p}^T}$  the covariance matrix of international prices shocks. Variance terms are computed for log changes. The proof is in Appendix A.

In Proposition 1, we extend Hulten's theorem to a small open economy with tradable and nontradable sectors, firm-level heterogeneity, and elastic aggregate labor supply. To a first order, GDP growth and its volatility can be decomposed into four distinctive channels that depend on observable sufficient statistics and parameters of the household's utility function.

The first channel is the aggregate channel, whose impact depends on the volatility of aggregate TFP shocks and the sum of all firms' Domar weights (aggregate sales share). The second and third terms correspond to channels related to the micro-structure of the economy at sector and firm level, respectively. The sectoral channel depends on the variance and covariance matrix of sector-level shocks and the vector of sectoral Domar weights. The firm-level channel depends on the volatility of firm-level shocks and the Herfindahl index of the firms' sale share. Aggregate, sector-, and firm-level channels are scaled by the parameter  $\vartheta$ , which is determined by parameters of household's preferences and the aggregate trade balance. If  $\vartheta > 1$  ( $< 1$ ), then shocks are amplified (dampened) by changes in the labor supply. Last, international prices depend on the variance and covariance matrix of tradable prices shocks and the vector of sectoral trade balances, scaled by  $(1 - \vartheta)$ .

**Definition 2.** *The fundamental volatility of aggregate output  $Y$  is defined by equation (8) for any combination of parameter values  $\{b^*, \sigma, \psi\}$  such that  $\vartheta = 1$  (i.e., labor supply is not responsive to real income changes).*

We show in Proposition 1 that the *fundamental* volatility of aggregate output doesn't depend on international prices shocks. For  $\vartheta = 1$ , we recover a variation of Hulten's theorem. To a first order, as in a closed economy setup, only TFP shocks (aggregate, sector-, and firm-level shocks) matter for aggregate output fluctuations, and the Domar weights summarize their importance. The neutrality of international prices shocks is related to the results of Kehoe and Ruhl (2008); Burstein and Cravino (2015); and Baqaee and Farhi (2021). For international prices shocks to matter, the aggregate labor supply must be elastic ( $\psi \neq 0$ ) and the income and substitution effects cannot fully cancel each other out.<sup>8</sup> Intuitively, when there is a trade imbalance in sector  $b_s \neq 0$ , a change in  $p_s$  changes the real income of the households, since the CPI index changes relative to the GDP deflator (see Lemma 1). If the supply of labor is elastic and the income and substitution effects are different, then  $L$  responds to the change in real income, which ultimately changes aggregate output.<sup>9</sup>

### 3 Quantitative Applications

It is well documented that emerging economies have significantly higher aggregate output volatility than developed economies (see, for example, Acemoglu and Zilibotti (1997)). In this section, using sectoral data, firm-level micro data and trade data from several emerging and developed economies, we quantify decomposition (8) and estimate how much each channel contributes to explain the differences in aggregate output volatility between emerging and developed economies. In the first part, we focus on estimating the contribution of *fundamental* volatility—i.e., the volatility explained by differences in the distribution of sectors and the distribution of firms. Second, we study the role of international transmission and discuss how sensitive are our results to different assumptions regarding households' preferences.

#### 3.1 Data Description

**Sample** We start by empirically defining emerging and developed economies and tradable and nontradable sectors. For the definition of country groups, we follow Kohn *et al.* (2021) and define developed economies as those members of OECD with average PPP-adjusted GDP per capita higher than \$25,000, and emerging economies as those

<sup>8</sup>In our setup, substitution and income fully cancel if there are log-preferences ( $\sigma = 1$ ) and a balanced aggregate trade balance ( $b^* = 0$ ).

<sup>9</sup>International prices shocks could also explain aggregate output fluctuations through higher-order moments, such as reallocation. But, for example, Kohn *et al.* (2021) find that the reallocation channel is the least relevant in their quantitative exercises. In our baseline theorem, the reallocation channel is muted since we focus on the first-order approximation.

countries with average PPP-adjusted GDP per capita lower than \$25,000.<sup>10</sup> We follow the standard in the literature and define tradable sectors as those belonging to the commodities and manufacturing categories and nontradable sectors as those belonging to services. After combining all of the data sources for each of the four channels (described below), we obtain a sample of 10 emerging and 19 developed economies.<sup>11</sup>

**Data Sources and Data Moments** We compute the business cycle volatility of each country as the variance of the cyclical component of GDP, using data from World Development Indicators (WDI) for the period 1970-2016.<sup>12</sup> In our sample, the median emerging economy has 2.2 times the business cycle volatility of the median developed economy. We combine data from several sources to compute the sufficient statistics to quantify each channel’s contribution. For the sectoral channel, we use OECD input-output tables to compute the sectoral Domar weights vector for 36 (tradable and nontradable) sectors for each country. To compute the sectoral TFP covariance matrix  $\Omega_{\bar{A}}$  we use sector-level TFP estimates from [Jorgenson, Ho and Stiroh \(2005\)](#), from which we subtract the commonly correlated component across sectors.<sup>13</sup> We assume that the volatility of TFP is the same for same sectors across countries, and equal to the one in US. This assumption allows us to focus on differences in sectoral composition while using the best estimates possible for long-run sectoral TFP volatility. For the firm-level channel, we use data from [Worldscope](#)—which covers more than 90% of publicly held firms’ market cap internationally—to compute the Domar weights of the largest 70 firms for each country.<sup>14</sup> The advantage of the [Worldscope](#) dataset is that it allows us to compute firm-level Domar weights using sales by domestic subsidiaries. We use the baseline estimates of [Gabaix \(2011\)](#) to compute firm-level TFP volatility  $\sigma_{A_i}^2$ , which we assume to be common across firms in both emerging and developed economies, and equal to the one in US. Last, for the international prices channel, we use data from the OECD to compute sectoral trade balances and international sector-level price data from the [Groningen Growth and Development Centre](#) to compute the volatility of tradable prices  $\Omega_{p^T}$ .

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<sup>10</sup>Following [Kohn \*et al.\* \(2021\)](#), we exclude from the sample large open economies such as China and US and ex-communist countries.

<sup>11</sup>See the list of countries and sectors in the sample in [Appendix B.2](#).

<sup>12</sup>Consistent with the theoretical framework, we compute the cyclical component as the variance of GDP log-differences.

<sup>13</sup>To do so, we subtract year fixed effects from the sectoral TFP series. See [Appendix B](#).

