The Business Cycle Volatility Puzzle
Emerging vs Developed Economies *

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Abstract

We study the role of micro and macro shocks in explaining the business cycle volatility differences between emerging and developed economies. Using a small open economy setup with heterogeneous firms and production linkages, we decompose the volatility of output in four major components that depend on observable sufficient statistics: sector-level shocks that depend on the sectoral composition of the economy, firm-level shocks that depend on the firm size distribution, international prices shocks that depend on disaggregated trade imbalances, and a residual aggregate shock component. In our application, we use commodity prices, input-output and firm-level micro data for several emerging and developed economies to study the contribution of each component to the excessive output volatility in emerging economies.

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1 Introduction

Emerging economies are characterized by higher business cycle volatility than developed ones. However well documented this fact is, the reasons behind the excessive volatility in emerging economies are still under discussion. Different strands of literature have identified three potential sources of business cycle volatility for a given economy: economy-wide (macro) shocks, international prices shocks, and the micro-structure of the economy (both at the sectoral and firm level). In this paper, we develop a unified framework to quantify how much each of these three channels contributes to explain the differences in output volatility between emerging and developed economies.

Our approach, which integrates multiple channels into a unique framework, allows us to quantitatively assess the contributions of each channel in a consistent manner and examine their interactions. Moreover, by using the model-induced sufficient statistics –which have a direct correspondence with the data– we are able to include a broad set of countries in the analysis.

We build a multi-sector small open economy model with heterogenous firms and production linkages. In the economy, there is a set of goods that can be traded internationally (tradables), and a set of goods which are only consumed and produced domestically (nontradables). Since the economy is relatively small, the prices of tradable goods are exogenous. Within each sector, firms produce a homogeneous good with a decreasing returns to scale technology that uses labor and intermediate inputs. Thus, there is an endogenous distribution of firms in the economy and production across sectors is linked through the firms' use of intermediate inputs. Firms' productivity is exogenous and has three components: aggregate, sectoral and firm-specific. Last, there is a representative household who owns all the firms in the economy, supplies labor, and consumes tradable and nontradable goods.

We use the framework to decompose aggregate output volatility into four channels that depend on sufficient statistics, to a first order approximation. First, the macro channel depends on aggregate sales over GDP and aggregate TFP volatility. Second, the international prices channel depends on the interaction between sectoral trade imbalances and the volatility of international prices. Last, we divide the channel related to the micro-structure of the economy in two: a sectoral and a granular channel. The sectoral channel depends on the sector-level TFP volatilities and the distribution of sales shares (Domar weights) across sectors, and the granular channel depends on the idiosyncratic TFP volatility and how concentrated are firms' sales across large firms in the economy.

For analytical clarity, in our baseline exercise we decompose aggregate output volatility in the macro, international prices, and micro-structure channels assuming no correlations between them. In the full version of the model, we allow for correlations between sectoral TFP's, between international prices, and within- sector correlations between sectoral TFP and sectoral prices.

We quantify how much each channel contributes to differences in GDP volatility between emerging and developed economies. To do so, we compute the model-induced sufficient statistics combining macro, trade, input-output production, 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 sectoral and idiosyncratic TFP volatilities are the same across emerging and developing economies, so the sectoral and granular channels are only driven by differences in the distribution of sales shares across sectors and firms.

When we allow for correlations between channels, we find that the sectoral structure of the economy explains as much as 43% of the excessive volatility in emerging economies, the granular channel explains 5%, the international prices channel has a minimal contribution of 1%, and the macro channel (residual) explains the remaining 51%.

In light of the quantitative findings, we zoom in each channel and document new empirical facts driving their contribution. Regarding the sectoral channel, we document that sectoral sales shares in emerging economies are concentrated in highly volatile sectors (e.g., agriculture and manufacturing), whereas in developed economies they are concentrated in the least volatile sectors (e.g., services), leading to a high contribution of sectoral structure to excessive volatility in emerging economies.[1] We relate these findings to the process of structural transformation which refers to the reallocation of economic activity away from agriculture and manufacturing and towards services as countries develop.[2] We run a counterfactual analysis to estimate the contribution of each sector in explaining volatility differences between emerging and developed economies, and find that agriculture contributes 46%, manufacturing contributes 53%, and services sectors contribute with negative 46%, meaning that this last sector plays a crucial role in explaining output volatility in developed economies, but not so in emerging ones.

At a more granular level, we bring a new empirical fact regarding large firms in

[1]These findings are in line with Koren and Tenreyro (2007). However, they document this fact for employment distribution instead of sales distribution, which is the relevant moment according to our theory.

[2]See Herrendorf, Rogerson and Ákos Valentinyi (2014) for a review of the literature.

emerging and developed economies that drives the contribution of the granular channel. We document that sales within the largest firms are more concentrated in emerging economies which, through the lens of our model, suggests that firms' idiosyncratic shocks could influence aggregate output more in emerging economies than in developed.

Related to the international prices channel, we document wide heterogeneity in trade balances within the broad categories of commodities and manufactures sectors for both emerging and developed economies. As suggested by the model, the existence of net exporter or net importer sectors in both groups of countries is likely to dampen the contribution of this channel.[3]

Last, we perform two additional exercises that complement our main analysis. First, from a time-series perspective, we study the evolution of differences in business cycle volatility between emerging and developed economies in the last decades and the role of changes in the economic structure.[4] We document that since the late 1970s, in both group of countries, output has become less volatile, but the volatility has decline more rapidly in emerging economies. Using historical input-output tables, we quantify the contribution of the sectoral channel in explaining the relative decline in output volatility in emerging economies. We find that changes in the sectoral composition of the economy don't contribute to this decline, which suggests that other channels should explain the disproportional reduction of output volatility in emerging economies during this period.

The second additional exercise relates to the granular channel. Recall that there are potential intrinsic volatility differences at the firm level that we assume out in our main quantitative application. Due to the lack of panel micro-data for a broad set of countries, it is hard to estimate these firm-level volatilities precisely. In an effort to obtain a rough estimation, we consider a version of our model in which we assume that the unexplained portion of the differences in output volatility between emerging and developed economies comes from intrinsic differences in firm-level volatility, instead of from differences in the aggregate volatility component (i.e., from the *macro* channel). We estimate that firm's instrinsic volatility is 31% higher in emerging economies com-

[3]In line with Kohn, Leibovici and Tretvoll (2021), we document that the median emerging economy is a net exporter of commodities and net importer of manufactures, whereas the median developed economy is mainly trade balanced in both sectors. However, we observe heterogeneity in the trade imbalances within these two aggregate sectors when looking at more disaggregated sector-level data, closing the gap between the two group of countries and leading to a small contribution of this channel.

[4]Some papers have documented the shift of economic activity in emerging and developed economies over time, from the primary to the service sectors [see, for a recent reference, Huneeus and Rogerson (2020)].

pared to developed ones, which is in line with previous findings.

All in all, we bring together the pieces of the business cycle volatility puzzle, we quantify their contribution to explaining the excessive volatility in emerging economies, and we document the driving forces behind them.

Related Literature and Contributions. The observation that emerging economies have a higher business cycle volatility than developed economies [see, for example, Lucas (1988, p4) and Acemoglu and Zilibotti (1997) for early references] ignited a literature that studies what are the channels behind this (relatively) excessive volatility in emerging economies. First, a large body of work has 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 [Aguiar and Gopinath (2007)], procyclical fiscal and monetary policy [Vegh and Vuletin (2014)], and more institutional instability [Mobarak (2005)]. Second, it is well-known that the primary production sectors have a higher relevance in the economic activity and trade in emerging economies. Thus, this observation motivated other set of papers which argue that the higher exposure of emerging economies to international prices (typically, commodity prices) shocks can explain the excessive volatility in emerging economies [see, for example, Kose (2002) for an early reference and Kohn *et al.* (2021) for a recent reference]. Finally, a smaller set of papers have focused on the role of sectoral differences across emerging and developed economies [see, for example, Da-Rocha and Restuccia (2006) and Koren and Tenreyro (2007)[5]].[6]

We contribute to the extensive literature that studies the excessive volatility in emerging economies by developing a macroeconomic framework with production linkages, tradable and nontradable sectors and within sector firm heterogeneity where we can quantify, for a large set of countries, the role of the aggregate, international prices, sectoral and granular (i.e., firm size distribution differences) channels using a sufficient statistic approach. By combining the channels on a single and consistent setup, it allows for the study of potential interactions between them. In addition, to our knowledge, this is the first paper that studies the role of the firm size distribution in this context.[7]

[5]The difference with respect to their work is that we derive theory-induced statistics, whereas they make an empirical analysis.