<sup>14</sup>As studied by [Gabaix \(2011\)](#), if there is a fat-tailed distribution of firms’ sale shares in the economy, when it comes to the firm-level channel, what matters for the impact of firms’ idiosyncratic shocks on aggregate volatility is how sales among the largest firms in the economy are concentrated.

## 3.2 Role of the Fundamental Volatility

In this section, we study how much of the differences in output volatility between emerging and developed economies can be accounted by differences in fundamental volatility. We focus on the contribution of differences in the sectoral- and firm-level distribution across emerging and developed economies.

To isolate the contribution of the micro-structure of the economy, we use decomposition (8) and assume: (i) fundamental volatility (i.e.,  $\vartheta = 1$  such that labor supply is unresponsive to real income changes); (ii) the sector-level covariance matrix is the same across countries; (iii) firm-level volatility is the same across countries; and (iv) the sum of Domar weights for non-top firms tends to zero.<sup>15</sup> These assumptions imply that the contributions of the sectoral and firm-level channels are explained *only* by differences in the micro-structure of the economy, and not by intrinsic differences in sector- and firm-level volatility across countries.<sup>16</sup> Then, the difference in output volatility between emerging and developed economies is

$$\begin{aligned} \text{Var}(\text{d log } Y_{\text{EM}}) - \text{Var}(\text{d log } Y_{\text{DEV}}) = & \\ & \underbrace{\Lambda'_{\text{EM}} \Omega_{\tilde{A}} \Lambda_{\text{EM}} - \Lambda'_{\text{DEV}} \Omega_{\tilde{A}} \Lambda_{\text{DEV}}}_{\text{sectoral distribution}} + \underbrace{\left[ \left( \lambda' \lambda \right)_{\text{EM}}^{\text{top}} - \left( \lambda' \lambda \right)_{\text{DEV}}^{\text{top}} \right] \sigma_{A_i}^2}_{\text{firm-level distribution}} \\ & + \underbrace{\Lambda_{\text{EM}}^2 \sigma_{A,\text{EM}}^2 - \Lambda_{\text{DEV}}^2 \sigma_{A,\text{DEV}}^2}_{\text{residual aggregate}}. \end{aligned} \quad (9)$$

Decomposition (9) shows that aggregate output volatility can be expressed in terms of sufficient statistics that can be taken directly from the data: differences in the distribution of Domar weights across sectors and differences in the Herfindahl index of firm-level Domar weights. Table 1 reports our main findings. Differences in the distribution of sectors and firms can explain much as 48% (43% sectoral and 5% firm-level) of the excessive aggregate output volatility in emerging economies. Next, we study and discuss in detail what determines the contribution of each channel.

<sup>15</sup>Figure C.2 shows that in both emerging and developed economies the cumulative sum of squared Domar weights (the sufficient statistic for the firm-level channel) becomes flat when roughly more than 15 to 20 firms are included.

<sup>16</sup>We don't rule out that differences in intrinsic volatility may exist and be relevant. See the next sub-section's discussion.

**Table 1: Volatility accounting: emerging vs developed economies**

	Contribution		
	Sectoral	Firm-level	Aggregate
Baseline (median)	0.43	0.05	0.52
[P25,P75]	[0.10,0.63]	[-0.01,0.05]	[0.91,0.32]

Note: the contributions of each channel are estimated using equation (9). Further details about the data and computation are in the text. “P25” refers to the result for the exercise using the 25th percentile of the distribution of sectoral and firm-level Domar weights and GDP volatility. “P75” refers to the result for the exercise using the 75th percentile of the distribution of sectoral and firm-level Domar weights and GDP volatility.

### 3.2.1 Sectoral channel

**Pattern 1.** *Sectoral Domar weights in emerging economies are concentrated in highly volatile sectors (i.e., manufacturing and agriculture), whereas in developed economies they are concentrated in the least volatile sectors (i.e., services).*

Table 2, Panel (a) summarizes the distribution of sectoral Domar weights in sectors that belong to the highest and lowest quartiles of sectoral volatility for emerging and developed economies. The sum of Domar weights across the most volatile sectors for the median emerging economy is 0.62, compared with 0.38 in developed economies, and the sum of Domar weights among the least volatile sectors is 0.70 in the median emerging economy vs 0.89 in the median developed economy.

**Table 2: Sectoral and firm distribution**

	Sum of Domar weights	
	Emerging	Developed
<i>(a) Sector volatility</i>		
Most volatile sectors	0.62 (0.46,0.68)	0.38 (0.32,0.40)
Least volatile sectors	0.70 (0.62,0.78)	0.89 (0.77,0.93)
<i>(b) Firms' concentration</i>		
Top firms	0.48 (0.24,0.55)	0.36 (0.29,0.49)

Source: World Development Indicators (WDI), [Jorgenson et al. \(2005\)](#) dataset, and Worldscope firm-level data.

Note: Panel (a) shows the sum of Domar weights across sector's volatility for the median emerging and developed economies. “Most volatile sectors” refer to sectors belonging to the highest quartile in volatility; “Least volatile sectors” refer to sectors belonging to the lowest quartile in volatility. Panel (b) shows the sum of Domar weights for top firms in the economy for the median emerging and developed economies. Top firms are the 70 largest firms in terms of sales. We report in parentheses values that correspond to the 25th and 75th percentiles.

**Relation to Structural Transformation.** We analyze which specific sectors are driving such a substantial contribution of the sectoral channel. As shown in the first three columns of Table 3, emerging economies tend to have relatively more sales shares in agriculture and manufacturing, which are the most volatile sectors. On the other hand, developed economies concentrate relatively more sales in services, which is a low-volatility sector. These patterns are consistent with the process of structural transformation, which has been widely studied in the macro-development literature. Structural transformation posits that as countries develop, they transition their production away from agriculture and manufacturing and toward services. We conduct a counterfactual analysis to quantify the relative importance of each sector in explaining the excessive volatility observed in emerging economies. Results are reported in the fourth column of Figure 3. If differences in sectoral Domar weights arose only from agriculture, the sectoral channel would explain 46% of GDP volatility differences. If they arose only from manufacturing, the sectoral channel would contribute 53%. Lastly, if the only differences arose from services, the sectoral channel would yield a negative contribution of -46%, which implies that this sector plays a pivotal role in explaining output volatility in developed economies but not in emerging economies.

**Table 3: Sectoral channel decomposition**

	Domar W		Volatility (std)	Contribution to differences
	EM	DEV		
Agriculture	0.21	0.05	0.10	46%
Manufacturing	0.62	0.42	0.08	53%
Services	1.00	1.32	0.06	-46%

Source: Authors' calculations based on World Development Indicators (WDI) and [Jorgenson et al. \(2005\)](#) dataset.

Note: The first column shows sectoral Domar weights for the median emerging (EM) and developed (DEV) economies; the second column shows sectoral TFP volatility; the third column shows the contribution of the sectoral channel (net cross-sector correlations) in the counterfactual scenario in which sale shares for all sectors but the one under analysis are the same in emerging and developed economies.

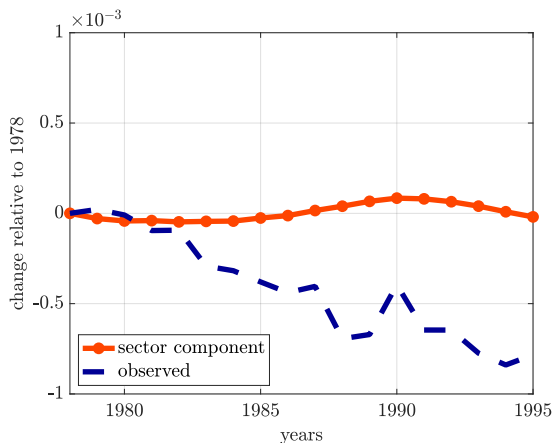
**Time-series Analysis.** Next, we study volatility differences between emerging and developed economies over time, and quantify the contribution of the sectoral channel in explaining the time series. We document a significant reduction in output volatility in both emerging and developed economies during the period between 1978 and 1995. Notably, this decline is more pronounced in emerging economies.<sup>17</sup>

We employ our theoretical framework from Section 2 to investigate the impact of

<sup>17</sup>In Appendix C.1, we use different samples to check for robustness and find that the decline in output volatility is robust across both groups of economies, and the relatively larger decline in emerging economies is robust but weaker. We focus on this period due to data availability.

changes in the sectoral structure of both developed and emerging economies on this *relative* reduction in output volatility in emerging economies. In calculating the time series of the sectoral channel, we allow Domar weights to vary over time, while keeping the covariance matrix of the sectoral TFP shocks ( $\Omega_{\bar{A}}$ ) fixed. We find that the sectoral channel alone cannot account for the relative decrease in output volatility in emerging economies, as illustrated in Figure 1. This suggests the presence of additional factors that influence these trends, such as improvements in macroeconomic policy management in emerging markets.<sup>18</sup>

**Figure 1:** *Output volatility and sectoral channel evolution*



Notes: This figure shows the evolution of the volatility driven by the sectoral distribution ( $\Lambda'_{EM,t}\Omega_{\bar{A}}\Lambda_{EM,t} - \Lambda'_{DEV,t}\Omega_{\bar{A}}\Lambda_{DEV,t}$ ) and the observed output volatility differences ( $\text{Var}(d \log Y_{EM}) - \text{Var}(d \log Y_{DEV})$ ) relative to base year 1978.

**Relevance of Correlated Sectoral Shocks** Alternatively, we assume that sectoral TFP shocks are uncorrelated, and find that the sectoral channel explains 83% of excessive output volatility in emerging economies. Thus, the sectoral channel’s contribution is significantly smaller if we take into account that sector-level TFP shocks can be correlated across sectors.

### 3.2.2 Firm-level channel

**Pattern 2.** *Firm-level Domar weights within the largest firms are more concentrated in emerging than developed economies.*

This pattern drives the contribution of the firm-level channel. Through the lens of our model, a higher concentration of sales in fewer large firms implies that shocks that hit large firms, given the same firm-level shocks volatility, would have a higher impact on

<sup>18</sup>We also document a surge in the significance of the service sector for both emerging and developed economies, which may be a key driver of the substantial decrease in output volatility observed in both types of economies—a phenomenon previously noted by [Carvalho and Gabaix \(2013\)](#) for the United States and other developed economies.

emerging economies' aggregate volatility than on developed economies'. Using firm-level data from Worldscope, we analyze how concentrated across the largest firms in the economy are sales shares. The dataset allows us to separate sales by domestic subsidiaries (the relevant ones for our theory) from foreign ones. Table 2, Panel (b) shows that sales within the largest firms are more concentrated in emerging economies, with the sum of Domar weights of the top 70 firms being 0.48 in emerging economies vs 0.36 in developed ones.

**Intrinsic Volatility Differences** Aggregate output in emerging economies could be more volatile because firms' idiosyncratic shocks are more volatile in emerging economies. We cannot measure directly the differences in firm-level volatility, and thus we assume that the residual portion of the excessive volatility comes only from *intrinsic* differences in firm-level volatility (i.e., we assume the aggregate channel is 0). In this exercise, we find that the idiosyncratic volatility of firms in emerging economies is 2 times and 31% higher than in developed economies with correlated and uncorrelated shocks, respectively. This suggests that the firm-level channel may be much more relevant if firms are moderately more volatile in emerging economies.<sup>19</sup>

### 3.3 International Prices Transmission

In this section, we focus on the role of the international prices channel in explaining output volatility differences in emerging and developed economies, and how sensitive it is to different assumptions regarding the households' preferences. We show in Proposition 1 that for international prices to transmit to aggregate output fluctuations, there must be trade imbalances across sectors and the labor supply must be responsive to real income fluctuations.

Sectoral trade imbalances reflect the fact that the consumption basket and production structure are different. Shocks to the international prices of sectors with trade imbalances will change households' real income. For example, if there is an increase in a good that is produced domestically but consumed abroad (i.e., exported), then the households' real income increases since the production price index increases more than the consumer price index. Importantly, shifts in real income, to a first order, translate into changes in aggregate output only if labor supply is responsive (or, more formally, if the income and substitution effect don't cancel each other out).

Using disaggregated trade data from COMTRADE (see Appendix C.3), we first document trade imbalances across emerging and developed economies. Figure C.3 shows

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<sup>19</sup>This number is comparable to previous findings that use firm-level data. See, for example, Kochen (2023)'s estimates for a set of high- and middle-income European economies.



the sectoral trade imbalances for 20 tradable sectors for the median emerging and developed economies. We observe that trade imbalances are much larger in emerging economies. In addition, as [Kohn et al. \(2021\)](#) observe, while emerging economies are net exporters of commodities and net importers of manufactures, developed economies are roughly balanced in the two sectors.