[6]Although it doesn't focus on differences between emerging and developed economies, Carvalho and Gabaix (2013) studies the role of sectoral composition in changes in volaility across time for the US and other developed economies.

[7]Previous work by Gabaix (2011) and di Giovanni and Levchenko (2012) has focused either on developed economies or the difference between large and small countries, respectively.

Our paper is also complementary to the strand of literature that studies the aggregate implications of the micro-structure of the economy [see, for example, Hulten (1978) and Baqaee and Farhi (2019)]. Similar to Baqaee and Farhi (2021), we derive an open economy variation of Hulten's theorem, but we focus on the case of a small open economy with tradable (exogenous international prices) and nontradable sectors (local market clearing), and we allow for a within sector distribution of firms by assuming decreasing returns to scale.

Finally, we contribute on the empirical front by documenting new empirical facts regarding differences in the micro structure of emerging and developed economies. We show that, in emerging economies, the sectoral sales tend to be more concentrated in the most volatile sectors and the firms' sales of largest firms tend to be more concentrated.

Organization. The rest of the paper is organized as follows: Section 2 describes the theoretical model and main proposition, Section 3 shows the main quantitative application and document several novel facts, Section 4 includes additional exercises, and Section 5 concludes.

2 Theoretical Framework

We develop a multi-sector small open economy model with heterogeneous firms and production linkages. Extending the seminal result from Hulten (1978), we show that the volatility of GDP can be decomposed in four channels: macro, international prices, sectoral, and granular channels. The convenient feature about our main proposition is that each channel depends on sufficient statistics, then we are not required to calibrate and estimate the model. We use this decomposition, in Section 3, to study quantitatively the contribution of each channel to differences in business cycle volatility between emerging and developed economies.

Differently from the literature that studies production networks in open economies [see, for example, Baqaee and Farhi (2021)], we assume (i) firms produce with a decreasing returns to scale production technology which allows us to have an endogenous distribution of firms within each sector; and (ii) there are tradable and nontradable sectors in the economy which allows us to study the role of international prices.

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 sub-set of nontradable sectors $\mathcal{S}^{NT}$ which can only be sold domestically and a sub-set of tradable sectors $\mathcal{S}^T$ which can be sold domestically and internationally, then

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

where $S_{NT} + S_{NT} = N$ is the total number of sectors.

The economy is relatively small, so we assume that tradable prices, p_s with $s \in \mathcal{S}^T$, are taken as exogenous. Within each sector $s \in \mathcal{S}$ there is an arbitrary finite number of heterogeneous firms $i \in \mathcal{I}_s$. The set of all firms in the economy is

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

where $\sum_{s=1}^{N} I_s$ is the total number of firms in the economy. Firms in sector $s \in \mathcal{S}$ produce an homogenous good, combining labor and intermediate inputs, and sell it at price p_s taking it as given (i.e., act competitively). The goods produced by domestic firms are consumed by the household and used by the firms to produce. In the case of tradable goods, they can be exported (i.e., part of them are not consumed domestically), and household and firms can import them for their consumption. There are no trade costs, so it is not necessary to keep track of the consumption, input, or production origin. To produce, firms use also domestic labor which is provided inelastically by the household.

There are five exogenous forces that could generate output fluctuations in this economy: aggregate, sectoral and firm-level shocks to firms' production, tradable prices shocks, and aggregate trade balance shocks.

2.1.1 Firms

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

$$\pi_i = \max_{L_i, \mathbf{X}_i} p_s y_i - w L_i - \mathbf{p} \mathbf{X}_i^{'}, \tag{1}$$

where y_i is the output produced by firm i, L_i is 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 intermediate good. The production function of firm i in sector s is

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

where $\mathcal{A}_i = \exp(a + \tilde{a}_s + a_i)$ is an exogenous productivity shifter composed by 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, we assume that the function $F_s(.)$ exhibits decreasing returns to scale, so there can be firm heterogeneity within sector even if the good is homogeneous [see, for example, Hopenhayn (1992)].

2.1.2 Households

We consider a representative household who consumes tradable and nontradable goods, supplies one unit of labor inelastically to domestic firms, and owns all the firms in the economy. The household maximizes constant returns to scale utility $U(.)$ over consumption choices $\mathbf{C}$, i.e.,

$$\max_{\mathbf{C}} U(\mathbf{C})$$

subject to the budget constraint

$$\mathbf{p}\mathbf{C}' + B^* \leq w + \sum_{i \in \mathcal{I}} \pi_i, \tag{2}$$

where $\mathbf{C} = \begin{bmatrix} C_1 & \cdots & C_s & \cdots & C_N \end{bmatrix}$ with C_s being household's consumption of sectoral good s, $\mathbf{p}$ vector of consumption goods prices, and B^* are exogenous net transfers to the rest of the world [similar to Baqaee and Farhi (2021)]. Households earnings are the sum of labor income w and the sum of all the firms' profits $\sum_{i \in \mathcal{I}} \pi_i$. Since firms' produce with 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

Labor market clearing requires that total amount of labor demanded by each firm i within all the sectors $s \in \mathcal{S}$ equals total amount of labor supplied by the representative household, wich is normalized to 1:

$$\sum_{i \in \mathcal{I}} L_i = 1. \tag{3}$$

Market clearing for each nontradable sector $s \in \mathcal{S}^{NT}$ requires that goods produced by the set of firms $\mathcal{I}_s$ within sector s equals demand in sector s, which is composed by the amount of good s consumed by households and the amount of good s demanded as intermediate input from all firms in the economy. As depicted in Figure 1a,

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

The aggregate resource constraint condition for this small open economy states that aggregate consumption plus exogenous aggregate net exports equals aggregate production across all sectors $s \in \mathcal{S}$ net of the use of intermediate inputs demanded from and to all sectors:

$$\mathbf{p}\mathbf{C}^{'} + B^{*} = \sum_{s \in \mathcal{S}} p_s \sum_{i \in \mathcal{I}_s} \mathcal{A}_i F_s \left(L_i, \mathbf{X}_i \right) - \sum_{i \in \mathcal{I}} \mathbf{p}\mathbf{X}_i^{'}. \tag{5}$$

Combining equation 5 with the nontradable sector's market clearing conditions 4, we obtain the following aggregate resource constraint for the set of tradable sectors $\mathcal{S}^T$:

$$\sum_{s \in \mathcal{S}^T} p_s \left(\sum_{i \in \mathcal{I}_s} y_i - C_s - \sum_{i \in \mathcal{I}} X_{i,s} \right) = B^{*}, \tag{6}$$

which states 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. The graphical representation of the resource constraint of any given sector $s \in \mathcal{S}^T$ is depicted in Figure 1b.

Gross domestic product (GDP) in this economy is given by aggregate production net of the use of intermediate inputs. Combining equation 5 with the nontradable sector's market clearing conditions 4, we can express GDP as

$$GDP = \mathbf{p}\mathbf{C}^{'} + B^{*} = w + \sum_{i \in \mathcal{I}} \pi_i.$$

Furthermore, given the assumption that utility function exhibits constant returns to scale [8] and that the aggregate price index is the numeraire, we obtain that

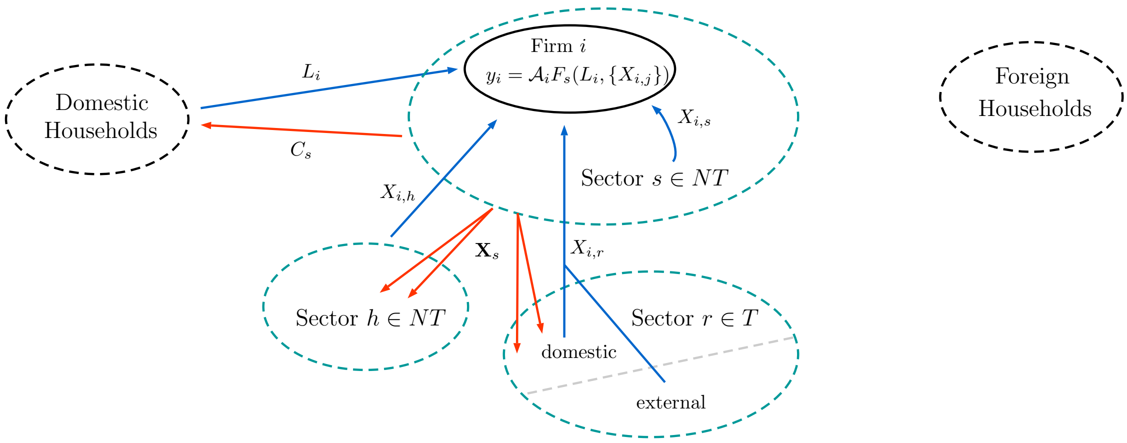
$$GDP = U\left(\mathbf{C}\right) + B^{*}, \tag{7}$$

which means that, different from a closed economy setup, in our small open economy GDP differs from welfare by the exogenous net exports.

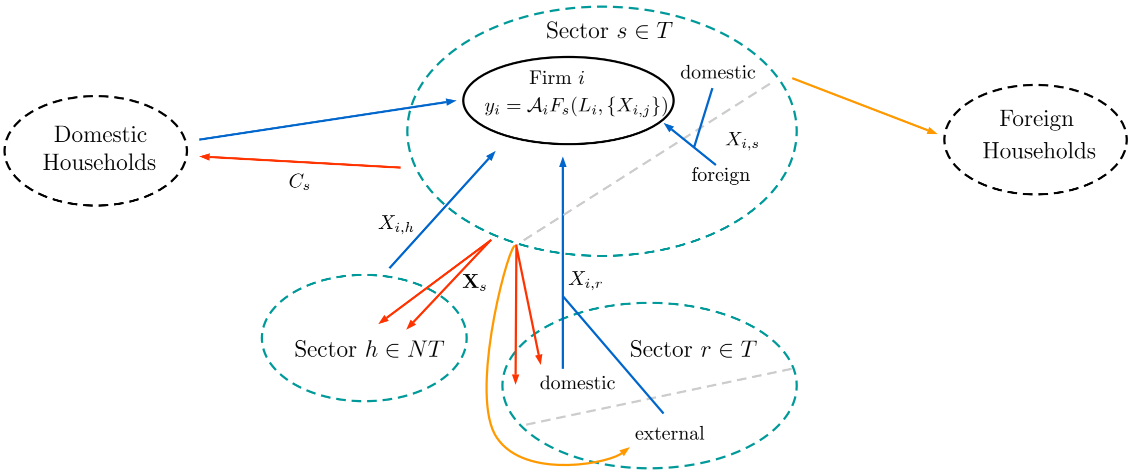
[8]Define the expenditure function of the household as $e(p, U) = \sum_s p_s C_s$. Since U is homogeneous of degree 1, we have $e(p, U) = Ue(p)$. Normalize the unit cost of consumption $e(p) = 1$ to obtain $\sum_i p_s C_s = U$, [Baqaee and Farhi (2021)].

Figure 1: The problem of the firm

(a) *Firm in nontradable sector* $s \in \mathcal{S}^{NT}$



(b) *Firm in tradable sector* $s \in \mathcal{S}^{T}$



Note: blue arrows represent inputs, red arrows represent output absorbed by the domestic market, and orange arrows represent output absorbed by the foreign market.

2.2 Competitive Equilibrium

In this section we define the competitive equilibrium for this economy.

Definition 1. *A competitive equilibrium is an allocation* $\left\{\{\mathbf{X}_i\}_{i\in\mathcal{I}}, \mathbf{C}, \{L_i\}_{i\in\mathcal{I}}\right\}$ *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 her utility,*
- *the nontradable goods and labor markets clear.*

The economy is efficient so the competitive equilibrium allocations coincide with the allocations of the planner's problem.[9]

2.3 Business Cycle Volatility Accounting

Before stating the main proposition of the paper, it is useful to define two key elements: the firm's Domar Weights and the sectoral trade imbalances.

Definition 2. *The Domar Weight of firm $i \in \mathcal{I}_s$ is defined as the sales share of firm i in GDP (Y) and denoted by λ_i, i.e.,*

$$\lambda_i \equiv \frac{p_s y_i}{Y}. \tag{8}$$

It then follows that the Sectoral Domar Weight for a sector s is defined as $\Lambda_s \equiv \sum_{i \in \mathcal{I}_s} \lambda_i$ and the Aggregate Domar Weight is defined as $\Lambda \equiv \sum_{i \in \mathcal{I}} \lambda_i$.

Definition 3. *Trade imbalance in sector $s \in \mathcal{S}_T$ is denoted by b_s and defined as the share in GDP (Y) of production in sector s net of consumption and intermediate inputs use, i.e.,*

$$b_s \equiv \frac{p_s \left(\sum_{i \in \mathcal{I}_s} y_i - C_s - \sum_{i \in \mathcal{I}} X_{i,s} \right)}{Y}. \tag{9}$$

Both definitions are related. If we replace in equation 9 the definition of the Domar weights, we have that the sectoral trade balance for a given sector s can be decomposed in the sales share of sector s net of the sum of the domestic households' consumption and domestic firms' expenditure of sector s good, i.e.,

$$b_s \equiv \Lambda_s - \frac{p_s C_s}{Y} - \frac{p_s \sum_{i \in \mathcal{I}} X_{i,s}}{Y}. \tag{10}$$

Assuming that the economy receives shocks to aggregate productivity, to its firms' idiosyncratic and sectoral productivity, to the external balance and to the international prices, using the Envelope Condition of the planner's problem for the economy described in Section 2.1, in Proposition 1 we show that GDP growth can be decomposed into four distinctive channels which depend on observable sufficient statistics.

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

$$d \log Y(B^*, \mathbf{p}^T, A, \tilde{A}_s, A_i) = \Lambda da + \sum_{s \in \mathcal{S}} \Lambda_s d\tilde{a}_s + \sum_{i \in \mathcal{I}} \lambda_i da_i + \sum_{s \in \mathcal{S}_T} b_s d \log p_s. \tag{11}$$

Assuming that the exogenous shocks are uncorrelated then it follows that the variance of GDP growth (in log differences) is

$$Var\left(d \log Y\right) = \underbrace{\Lambda^2 \sigma_A^2}_{macro} + \underbrace{\sum_{s \in \mathcal{S}} \Lambda_s^2 \sigma_{\tilde{A}_s}^2}_{sector} + \underbrace{\sum_{i \in \mathcal{I}} \lambda_i^2 \sigma_{A_i}^2}_{granular} + \underbrace{\sum_{s \in \mathcal{S}_T} b_s^2 \sigma_{p_s}^2}_{int.\ prices}, \tag{12}$$

where $\log A_i \equiv a_i$, $\log \tilde{A}_s \equiv \tilde{a}_s$, $\log A \equiv a$.

[9]This is relevant for the proof of the main proposition of the paper.

The first channel is the aggregate or *macro* channel, whose impact depends on the sum of the total sales shares (i.e., Domar weights), $\Lambda \equiv \sum_{i\in\mathcal{I}} \lambda_i$. The second and third terms are the channels of growth related to the micro-structure of the economy at the *sector* and *granular* level, respectively. The sectoral channel shows that the relevance of a productivity shock in sector s, $\tilde{A}_s$, depends on the sector's Domar weight, which is represented by the sum of Domar weights across firms within each sector, $\Lambda_s \equiv \sum_{i\in\mathcal{I}_s} \lambda_i$. Analogously, in the granular channel the relevance of an idiosyncratic shock to firm i depends on the firm's Domar weight, λ_i. The last term is the *international prices* channel, in which the relevance of a shock to the price of tradable good p_s for $s \in \mathcal{S}^T$ depends on its sectoral trade balance b_s.

In a closed economy, the celebrated Hulten (1978)'s Theorem states that the Domar weight of a firm/sector summarizes the importance of the firm/sector's TFP shock on aggregate output. In Proposition 1, we show that this result also holds in an open economy setup even when the tradable sector prices are exogenous (i.e., no market clearing in the tradable sectors). Intuitively, a positive TFP shock to a firm in the tradable sector increments how much they can produce and also relaxes the external resource constraint (equation 6). Relaxing the external resource constraint works analogously to a reduction in the intermediate inputs' price then the summary statistic is the same for a firm in the tradable and nontradable sector.