To estimate the contribution of international prices to the excessive output volatility in emerging economies, we compute  $\mathbf{p}^T$  and  $\Omega_{\mathbf{p}^T}$  using sectoral prices data and construct the vector of observed trade imbalances for emerging  $\mathbf{b}_{EM}$  and developed  $\mathbf{b}_{DEV}$ . Using equation (8) for emerging and developed economies, we define the contribution of the international prices channel as

$$(1 - \vartheta)^2 \frac{[\mathbf{b}'_{EM} \Omega_{\mathbf{p}^T} \mathbf{b}_{EM} - \mathbf{b}'_{DEV} \Omega_{\mathbf{p}^T} \mathbf{b}_{DEV}]}{\text{Var}(\text{d log } Y_{EM}) - \text{Var}(\text{d log } Y_{DEV})}. \quad (10)$$

In [Table 4](#), we compute the contribution for various values of  $\psi$  and  $\sigma$ ; recall that  $\vartheta \equiv \left( \frac{1+\psi}{1+\psi\sigma(1-b^*)} \right)$ . We find that the contribution of the international prices channel ranges from 0.2% to 16.2%. These results suggest that by muting the income effect, preferences such as GHH ( $\sigma = 0$ ), which are commonly used in the literature, can significantly amplify the transmission of commodity prices shocks to aggregate GDP fluctuations through real income changes.

**Table 4:** *International prices channel*

<i>Parameters</i>				
$\sigma$	2	2	0	0
$\psi$	2	4	2	4
Contribution	0.2%	0.2%	4.0%	16.2%

Note: Contributions are estimated using equation (10) with trade data from COMTRADE and sectoral price data from [Jorgenson et al. \(2005\)](#). We assume  $b^* = -0.02$  for both country categories. Further details in [Appendix C.3](#).

## 4 Conclusion

In this paper, we study why emerging economies are more volatile than developed economies through the lens of a small open economy general equilibrium model with production linkages, tradable and nontradable sectors, heterogeneous firms within each sector, and elastic aggregate labor supply.

Our main proposition shows that in this comprehensive economy, aggregate output

can fluctuate through four channels—aggregate, sectoral, firm-level, and international prices—which depend on observable sufficient statistics and a parameter that summarizes the responsiveness of labor to changes in labor income. Using sector- and firm-level data from several countries, we find that differences in the sectoral and firm distribution between emerging and developed economies can explain around half of the greater output volatility in emerging economies. On the other hand, we find that the international prices channel’s relevance depends on the households’ preferences.

The paper remains silent on why the micro-structure of the economy (distribution of sectors and firms) differs between emerging and developed economies. Whether differences are driven by heterogeneity in natural endowments, skills distribution, market structure, or inefficiencies would have different normative implications. We leave these interesting research avenues for future work.

## REFERENCES

- ACEMOGLU, D. and ZILIBOTTI, F. (1997). Was Prometheus Unbound by Chance? Risk, Diversification, and Growth. *Journal of Political Economy*, **105** (4), 709–751.
- AGUIAR, M. and GOPINATH, G. (2007). Emerging market business cycles: The cycle is the trend. *Journal of Political Economy*, **115** (1), 69–102.
- BAQAEE, D. and FARHI, E. (2021). Networks, Barriers, and Trade, working paper, NBER No. 26108.
- BURSTEIN, A. and CRAVINO, J. (2015). Measured Aggregate Gains from International Trade. *American Economic Journal: Macroeconomics*, **7** (2), 181–218.
- CALVO, G. A., IZQUIERDO, A. and TALVI, E. (2006). Sudden Stops and Phoenix Miracles in Emerging Markets. *American Economic Review*, **96** (2), 405–410.
- CARVALHO, V. and GABAIX, X. (2013). The Great Diversification and Its Undoing. *American Economic Review*, **103** (5), 1697–1727.
- DA-ROCHA, J. M. and RESTUCCIA, D. (2006). The role of agriculture in aggregate business cycles. *Review of Economic Dynamics*, **9** (3), 455–482.
- DI GIOVANNI, J. and LEVCHENKO, A. A. (2012). Country size, international trade, and aggregate fluctuations in granular economies. *Journal of Political Economy*, **120** (6), 1083–1132.

- DRECHSEL, T. and TENREYRO, S. (2018). Commodity booms and busts in emerging economies. *Journal of International Economics*, **112** (C), 200–218.
- GABAIX, X. (2011). The Granular Origins of Aggregate Fluctuations. *Econometrica*, **79** (3), 733–772.
- HERRENDORF, B., ROGERSON, R. and ÁKOS VALENTINYI (2014). Chapter 6 - growth and structural transformation. In P. Aghion and S. N. Durlauf (eds.), *Handbook of Economic Growth, Handbook of Economic Growth*, vol. 2, Elsevier, pp. 855–941.
- HOPENHAYN, H. A. (1992). Entry, exit, and firm dynamics in long run equilibrium. *Econometrica*, **60** (5), 1127–1150.
- HULTEN, C. R. (1978). Growth Accounting with Intermediate Inputs. *The Review of Economic Studies*, **45** (3), 511–518.
- HUO, Z., LEVCHENKO, A. A. and PANDALAI-NAYAR, N. (2023). International Co-movement in the Global Production Network, working paper.
- JORGENSON, D., HO, M. S. and STIROH, K. (2005). *Productivity, Vol. 3 Information Technology and the American Growth Resurgence*. MIT Press.
- KEHOE, T. J. and RUHL, K. J. (2008). Are Shocks to the Terms of Trade Shocks to Productivity? *Review of Economic Dynamics*, **11** (4), 804–819.
- KOCHEN, F. (2023). Finance Over the Life Cycle of Firms, working paper.
- KOHN, D., LEIBOVICI, F. and TRETVOLL, H. (2021). Trade in Commodities and Business Cycle Volatility. *American Economic Journal: Macroeconomics*, **13** (3), 173–208.
- KOREN, M. and TENREYRO, S. (2007). Volatility and Development. *The Quarterly Journal of Economics*, **122** (1), 243–287.
- LUCAS, R. E. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics*, **22** (1), 3–42.
- MOBARAK, A. M. (2005). Democracy, Volatility, and Economic Development. *The Review of Economics and Statistics*, **87** (2), 348–361.
- NEUMEYER, P. A. and PERRI, F. (2005). Business Cycles in Emerging Economies: The Role of Interest Rates. *Journal of Monetary Economics*, **52** (2), 345–380.
- SHOUSA, S. (2016). Macroeconomic Effects of Commodity Booms and Busts: The Role of Financial Frictions, working paper.