Moreover, Proposition 1 shows that the sectoral trade balances are the relevant statistic to measure the impact of shocks to international prices in aggregate volatility. Intuitively, an increment in p_s when $s \in \mathcal{S}^T$ works in the same way as a TFP shock, but makes it more expensive for domestic consumption for households and as an intermediate input for firms. This is reflected in equation (10), where we can write the trade balance as the sector-level domar weight net of domestic household's consumption and firms' intermediate input expenditures. Lastly, we find that the shocks to the external aggregate balance B^* don't affect aggregate output. Intuitively, the increase in output from an increase in B^* is fully compensated by a tightening of the aggregate resource constraint.[10]

2.3.1 Volatility Accounting

We can express equation 12 in terms of business cycle volatility differences between emerging (EM) and developed (DEV) economies as follows:

$$Var\left(\mathrm{d}\log Y_{\mathrm{EM}}\right) - Var\left(\mathrm{d}\log Y_{\mathrm{DEV}}\right) \;=\; \underbrace{\Lambda^2_{\mathrm{EM}}\sigma^2_{A,\mathrm{EM}} - \Lambda^2_{\mathrm{DEV}}\sigma^2_{A,\mathrm{DEV}}}_{\text{macro}}$$

[10]This result is analogous to the ones in Baqaee and Farhi (2021) and Burstein and Cravino (2015).

$$
+\underbrace{\sum_{s\in\mathcal{S}}\Lambda_{s,\text{EM}}^2\sigma_{\tilde{A}_s,\text{EM}}^2-\sum_{s\in\mathcal{S}}\Lambda_{s,\text{DEV}}^2\sigma_{\tilde{A}_s,\text{DEV}}^2}_{\text{sectoral}}+\underbrace{\sum_{i\in\mathcal{I}^{\text{EM}}}\lambda_{i,\text{EM}}^2\sigma_{A_i,\text{EM}}^2-\sum_{i\in\mathcal{I}^{\text{DEV}}}\lambda_{i,\text{DEV}}^2\sigma_{A_i,\text{DEV}}^2}_{\text{granular}}
$$

$$
+\underbrace{\sum_{s\in\mathcal{S}_T}\left(b_{s,\text{EM}}^2-b_{s,\text{DEV}}^2\right)\sigma_{p_s}^2}_{\text{international prices}}. \tag{13}
$$

Equation (13) shows analytically how each channel can contribute in explaining the volatility differences between emerging and developed economies.

The macro channel is affected by two forces. On the one hand, there could be differences in the total sum of Domar weights. On the other hand, there could be differences in the volatility of aggregate shocks between emerging and developed economies. The sectoral channel is affected by the differences in the distribution of sectoral Domar weights, and also by differences in sectoral idiosyncratic volatility between the two group of countries. Analogously, the granular channel is affected by differences in the distribution of firms' Domar weights, and also by differences in firms' idiosyncratic volatility between emerging and developed economies. The international prices channel is affected by the differences in sectoral (or good-level) trade imbalances, and we assume that both economies for the same tradable good s face the same volatility of its price σ_{p_s}.

Appendix A.2 shows analytically the volatility accounting terms under the assumptions used in our baseline quantitative application.

2.3.2 Volatility Accounting with Correlated Shocks

In Proposition 1, we assume all shocks are uncorrelated — across and within types of shocks — up to a first order. In Corollary 1, we extend our baseline proposition to allow for correlated shocks.

Corollary 1 (Proposition 1 with Correlated Shocks)**.** *When allowing for correlations across sectoral TFP shocks, across idiosyncratic TFP shocks and across international prices shocks, and between prices and sectoral TFP shocks, the variance of GDP growth can be decomposed in:*

$$
Var\left(d\log Y\right)=\underbrace{\Lambda^2\sigma_A^2}_{\textit{aggregate}}+\underbrace{\mathbf{\Lambda}'\Omega_{\tilde{A}}\mathbf{\Lambda}}_{\textit{sectoral}}+\underbrace{\lambda'\Omega_A\lambda}_{\textit{granular}}+\underbrace{\mathbf{b}'\Omega_{p^T}\mathbf{b}}_{\textit{international prices}}+\underbrace{\mathbf{b}'\Omega_{(p^T,\tilde{A}_T)}\mathbf{\Lambda}_T}_{\textit{international prices and sectors}}, \tag{14}
$$

where $\mathbf{\Lambda}$ is the vector of sector-level Domar weights, $\Omega_{\tilde{A}}$ is the covariance matrix of sectoral TFP growth (in log changes), λ is the vector of firm-level Domar weights, Ω_A is the covariance *matrix of idiosyncratic shocks,* $\mathbf{b}$ *is the vector of trade balances,* Ω_{p^T} *is the covariance matrix of international goods price changes,* $\Omega_{(p^T, \tilde{A}_T)}$ *is the covariance matrix between international prices changes and sectoral TFP growth in the tradable sectors, and* $\mathbf{\Lambda}_T$ *is the vector of sector-level Domar weights for the tradable sectors.*

In the setup with correlations, we have an additional channel that interacts international prices shocks to sectoral TFP shocks in the tradable sectors, which depends on the vector of trade balances, sectoral Domar weights and covariance matrix of price changes and TFP growth in the tradable sectors.

Using equation (14) we can perform the same volatility accounting exercise as in equation (13). The analytical expression that decomposes the volatility differences is significantly less tractable than under the particular case of uncorrelated shocks. In the quantitative application, we study the decomposition with and without correlations using macro, trade, input-output and firm-level data for several emerging and developed economies.

3 Quantitative Exercise and Empirical Patterns

In this section, we first describe the sample and data sources. Next, using our theoretical framework, we quantify the contribution of the macro, sectoral, granular and international prices channels in explaining the excessive business cycle volatility in emerging economies. Finally, to shed light on the driving forces behind each channel, we document several new empirical facts regarding emerging and developed economies.

3.1 Sample and Data Sources

In this subsection, we describe the sample and data sources used for our quantitative application.

Sample. We start by empirically defining emerging and developed economies and tradable and nontradable sectors. For the definition of the 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 countries with average PPP adjusted GDP per capita lower than $25,000.[11] 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

[11] Following Kohn *et al.* (2021) we exclude from the sample large open economies such as China and US and ex-communist countries.

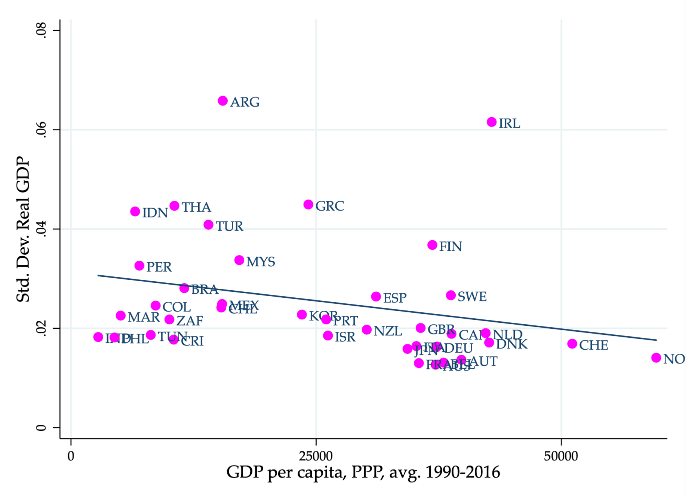
belonging to services. After combining all the data sources for each of the four channels (described below) we end up with a sample of 10 emerging and 19 developed economies.[12]

Data Sources. Next, we describe the data sources used to estimate the contribution of each channel to busines cycle volatility.

To estimate each countries' business cycle volatility we use GDP data from the World Development Indicators (WDI) for the period 1970-2016. The business cycle volatility indicator is computed as standard in the literature, by calculating the variance of the cyclical component of GDP.

In Figure 2 we document the negative relation between GDP volatility and GDP levels, a well-known empirical pattern that lies on the core of all the studies that try to explain aggregate volatility in emerging economies [see Acemoglu and Zilibotti (1997) for an early reference]. In our sample, the median emerging economy has 2.2 times the business cycle volatility of the median developed economy.

Figure 2: Business cycle volatility across the development spectrum



Source: authors' calculations based on World Development Indicators (WDI).

We combine data from several data sources to compute the sufficient statistics to quantify each channel's contribution (see Table 1 for a summary). For the international prices channel, we use COMTRADE sectoral trade data to compute the trade balances B_s and Jorgenson *et al.* (2005) dataset to compute the tradable prices' covariance matrix Ω_{p^T}. For the sectoral channel, we use the OECD input-output tables to

[12] See list of countries and sectors in the sample in Appendix C.2.

Table 1: Data Sources by Channel

	International Prices		Sectoral	Macro	Granular
Sufficient statistic	$\mathbf{b}_c$		$\mathbf{\Lambda}_c$	Λ_c	λ_c
Data sources	COMTRADE		OECD		Worldscope
Volatility	Ω_{p^T}	$\text{diag}\left(\Omega_{(p^T,\tilde{A}_T)}\right)$	$\Omega_{\tilde{A}}$	$\sigma^2_{\tilde{A}_c}$	$\sigma^2_{\tilde{A}_i}$
Data sources	Jorgenson, Ho and Stiroh (2005)			Residual	Gabaix (2011)

compute the sectoral Domar weights vector $\mathbf{\Lambda}_c$ for 36 (tradable and nontradable) sectors for each country. To compute the sectoral TFP covariance matrix $\Omega_{\tilde{A}}$ we use updated sector-level TFP estimates from Jorgenson *et al.* (2005) net of the commonly correlated component across sectors.[13] For the macro channel, we use the sectoral Domar weights from the OECD input-output tables to estimate the aggregate Domar weight Λ_c for the macro channel. For the channel of international prices and sectoral shocks, using the sectoral TFP estimates and international price series for the tradable sectors we estimate the diagonal of their covarinace matrix $\text{diag}\left(\Omega_{(p^T,\tilde{A}_T)}\right)$.[14] Lastly, for the granular channel, we use data from Worldscope, which covers more than 90% of publicly held firms market cap internationally, to compute the Domar weight of the largest 70 firms λ_c for each country.[15] The great advantage of the Worldscope dataset is that it allows us to distinguish between sales done by domestic and international subsidiaries, so we can compute the economically relevant firm-level Domar weights (i.e., using only sales by domestic subsidiaries). Finally, we use the baseline estimates from Gabaix (2011) to compute the firm-level TFP volatility $\sigma^2_{\tilde{A}_i}$, which we assume common across firms in both emerging and developed economies.

To do the exercise without correlations we use the diagonal elements of the sectoral TFP covariance matrix and assume the covariance matrix is $\Omega_{(p^T,\tilde{A}_T)} = \mathbf{0}_{S^T \times S^T}$.

[13] We assume that volatility of TFP is the same for same sectors across countries, and equal to the one in US. This highlights the role of sectoral composition and allows us to use the best estimates possible for long-run TFP sectoral volatility. This is discussed later in the results and in appendix A.

[14] We take the diagonal to restrict covariances to within sector price and TFP co-movements.

[15] As studied by Gabaix (2011), if there is a fat-tailed distribution of firms' sale shares in the economy, when it comes to the granular channel, what matters for the impact of firms' idiosyncratic shocks on aggregate volatility is how concentrated are sales among the largest firms in the economy.

3.2 Quantitative Exercise

Now, we use our accounting framework to quantify the contribution of each channel to the excessive volatility in emerging economies. We consider two scenarios: the *benchmark* case where shocks are uncorrelated (equation 13), and the *correlated shocks* case in which we allow for correlations between sectoral TFP's, correlations between international prices, and correlations between sectoral TFP and prices (decomposition based on equation 14). In both scenarios, we isolate the contribution of the micro-structure of the economy by making two additional assumptions: (i) sector-level covariance matrix is is the same across countries (but can differ across sectors); and (ii) firm-level volatility $\sigma_{A_i}\ \forall i \in \mathcal{I}^c$ is the same across firms and across countries. Notice that these assumptions imply that the contribution of the sectoral and granular channels are explained *only* by differences in the micro-structure of the economy, instead of intrinsic differences in sector- and firm-level volatility across countries.[16] Further details of the analytical decomposition are included in Appendix A.2.

Table 2: Volatility Accounting: Emerging vs Developed Economies

Channel		Contribution	
		benchmark	correlated shocks
Macro		12%	51%
International Prices		0%	1%
Micro	Sectoral	83%	43%
	Granular	5%	5%
Int. Prices and Sectoral interaction		-	0.3%

Notes: the table shows the contribution of each channel in explaining the difference between emerging and developed economies volatility for our baseline exercise (with and without shocks correlations). Details in the text.

In Table 2 we show the quantitative contribution of each channel under the *benchmark* and *correlated shocks* scenarios. We find that the micro structure of the economy plays a substantial role in explaining the excesive volatility in emerging economies, contributing as much as 88% (83% sectoral and 5% granular) when shocks are uncorrelated and 48% (43% sectoral and 5% granular) when we allow for correlations. In both scenarios, the international prices channel plays almost no role. The macro channel – which is

[16]We don't rule out that differences in intrinsic volatility may exist and be relevant. See next section's discussion.

computed as a residual – explains 12% and 51% of the differences respectively.

3.3 New Empirical Patterns

In this section, we document four new empirical patterns that lie behind the contribution of the sectoral, granular, and international prices channels.

3.3.1 Sectoral Channel

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

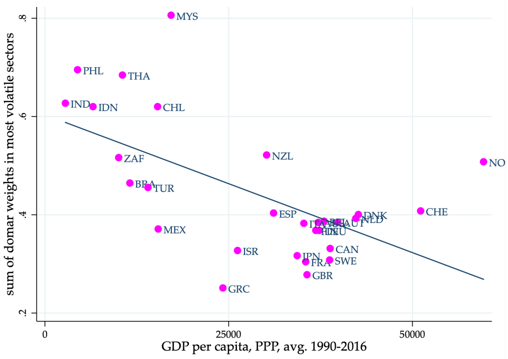
This empirical pattern is represented in Figure 3. In the top panel 3a, we show the negative correlation between GDP per capita levels and the sum of sectoral Domar weights of the sectors that belong to the highest quartile of sectoral volatility. In panel 3b, we show the distribution for emerging and developed economies. The sum of Domar weights across the most volatile sectors for the median emerging economy is 0.62 compared to 0.38 in developed economies.

In the bottom panel of Figure 3 we replicate the analysis in the top panel, but this time we concentrate on the least volatile sectors. In contrast with the case of the most volatile sectors, in panel 3c we observe a positive correlation between income per capita levels and the sum of sectoral Domar weights for those sectors that belong to the lowest quartile of sectoral volatility. From the distribution across emerging and developed economies that we show in 3d, we obtain that 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.

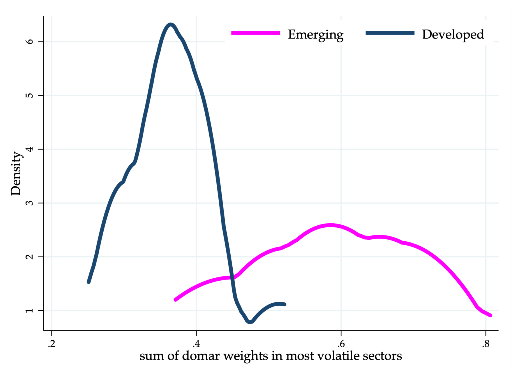
In Figure 3e we summarize this new empirical fact for emerging and developed economies. Notice that it points directly to the forces behind the sectoral channel that we derive from our accounting framework. Translated in terms of equation (13), emerging economies are characterized by higher $\sum_{i \in \mathcal{I}_s} \lambda_i$ in sectors with higher $\sigma^2_{\tilde{A}_s}$, whereas developed economies are characterized by higher $\sum_{i \in \mathcal{I}_s} \lambda_i$ in sectors with lower $\sigma^2_{\tilde{A}_s}$, leading to a high contribution of the sectoral channel on aggregate volatility differences.

Figure 3: Sectoral compositional differences across the development spectrum

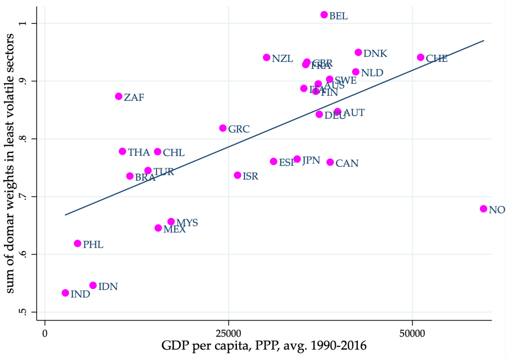
(a) *GDP vs sales shares in most volatile sectors*



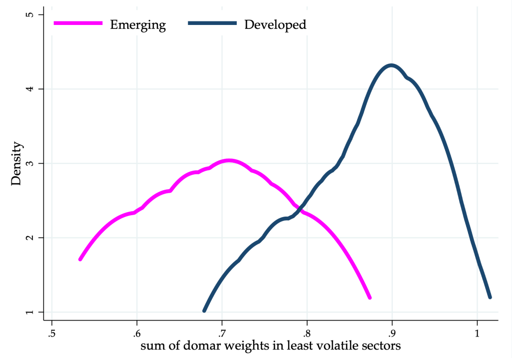
(b) *Density of sales shares in most volatile sectors*



(c) *GDP vs sales shares in least volatile sectors*



(d) *Density of sales shares in least volatile sectors*



(e) *Sector-level Domar weights*

	Emerging	Developed
Sum of Domar weigths of most volatile sectors	0.62 (0.46,0.68)	0.38 (0.32,0.40)
Sum of Domar weigths of least volatile sectors	0.70 (0.62,0.78)	0.89 (0.77,0.93)

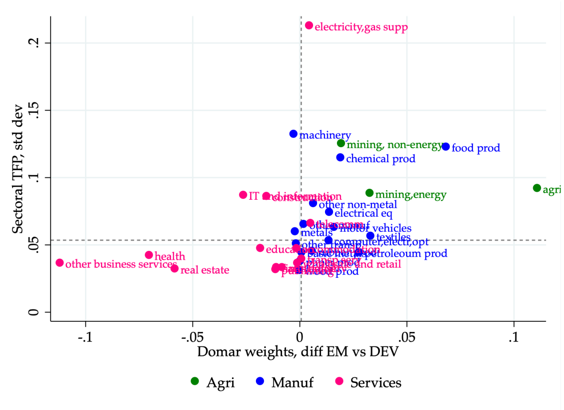
Source: authors' calculations based on World Development Indicators (WDI) and Jorgenson *et al.* (2005) dataset.
Note: in panels (a) and (b) most volatilie sectors refer to the sectors belonging to the highest quartile in volatility; in panels (c) and (d) least volatile sectors refer to the sectors belonging to the lowest quartile in volatility; in panel (d) we report in parentheses the values corresponding to the 25th and 75th pct, and the most and least volatile sectors refer to the sectors belonging to the highest and lowest quartile of volatility.