URIBE, M. and YUE, V. Z. (2006). Country Spreads and Emerging Countries: Who Drives Whom. *Journal of International Economics*, pp. 6–36.

VEGH, C. A. and VULETIN, G. (2014). The Road to Redemption: Policy Response to Crises in Latin America. *IMF Economic Review*, **62** (4), 526–568.

## A Appendix

### A.1 Proof of Lemma 1

**Lemma 1.** *In an economy with shocks to  $\{A, \tilde{A}_s, A_i, \mathbf{p}^T\}$ , the GDP deflator growth is*

$$d \log P_y = \sum_{s \in \mathcal{S}^T} b_s d \log p_s. \quad (11)$$

where  $b_s$  is the trade balance of sector  $s$ .

*Proof.* Changes in CPI can be defined as

$$d \ln P = \sum_{s \in \mathcal{S}} \frac{p_s C_s}{\sum_{s \in \mathcal{S}} p_s C_s} d \log p_s,$$

which can be split in different sectors as

$$d \ln P = \sum_{s \in \mathcal{S}^T} \frac{p_s C_s}{\sum_{s \in \mathcal{S}} p_s C_s} d \log p_s + \sum_{s \in \mathcal{S}^{NT}} \frac{p_s C_s}{\sum_{s \in \mathcal{S}} p_s C_s} d \log p_s. \quad (12)$$

By definition, the nominal GDP is  $\tilde{\mathcal{Y}} = \sum_{s \in \mathcal{S}} p_s (y_s - X_s)$ , where  $X_s = \sum_{i \in \mathcal{I}} X_{i,s}$  and  $y_s = \sum_{i \in \mathcal{I}_s} y_i$  aggregated to the sector-level. Notice that nominal GDP and GDP deflated by CPI are the same since the CPI is normalized to 1 (i.e.,  $d \ln P = 0$ ). Furthermore, scaling (12) by the ratio of total expenditure to GDP and using (12)  $dP = 0$ , then

$$0 = \sum_{s \in \mathcal{S}^T} \frac{p_s C_s}{\tilde{\mathcal{Y}}} d \log p_s + \sum_{s \in \mathcal{S}^{NT}} \frac{p_s C_s}{\tilde{\mathcal{Y}}} d \log p_s. \quad (13)$$

The GDP deflator growth is

$$d \log P_y = \sum_{s \in \mathcal{S}} \frac{p_s (y_s - X_s)}{\tilde{\mathcal{Y}}} d \log p_s,$$

then using the non-tradable market clearing  $y_s = C_s + X_s$  and (13), the GDP deflator

growth is

$$d \log P_y = \sum_{s \in \mathcal{S}^T} b_s d \log p_s. \quad (14)$$

where  $b_s \equiv \frac{(y_s - X_s - C_s)}{\tilde{y}}$ .

□

## A.2 Proof of Proposition 1

Using the firms' optimal choices and market clearing conditions in the non-tradable sector and labor markets, we can write the aggregate production function as

$$\tilde{Y}(\mathcal{A}, \mathbf{p}^T, L) = H(\mathcal{A}, \mathbf{p}^T, L) L.$$

**Assumption 1.** We assume that the aggregate production function satisfies the following assumption

$$\frac{\partial H(\mathcal{A}, \mathbf{p}^T, L)}{\partial L} \rightarrow 0 \quad (15)$$

This assumption assures that aggregate labor endowment doesn't affect the allocations across firms, therefore aggregate TFP, in equilibrium.

*Proof of Proposition 1.* The economy is efficient then to show the SOC Hulten Theorem using the envelope conditions of the planner's problem. We do this in two steps, first, we show the standard Hulten theorem with fixed  $L$ , and then we find  $L$  to determine the total response of aggregate output.

**Planner's problem.** Using the aggregation properties, given  $L$ , the planner solves the following problem

$$\begin{aligned} \tilde{Y}(A, \tilde{A}_s, A_i, \mathbf{p}^T) &= \max_{\{X_{i,s}\}, L_i, C_s} \mathcal{C}(\{C_s\}_{s=1}^S) + B^* \\ &+ \sum_{s \in \mathcal{S}^{NT}} \mu_s \left[ \sum_{i \in \mathcal{I}_s} \mathcal{A}_i F_s(L_i, \{X_{i,j}\}_{j=1}^S) - C_s - \sum_{j \in \mathcal{S}} \sum_{i \in \mathcal{I}_j} X_{i,s} \right] \\ &+ \lambda \left( L - \sum_{j \in \mathcal{S}} \sum_{i \in \mathcal{I}_j} L_i \right) \\ &+ \mu^T \left[ \sum_{s \in \mathcal{S}^T} p_s \left( \sum_{i \in \mathcal{I}_s} \mathcal{A}_i F_s(L_i, \{X_{i,j}\}_{j=1}^S) - C_s - \sum_{j \in \mathcal{S}} \sum_{i \in \mathcal{I}_j} X_{i,s} \right) - B^* \right] \end{aligned}$$

where  $\mathcal{A}_i = A\tilde{A}_s A_i$  if the TFP shifter,  $\mu_s$  is the lagrange multiplier on the market clearing condition of nontradable sector  $s \in \mathcal{S}^T$ ,  $\lambda$  is the multiplier on the labor supply constraint, and  $\mu^T$  the mutiplier on the tradable sectors aggregate resource constraint. Notice that  $\tilde{\mathcal{Y}}(A, \tilde{A}_s, A_i, \mathbf{p}^T)/P_y = \mathcal{Y}(A, \tilde{A}_s, A_i, \mathbf{p}^T)$  where  $\tilde{\mathcal{Y}}$  is the nominal GDP (or deflated by CPI),  $P_y$  is the GDP deflator, and  $\mathcal{Y}$  is the real GDP deflated by the GDP deflator. Finally, the net external balance are  $B^*$  and the tradable sectors prices are  $\mathbf{p}^T$ . First the envelope conditions for  $A, \tilde{A}_s, A_i,$ and  $p_s$  for  $s \in \mathcal{S}^T$ :

$$\begin{aligned}\frac{\partial \tilde{\mathcal{Y}}(A, \tilde{A}_s, A_i, \mathbf{p}^T)}{\partial A} &= \sum_{s \in \mathcal{S}^{NT}} \mu_s \sum_{i \in \mathcal{I}_s} \tilde{A}_s A_i F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right) + \mu^T \sum_{s \in \mathcal{S}^T} p_s \sum_{i \in \mathcal{I}_s} \tilde{A}_s A_i F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right) \\ \frac{\partial \tilde{\mathcal{Y}}(A, \tilde{A}_s, A_i, \mathbf{p}^T)}{\partial \tilde{A}_s} &= \mathbf{1}_{s \in \mathcal{S}^{NT}} \mu_s \sum_{i \in \mathcal{I}_s} A A_i F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right) + \mathbf{1}_{s \in \mathcal{S}^T} \mu^T p_s \sum_{i \in \mathcal{I}_s} A A_i F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right) \\ \frac{\partial \tilde{\mathcal{Y}}(A, \tilde{A}_s, A_i, \mathbf{p}^T)}{\partial A_i} &= \mathbf{1}_{s \in \mathcal{S}^{NT}} \mu_s A \tilde{A}_s F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right) + \mathbf{1}_{s \in \mathcal{S}^T} \mu^T p_s A \tilde{A}_s F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right) \\ \frac{\partial \tilde{\mathcal{Y}}(A, \tilde{A}_s, A_i, \mathbf{p}^T)}{\partial p_s} &= \mu^T \left( A \tilde{A}_s A_i F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right) - C_s - \sum_{j \in \mathcal{S}} \sum_{i \in \mathcal{I}_j} X_{i,s} \right).\end{aligned}$$

The FOC with respect to consumption are

$$\frac{\partial \mathcal{C} \left( \{C_s\}_{s=1}^S \right)}{\partial C_s} = \mathbf{1}_{s \in \mathcal{S}^{NT}} \mu_s + \mathbf{1}_{s \in \mathcal{S}^T} \mu^T p_s.$$

From the decentralized problem of the household the optimal conditions are

$$\frac{\partial \mathcal{C} \left( \{C_s\}_{s=1}^S \right)}{\partial C_s} = p_s.$$

which implies that  $\mu^T = 1$  and  $\mu_s = p_s$ . Then replacing in the envelope conditions of the planner's problem and rearranging terms using the definition of firm-level Domar weights, i.e.

$$\lambda_i \equiv \frac{p_s A \tilde{A}_s A_i F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right)}{\tilde{\mathcal{Y}}},$$

then the optimal conditions are

$$\begin{aligned}\frac{\partial \tilde{\mathcal{Y}}(A, \tilde{A}_s, A_i, \mathbf{p}^T)/\tilde{\mathcal{Y}}}{\partial A/A} &= \frac{\sum_{s \in \mathcal{S}} p_s \sum_{i \in \mathcal{I}_s} A \tilde{A}_s A_i F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right)}{\tilde{\mathcal{Y}}} = \sum_{s \in \mathcal{S}} \sum_{i \in \mathcal{I}_s} \lambda_i \\ \frac{\partial \tilde{\mathcal{Y}}(A, \tilde{A}_s, A_i, \mathbf{p}^T)/\tilde{\mathcal{Y}}}{\partial \tilde{A}_s/\tilde{A}_s} &= \frac{p_s \sum_{i \in \mathcal{I}_s} A \tilde{A}_s A_i F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right)}{\tilde{\mathcal{Y}}} = \sum_{i \in \mathcal{I}_s} \lambda_i\end{aligned}$$

$$\frac{\partial \tilde{\mathcal{Y}}(A, \tilde{A}_s, A_i, \mathbf{p}^T) / \tilde{\mathcal{Y}}}{\partial A_i / A_i} = \frac{p_s A \tilde{A}_s A_i F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right)}{\tilde{\mathcal{Y}}} = \lambda_i$$

$$\frac{\partial \tilde{\mathcal{Y}}(A, \tilde{A}_s, A_i, \mathbf{p}^T) / \tilde{\mathcal{Y}}}{\partial p_s / p_s} = \frac{p_s \left( A \tilde{A}_s A_i F_s \left( L_i, \{X_{i,j}\}_{j=1}^S \right) - C_s - \sum_{j \in \mathcal{S}} \sum_{i \in \mathcal{I}_j} X_{i,s} \right)}{\tilde{\mathcal{Y}}} \equiv b_s$$

The first order response of output, fixed  $L$ , to changes to shocks  $\{A, \tilde{A}_s, A_i, \mathbf{p}^T\}$  is

$$\partial \log \tilde{\mathcal{Y}}(A, \tilde{A}_s, A_i, \mathbf{p}^T) = \sum_{s \in \mathcal{S}} \sum_{i \in \mathcal{I}_s} \lambda_i \partial a_i + \sum_{s \in \mathcal{S}} \sum_{i \in \mathcal{I}_s} \lambda_i \partial \tilde{a}_s + \sum_{s \in \mathcal{S}} \sum_{i \in \mathcal{I}_s} \lambda_i \partial a_i + \sum_{s \in \mathcal{S}} b_s \partial \log p_s. \quad (16)$$

Equation (16) is Hulten's theorem for our economy when labor is inelastic and GDP is deflated by the CPI.<sup>20</sup> Using the properties of the aggregate production function and for  $L$  fixed, we it is straightforward that  $d \log \tilde{Y} = d \log H$ .

**Find  $L$  and  $Y$  response.** Using Assumption 1 we solve for the household's  $L$  choice problem, such that

$$\max_L \frac{(HL - B^*)^{1-\sigma}}{1-\sigma} - \frac{L^{1+\frac{1}{\psi}}}{1+\frac{1}{\psi}}$$

then the optimality condition is

$$H (\tilde{Y} - B^*)^{-\sigma} = L^{\frac{1}{\psi}} \rightarrow H^{\psi+1} (\tilde{Y} - B^*)^{-\psi\sigma} = \tilde{Y}$$

Next, using logs, first difference and log-linearizing  $\log (\tilde{Y} - B^*)$ <sup>21</sup>

$$\partial \log \tilde{Y} = \left( \frac{1 + \psi}{1 + \psi\sigma(1 - b^*)} \right) \partial \log H,$$

where  $b^* = \frac{B_0^*}{\tilde{Y}_0 - B_0^*}$ . Last, using Lemma 1, we deflate  $\tilde{Y}$  by the GDP deflator and using (16), then it follows that

$$\partial \log Y = \left( \frac{1 + \psi}{1 + \psi\sigma(1 - b^*)} \right) \left[ \Lambda \partial a + \sum_{s \in \mathcal{S}} \Lambda_s \partial a_s + \sum_{i \in \mathcal{I}} \lambda_i \partial a_i \right]$$

$$+ \psi \left( \frac{1 - \sigma(1 - b^*)}{1 + \psi\sigma(1 - b^*)} \right) \sum_{s \in \mathcal{S}^T} b_s \partial \log p_s.$$

□

<sup>20</sup>In a previous version of the theorem we consider shocks to  $B^*$ , but they don't affect real output when aggregate labor supply is inelastic. This result is consistent with the results by [Burstein and Cravino \(2015\)](#); [Baqae and Farhi \(2021\)](#).