We analyze which specific sectors are driving such an important contribution of this channel. In Figure 4a we plot, for each sector, its TFP volatility (in standard deviations) against the differences in its sales shares between emerging and developed economies. We find that agriculture and food production (i.e., primary sectors) are among the most volatile sectors, and also the ones where sales shares are largest in emerging economies relative to developed ones. On the other hand, health, business and real estate sectors are the least volatile and the ones where sales share are largest in developed economies relative to emerging ones.

These sectoral composition patterns can be mapped to the process of structural transformation –widely studied in the development literature– which states that agriculture has relatively more importance in the least-developed economies, services sectors have relatively more importance in the most-developed economies, and the relationship between development and manufacturing follows a hump shape. For a more direct link, we aggregate sectors in agriculture, manufacturing and services and compute their sales share in emerging and developed economies, and their sectoral TFP volatility. As shown in the first three columns of Figure 4b, emerging economies tend to have relatively more sales share in agriculture and manufacturing, which are the most volatile sectors. In the case of services, the balance leans towards developed economies, which tend to concentrate relatively more sales in this low volatile aggregate sector.

Figure 4: Business cycle volatility and structural transformation

(a) *Sectoral volatility and differences in sales shares*



(b) *Sectoral channel decomposition*

	Domar W EM	Domar W DEV	Volatility (std)	Contribution to differences
Agriculture	0.21	0.05	0.10	46%
Manufacturing	0.62	0.42	0.08	53%
Services	1.00	1.32	0.06	-46%
Total				57%

Source: authors' calculations based on World Development Indicators (WDI) and Jorgenson *et al.* (2005) dataset.
Note: in panel (b), the first column shows the sectoral Domar weights; the second column shows the sectoral TFP volatility; and the third column shows the contribution of the sectoral channel (net of cross-sector correlations) in the counterfactual scenario in which the sale shares for all sectors but the one under analysis are the same in emerging and developed economies.

We then estimate the relative importance of each aggregate sector in explaining the excessive volatility in emerging economies. To do so, we run the following counterfactual exercise: for each sector (i.e., agriculture, manufacturing and services) we estimate what would the sectoral channel contribute to explain differeces in output volatility if the only sectoral composition differences came from that sector (i.e., if the sale shares for all sectors but the one under analysis were the same in emerging and developed economies). The results are shown in the fourth column of Figure 4b. If the only sectoral differences came from agriculture, then the sectoral channel would contribute 46% in explaining volatility differences. If, instead, the only sectoral differences came from manufacturing, the sectoral channel would explain 53% of the excessive volatility in emerging economies, meaning that the largest differences between emerging and developed come from this aggregate sector. Last, if the only sectoral differences came from services, then the sectoral channel would contribute with a negative 46%, meaning that this sector plays a crucial role in exlpaining output volatility in developed economies, but not so in emerging ones.

In turn, Figure 4 can be interpreted as suggestive evidence that the process of structural transformation has implications on business cycle volatility differences between emerging and developed economies.

3.3.2 Granular Channel

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

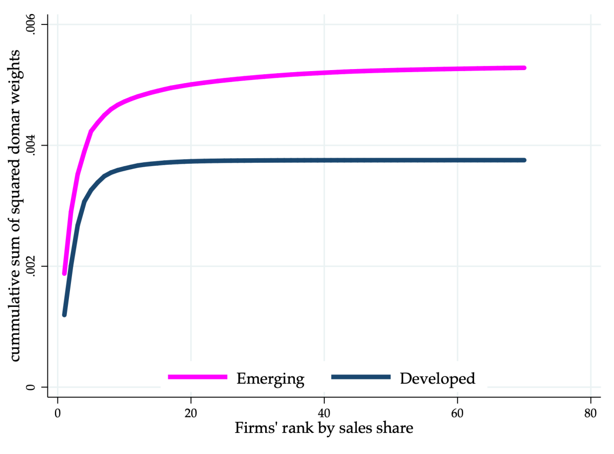
Using firm-level data from Worldscope, we analyze how concentrated are the sales shares across the largest firms in the economy [see, for reference, Gabaix (2011)].

In Figure 5, we show the cummulative sum of squared Domar weights for the Top 1st to Top 70th firms in emerging and developed economies.[17] Two aspects are worth noticing. First, the sum becomes flat when roughly more than 15 firms are included, which implies that idiosyncratic shocks to firms at the bottom of the distribution are negligible in the aggregate, and therefore have no implications for differences between emerging and developed economies. Second, sales within the largest firms are more concentrated in emerging economies, as documented in both panels of Figure 5. 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 emerging economies aggregate volatility than on developed.

[17] As mentioned before, for multinational firms (i.e., with establishments in many countries) we use the sales by domestic establishments to compute the economically relevant firm-level Domar weights.

Figure 5: Firm distribution differences across the development spectrum

(a) *Cummulative sum of squared Domar weights*



(b) *Firm-level Domar weights*

	Emerging	Developed
Sum of Domar weigths of top 70 largest firms	0.48 (0.24,0.55)	0.36 (0.29,0.49)

Source: authors' calculations based on Worldscope firm level data.
Note: in panels (a) we show the cummulative sum of squared Domar weights from the Top 1 to Top 70 firms in terms of sales ;in panel (b) we report in parentheses the values corresponding to the 25th and 75th pct, and Top 70 largest firms are defined in terms of sales by domestic establishments.

3.3.3 International Prices Channel

Pattern 3. *There is wide heterogeneity in trade balances within the broad categories of commodities and manufactures sectors for both emerging and developed economies.*

We study the trade balance patterns across 20 tradable sectors [18] for both emerging and developed economies in Figures 6a and 6b respectively. We also aggregate the 20 sectors into the commodities and manufactures categories to replicate the empirical fact studied by Kohn *et al.* (2021), in which emerging economies are net exporters of commodities and net importers of manufactures, whereas developed economies are mostly trade balanced in both. Our more granular approach with 20 sectors uncovers that there is wide heterogeneity in trade balances within the broad categories of commodities and manufactures in both groups of countries.

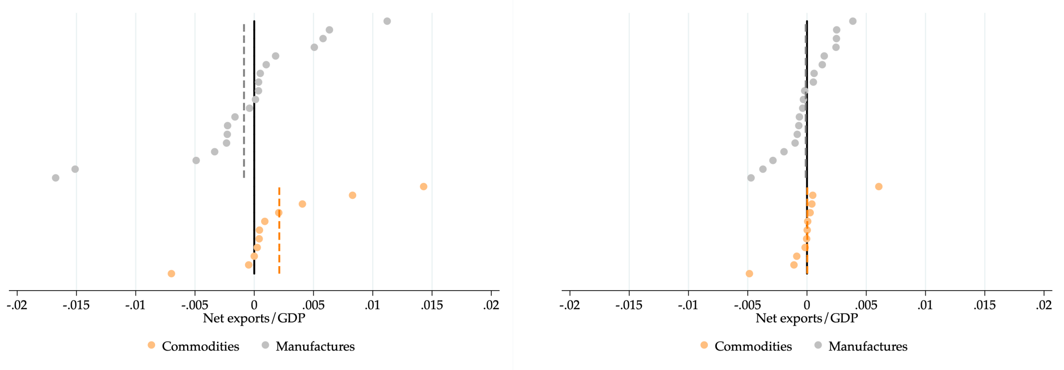
Recall from equation (13) that the two forces affecting the international prices channels were sectoral trade imbalances (the existence of net exporter or net importer sectors) together with the volatility in international prices, with the latter being common

[18] See list of sectors in the sample in Appendix C.2.

across countries. Therefore, the fact that both emerging and developed economies face trade imbalances for many of the 20 sectors is likely to dampen the contribution of the international prices channel relative to only considering commodity and manufacturing sectors, as in Kohn *et al.* (2021).