<sup>21</sup>Log approx for  $\log (\tilde{Y} - B^*) - \log (\tilde{Y}_0 - B_0^*) = \frac{\tilde{Y} - \tilde{Y}_0}{\tilde{Y}_0 - B_0^*}$  then  $d \log (\tilde{Y} - B^*) = \left( \frac{\tilde{Y}_0}{\tilde{Y}_0 - B_0^*} \right) d \log \tilde{Y}$ . Due to Inada conditions we know  $\tilde{Y} - B^* > 0$ .

## ONLINE APPENDIX

# "The Business Cycle Volatility Puzzle: Emerging vs Developed Economies" by Lucia Casal and Rafael Guntin

## B Data Appendix

In this Appendix, we explain the data sources, measurement and sampling used.

### B.1 Data Sources by Channel

**Business Cycle (GDP) Volatility.** We use the GDP in constant LCU series from World Development Indicators (WDI) for the period 1970-2016 to compute the volatility of GDP for each country.

**Sectoral Channel.** Given the lack of long time series of sectoral productivity across countries, we assume sectoral volatilities to be the same across developed and emerging economies. We use the dataset from [Jorgenson et al. \(2005\)](#) to construct the sector-level TFP series. To remove the common component of TFP growth we run the following regression

$$d\log(A_{st}) = \alpha_t + d\log(\tilde{A}_{st}),$$

where  $dx_t = x_t - x_{t-1}$ ,  $A_{st}$  are the observed sectoral TFPs,  $\alpha_t$  time (year) FE, and the residual  $d\log(\tilde{A}_{st})$  is the sectoral TFP used in the estimation of the covariance matrices. We construct a crosswalk from the 77 sectors in [Jorgenson et al. \(2005\)](#) to compute the average sectoral volatility for each of the 36 OECD sectors.

We use the OECD input output tables to estimate the sectoral Domar weights for emerging and developed economies. For each sector we compute the share of gross output on aggregate value added (GDP), for both tradable and nontradable sectors (36 sectors in total).

To compute the long-run changes in Domar weights — in the time-series exercise — we use historical input-output data from WIOD, which covers the period 1965 to 2000. Domar weights are calculated using 11-year window, where the reference year is the 6th year (i.e., median year of the window).



*Firm-level Channel.* We use the Worldscope dataset to compute the firms' Domar weights  $\lambda_i$ . Worldscope contains financial statements of up to 90,000 public companies in both emerging and developed economies. The main advantage of Worldscope is that it covers both emerging and developed economies and distinguishes between domestic and foreign sales for each company, where domestic sales are sales done by establishments located in the country. Domestic sales are computed as 1 minus the share of foreign sales (1-ITEM8731) times total sales in USD (ITEM7240). Finally, the Domar weight is computed as the domestic sales over GDP from WDI in current USD.

**Table B.1:** *Sample selection: Worldscope*

Criteria	drop	sample
Year $\geq$ 2000	341,292	1,223,875
Missing sales data	223,855	1,000,020
Domestic sales data	269,761	730,259
Duplicates	177,576	552,683
Irregular foreign sales shares (<0%, >100%)	177,576	373,542
Top 70 firms per country-year	250,203	123,339
Country sample	36,522	86,817

Table B.1 shows our sample selection criteria in Worldscope.

## B.2 Countries and Sectors

**Table B.2:** *Countries in the baseline sample*

Emerging	Developed
Brazil	Australia
Chile	Austria
Indonesia	Belgium
India	Canada
Mexico	Denmark
Malaysia	Finland
Philippines	France
Thailand	Greece
Turkey	Germany
South Africa	Ireland
	Israel
	Italy
	Japan
	Netherlands
	Norway
	Spain
	Sweden
	Switzerland
	United Kingdom

**Table B.3:** *Tradable and nontradable OECD sectors*

Tradables	Nontradables
Mining and ext.of energy prod	Electricity, gas, water supply
Coke and refined petroleum products	Other business sector services
Machinery and equipment	Financial and insurance activities
Other transport equipment	Wholesale and retail trade; repair of motor vehicles
Motor vehicles, trailers and semi-trailers	Public admin. and defence; compulsory social security
Chemicals and pharmaceutical products	Publishing, audiovisual and broadcasting activities
Electrical equipment	Real estate activities
Textiles, wearing apparel, leather and related products	Construction
Fabricated metal products	Telecommunications
Basic metals	Arts, entertainment, recreation and other service activities
Mining support service activities	Transportation and storage
Other non-metallic mineral products	Human health and social work
Rubber and plastic products	Accommodation and food services
Other manufacturing	Education
Computer, electronic and optical products	IT and other information services
Wood products	
Paper products and printing	
Agriculture, forestry and fishing	
Mining and ext.of non-energy prod	

## C Additional Exercises

In this section, we provide further detail of the additional exercises.

## C.1 Structural Transformation and Business Cycle Volatility

We describe the sample used in the exercise that uses historical input-output data from WIOD.

**Table C.1:** *Countries in the long-run sample*

Emerging	Developed
Brazil	Australia
India	Austria
Korea	Belgium
Mexico	Canada
Portugal	Denmark
	Finland
	France
	Germany
	Greece
	Ireland
	Italy
	Japan
	Netherlands
	Spain
	Sweden
	United Kingdom

Next, we perform a robustness check for different sample selections of the evolution of the relative volatility of emerging economies.

**Table C.2:** *Changes in volatility differences: sample robustness*

	sample		
	baseline	long-run	large*
$\left( \sigma_{EM,1978}^2 - \sigma_{DEV,1978}^2 \right)$	1.20	0.74	0.97
$\left( \sigma_{EM,1995}^2 - \sigma_{DEV,1995}^2 \right)$	0.41	0.60	0.59
$\Delta_{1978-1995}$	-0.79	-0.15	-0.38

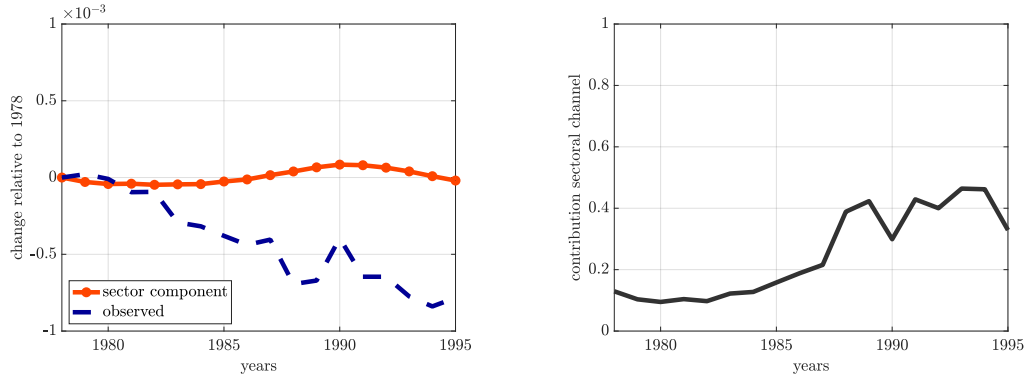
Source: authors' calculations using WIOD and WDI data. Notes: volatility terms are expressed in  $10^{-3}$  units.  
\*baseline sample in [Kohn et al. \(2021\)](#)

Finally, we compute the exercise using the theoretical framework. We compare the changes in relative volatility driven only by the sectoral channel and the observed decline, and we compute the contribution of the channel in explaining the level of the excessive volatility in emerging economies.

**Figure C.1: Sectoral channel and relative decline in volatility**

**(a) Output volatility and sectoral channel changes**

**(b) Contribution to volatility differences**

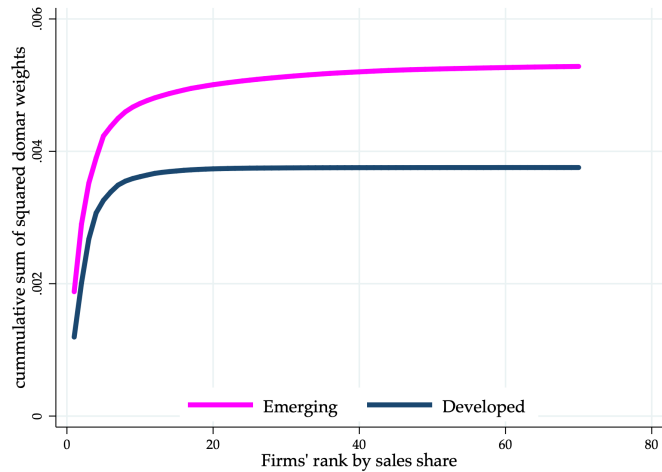


Notes: panel (a) shows the change of the sectoral channel  $(\Lambda'_{EM,t}\Omega_{\bar{A}}\Lambda_{EM,t} - \Lambda'_{DEV,t}\Omega_{\bar{A}}\Lambda_{DEV,t})$  and the observed  $(\sigma^2_{EM,t} - \sigma^2_{DEV,t})$  relative to base year 1978. Panel (b) shows the evolution of the contribution of the sectoral channel to the volatility differences between emerging and developed economies.

## C.2 Firm Distribution

Figure C.2 shows that the sum of the squared Domar from the Top 1 to Top 70 firms by sales of their domestic establishments. The sum become flat after a low number of firms.

**Figure C.2: Cummulative sum of squared Domar weights**



Source: Worldscope firm-level data.

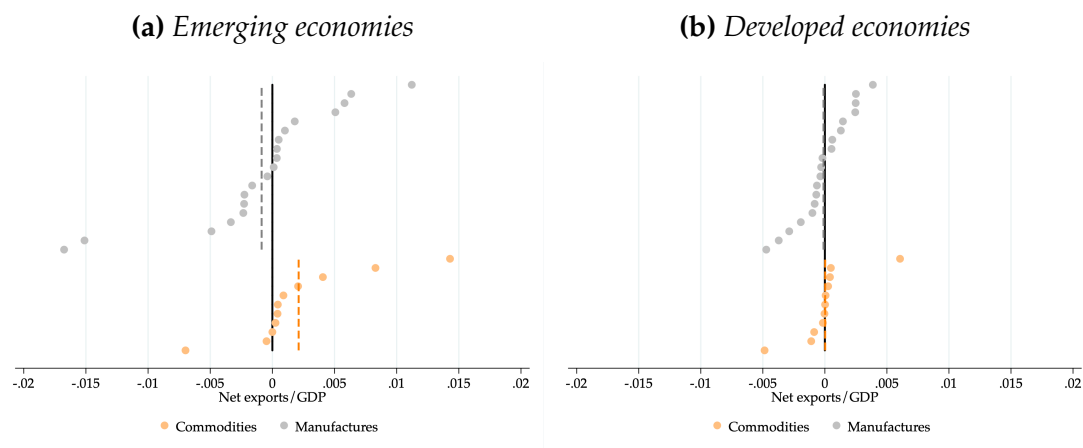
Note: the figure shows the cummulative sum of squared Domar weights from the Top 1 to Top 70 firms in terms of sales by domestic establishments.

## C.3 International Prices Data

We use international trade sector-country data from COMTRADE to compute the country-sector trade imbalances  $b_s$ . Trade imbalances  $b_s$  are defined as a sector  $s$  exports minus

imports as a share of GDP. We construct the series consistent with the OECD tradable sectors. We use data from U.S. sector-level prices from [Jorgenson \*et al.\* \(2005\)](#) to compute the volatility of tradable sectors prices. We deflate the time series by US CPI. The main advantage of using this dataset is that it is consistent with our sector-level TFP estimates.

**Figure C.3:** Sectoral trade imbalances (as % of GDP)



Source: authors' calculations based on COMTRADE.

Note: orange and gray dashed lines represent averages within commodities and manufactures' sectors respectively. Within each broad category, sectors are ordered by their net trade balance.