Figure 6: Sectoral trade imbalances (as % of GDP)

(a) *Emerging economies* **(b)** *Developed economies*



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.

4 Additional Exercises

In this section, we perform two additional exercises which are complementary to the baseline quantification exercises. First, we document the evolution of changes in the patterns of output volatility between emerging and developed economies and we quantify the contribution of changes in the economic structure over time. Second, we consider an alternative version of the model where we assume the residual component is fully explained by idiosyncratic firm-level volatility differences across emerging and developed economies, which allows us to indirectly infer them.

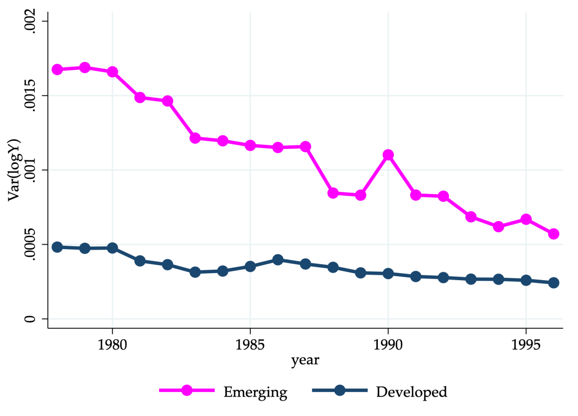
4.1 Time-Series Analysis

In our main analysis, we find that differences in the economic structure of developed and emerging economies explain a significant fraction of their volatility differences. In this section, we study how these volatility differences evolved over time and what role did the economic structure played.

First, in Figure 7a, we show the evolution of output volatility between 1978 and 1995. During this period, both emerging and developed economies reduced significantly their output volatility. Moreover, we observe a stronger decline of output volatility in emerging than developed economies.[19]

Figure 7: Aggregate volatility and structural transformation

(a) *Output volatility*



(b) *Sectoral Domar weights*

	Emerging			Developed		
	1978	1995	Δ	1978	1995	Δ
Agriculture	0.21	0.12	-0.09	0.13	0.07	-0.06
Manufacturing	0.70	0.65	-0.05	0.73	0.55	-0.18
Services	0.87	1.12	0.25	1.10	1.26	0.16

Source: authors' calculations based on World Development Indicators (WDI) and World Input-Output Database (WIOD) data. Notes: in panel (a), we show the evolution of the GDP volatility in Emerging and Developed economies. We compute the volatility of output $Var_t(\log Y_c)$ using a 15-year window with t being the median year in the window. The classification of countries is the same as in the baseline exercises, but the set of countries used is limited to those with WIOD data. In panel (b), we show the Domar weights for the agriculture, manufacturing and services sectors for 1978 and 1995 and their change in this period by country groups. The Domar weights $\Lambda_{sc,t}$ are computed using a 11-year window, where t is the median date of the window. Further details of the data and sample are available in the text and the Appendix B.1.

Next, using historical input-output data from the World Input-Output Database (WIOD) we study, for the same period, the changes in the economies' sectoral composition. Figure 7b shows that in both emerging and developed economies the Domar weights of the service sectors increments significantly, while there is a decrease in the weights of the manufacturing and agricultural sectors. Moreover, the reduction in the Domar weight of the manufacturing sectors is more than three times larger in developed

[19]In Appendix B.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.

economies, whereas the reduction in the Domar weight of the agricultural sector is slightly larger in emerging economies. These patterns are consistent with previous evidence on the rise of the service economy and the deindustrialization of developed economies.

Next, using our theoretical framework we study the role of changes in the sectoral structure of developed and emerging economies in the *relative* decline of output volatility in emerging economies.[20] To compute the time series of the sectoral channel we vary the Domar weights across time $\Lambda_{sc,t}$ and use the covariance matrix of the sectoral TFP shocks $\Omega_{\tilde{A}}$ which we assume fixed over time. We find that the sectoral channel can't explain the relative decline in output volatility in emerging economies [see figure B.1a in Appendix B.1]. This suggests that other drivers should explain the relative decline (e.g., improvements in macroeconomic policy management in emerging markets). As a counterpart, the contribution of the sectoral channel in explaining the differences between emerging and developed economies becomes increasingly more important over time [see figure B.1b].

4.2 Firm Level Intrinsic Volatility Differences

There are potential intrinsic volatility differences at the firm level that we are muting in the baseline quantitive application. Since we cannot estimate firm-level volatility differences directly (this would require firm-level panel data for a large set of emerging and developed economies) we use the theoretical model to infer them indirectly. To do this, we assume that there are no aggregate TFP volatility differences (i.e., $\sigma_{A,\text{EM}} = \sigma_{A,\text{DEV}}$) and that the residual portion of the excessive volatility comes only from *intrinsic* differences in firm-level volatility (i.e., $\sigma_{A_{i,\text{EM}}} \neq \sigma_{A_{i,\text{DEV}}}$). We show in Appendix B.2 the analytical counterpart of this version.

Through the lens of the model, in the scenario where we allow for correlations between shocks, we quantitatively estimate that the idiosyncratic volatility of firms in emerging economies is 31% higher compared to developed ones, which is comparable to previous findings [see, for example, Kochen (2023) for a set of developed and emerging European economies].

[20]The surge in the relevance of the service sector could be a relevant driver of the observed sharp decline in output volatility in both types of economies [as observed by Carvalho and Gabaix (2013) for U.S. and other developed economies].

5 Conclusion

In this paper, we study how business cycle volatility differences between emerging and developed economies can be explained by four channels: macro shocks, international prices shocks, and the micro-structure of the economy at the sector and firm-level. We build a multi-sector small open economy model with heterogenous firms and production linkages. The model allows for a consistent and unified framework to decompose aggregate output volatility in the four channels that depend only in terms of sufficient statistics (i.e., no need to calibrate parameters and estimate full model), and also allows for interactions across channels.

In the quantitative application we combine macro, trade, input-outputs and firm level data for 10 emerging and 19 developed economies to compute the contribution of each channel. We find that differences in the sectoral composition of the economies play a significant role, and explain as much as 43% of the differences in output volatility. Differences in the distribution of firms contribute by 5% and the international prices channel plays almost no role, thus the remaining 51% is explained by aggregate shocks.

To shed light on the drivers behind each channel, we document that differences in the micro structure are driven by the fact that in emerging economies sectoral sales tend to be more concentrated in highly volatile sectors and firms' sales tend to be more concentrated towards the largest firms. We also provide suggestive evidence that the process of structural transformation –in which as countries develop they reallocate resources away from agriculture and manufacturing and towards services sectors– has implications for business cycle volatility differences between emering and developed economies. From a time-series perspective, we document that business cycle volatility has decline in both emerging and developed economies, but it has decline relatively more in emerging ones. Through the lens of the model, we estimate that sectoral compositional differences can't explain this trend, suggesting that other drivers should be behind the relative decline in output volatility in emerging economies (e.g., improvements in macroeconomic policy management in emerging markets).

The paper remains silent on why the micro-structure of the economy differs between emerging and developed economies. Whether differences are driven by heterogeneity in natural endowments, skills distribution, market structure or inefficiencies, it would have different normative implications. We left the understanding of the sources of the heterogeneity and its normative implications for future research.

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Appendices

A Theory Appendix

A.1 Proof of Proposition 1

Proof. The economy is efficient then to show the SOC Hulten Theorem setup the planner's problem. The planner maximizes household consumption subject to the market clearing for every nontradable good, labor market clearing and the aggregate resource constraint. Differently from Baqaee and Farhi (2021) since X^* is exogenous for our setup the planner's problem is equivalent to a problem where total GDP is maximized.

Planner's problem

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

where μ_s is the lagrange multiplier on the market clearing condition of nontradable sector $s \in \mathcal{S}^T$, λ is the multiplier on the labor supply constraint, and μ^T the mutiplier on the tradable sectors aggregate resource constraint. Notice that in equilibrium total output depends on the productivity shifter $\mathcal{A}_i = A\tilde{A}_s A_i$ then $\tilde{\mathcal{Y}}(\mathcal{A}_i, B^*, \mathbf{p}^T) = \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)$, net external balance B^* and the tradable sectors prices $\mathbf{p}^T$.

Optimal conditions

First the envelope conditions for $A, \tilde{A}_s, A_{is}, B^*$and p_s for $s \in \mathcal{S}^T$:

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

$$\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)}{\partial B^*} = 1 - \mu^T$$

The FOC with respect to consumption are

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

From the descentralized problem of the household the optimal conditions are

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

which implies that $\mu^T = 1$ and $\mu_s = p_s$. Then replacing in the envelope conditions of the planner's problem:

$$\begin{aligned}
\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)}{\partial A} &= \sum_{s\in\mathcal{S}} p_s \sum_{i\in\mathcal{I}_s} \tilde{A}_s A_i F_s\left(L_i, \{X_{i,j}\}_{j=1}^{S}\right) \\
\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)}{\partial \tilde{A}_s} &= p_s \sum_{i\in\mathcal{I}_s} A A_i F_s\left(L_i, \{X_{i,j}\}_{j=1}^{S}\right) \\
\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)}{\partial A_{is}} &= p_s A \tilde{A}_s F_s\left(L_i, \{X_{i,j}\}_{j=1}^{S}\right) \\
\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)}{\partial p_s} &= A \tilde{A}_s A_i F_s\left(L_i, \{X_{i,j}\}_{j=1}^{S}\right) - C_s - \sum_{j\in\mathcal{S}} \sum_{i\in\mathcal{I}_j} X_{i,s} \\
\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)}{\partial B^*} &= 0
\end{aligned}$$

Rearranging terms and defining the Domar weight of firm $i \in \mathcal{I}_s$ as $\lambda_i \equiv \frac{p_s A \tilde{A}_s A_i F_s\left(L_i, \{X_{i,j}\}_{j=1}^{S}\right)}{\mathcal{Y}}$ then we have:

$$\begin{aligned}
\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)/\mathcal{Y}}{\partial A/A} &= \frac{\sum_{s\in\mathcal{S}} p_s \sum_{i\in\mathcal{I}_s} A\tilde{A}_s A_i F_s\left(L_i, \{X_{i,j}\}_{j=1}^{S}\right)}{\mathcal{Y}} = \sum_{s\in\mathcal{S}} \sum_{i\in\mathcal{I}_s} \lambda_i \\
\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)/\mathcal{Y}}{\partial \tilde{A}_s/\tilde{A}_s} &= \frac{p_s \sum_{i\in\mathcal{I}_s} A\tilde{A}_s A_i F_s\left(L_i, \{X_{i,j}\}_{j=1}^{S}\right)}{\mathcal{Y}} = \sum_{i\in\mathcal{I}_s} \lambda_i \\
\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)/\mathcal{Y}}{\partial A_i/A_i} &= \frac{p_s A\tilde{A}_s A_i F_s\left(L_i, \{X_{i,j}\}_{j=1}^{S}\right)}{\mathcal{Y}} = \lambda_i \\
\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)/\mathcal{Y}}{\partial p_s/p_s} &= \frac{p_s\left(A\tilde{A}_s A_i F_s\left(L_i, \{X_{i,j}\}_{j=1}^{S}\right) - C_s - \sum_{j\in\mathcal{S}} \sum_{i\in\mathcal{I}_j} X_{i,s}\right)}{\mathcal{Y}} \equiv b_s \\
\frac{\partial \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)}{\partial B^*} &= 0
\end{aligned}$$

The first order response of output to changes in $A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T$ is

$$\partial \log \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T) = \sum_{s\in\mathcal{S}} \sum_{i\in\mathcal{I}_s} \lambda_i \partial a + \sum_{s\in\mathcal{S}} \sum_{i\in\mathcal{I}_s} \lambda_i \partial \tilde{a}_s + \sum_{s\in\mathcal{S}} \sum_{i\in\mathcal{I}_s} \lambda_i \partial a_i + \sum_{s\in\mathcal{S}} b_s \partial \log p_s. \quad (15)$$

Assuming that all exogenous shocks are uncorrelated then it follows that the variance of GDP growth is

$$\text{Var}\left(\partial \log \mathcal{Y}(A, \tilde{A}_s, A_i, B^*, \mathbf{p}^T)\right) = \underbrace{\left(\sum_{s\in\mathcal{S}}\sum_{i\in\mathcal{I}_s}\lambda_i\right)^2 \sigma_A^2}_{\text{macro}} + \underbrace{\sum_{s\in\mathcal{S}}\left(\sum_{i\in\mathcal{I}_s}\lambda_i\right)^2 \sigma_{\tilde{A}_s}^2}_{\text{sector}} + \underbrace{\sum_{s\in\mathcal{S}}\sum_{i\in\mathcal{I}_s}\lambda_i^2\sigma_{A_i}^2}_{\text{granular}} + \underbrace{\sum_{s\in\mathcal{S}} b_s^2\sigma_{p_s}^2}_{\text{commodities}}. \tag{16}$$

$\square$

A.2 Quantitative Application of Equation (13)

In this section, we show analytically the assumptions in the quantitative exercise in Section 5. First, we can decompose the sectoral channel as follows:

$$\underbrace{\left(\sum_{s\in\mathcal{S}}\Lambda_{s,\text{EM}}^2 - \sum_{s\in\mathcal{S}}\Lambda_{s,\text{DEV}}^2\right)\sigma_{\tilde{A}_s,\text{DEV}}^2}_{\text{Domar weight sectoral distribution}} + \underbrace{\sum_{s\in\mathcal{S}}\Lambda_{s,\text{EM}}^2\left(\sigma_{\tilde{A}_s,\text{EM}}^2 - \sigma_{\tilde{A}_s,\text{DEV}}^2\right)}_{\text{sector volatility differences}}. \tag{17}$$

In the data, we measure the first component of equation (17) which explains the differences in volatility due to the distribution of Domar weights, and we don't measure the second component which is related to sectoral intrinsic differences in the volatile of emerging than developed economies sectors. Second, we can analogously decompose the granular component as follows:

$$\underbrace{\left(\sum_{i\in\mathcal{I}_{\text{EM}}^{\text{top}}}\lambda_{i,\text{EM}}^2 - \sum_{i\in\mathcal{I}_{\text{DEV}}^{\text{top}}}\lambda_{i,\text{DEV}}^2\right)\sigma_{A_i,\text{DEV}}^2}_{\text{Top firms - Domar weight concentration}} + \underbrace{\left(\sum_{i\in\mathcal{I}_{\text{EM}}^{\text{bottom}}}\lambda_{i,\text{EM}}^2 - \sum_{i\in\mathcal{I}_{\text{DEV}}^{\text{bottom}}}\lambda_{i,\text{DEV}}^2\right)\sigma_{A_i,\text{DEV}}^2}_{\text{Bottom firms - Domar weight concentration (in data} \to 0)}$$
$$+ \underbrace{\sum_{i\in\mathcal{I}_{\text{EM}}}\lambda_{i,\text{EM}}^2\left(\sigma_{A_i,\text{EM}}^2 - \sigma_{A_i,\text{DEV}}^2\right)}_{\text{volatility firm-level differences}}. \tag{18}$$

First, following standard practice in the literature, we assume all firms have the same idiosyncratic volatility. Second, the first line of (18) includes the components which explains the differences in volatility due to the concentration of Domar weights. We split this component in two: a top firms and bottom firms components. Since the distribution of firms is fat-tailed we have that $\sum_{i\in\mathcal{I}_{\text{EM}}^{\text{bottom}}}\lambda_{i,\text{EM}}^2 \to 0$ and $\sum_{i\in\mathcal{I}_{\text{DEV}}^{\text{bottom}}}\lambda_{i,\text{DEV}}^2 \to 0$ then in our measurement we abstract from the second term. Last, we don't measure intrinsic differences in the firm-specific shocks in emerging and developed economies, then (similarly to the sectoral component) the term in the second line of (18) is not computed in this exercise.

The accounting in our exercise is then

$$
\begin{aligned}
1 = & \underbrace{\frac{\left(\sum_{s\in\mathcal{S}} \Lambda_{s,\mathrm{EM}}^2 - \sum_{s\in\mathcal{S}} \Lambda_{s,\mathrm{DEV}}^2\right)\sigma_{\tilde{A}_s,\mathrm{DEV}}^2}{\sigma_{Y,\mathrm{EM}}^2 - \sigma_{Y,\mathrm{DEV}}^2}}_{\text{sectoral contribution}} \\
& + \underbrace{\frac{\left(\sum_{i\in\mathcal{I}_{\mathrm{EM}}^{\mathrm{top}}} \lambda_{i,\mathrm{EM}}^2 - \sum_{i\in\mathcal{I}_{\mathrm{DEV}}^{\mathrm{top}}} \lambda_{i,\mathrm{DEV}}^2\right)\sigma_{A_i,\mathrm{DEV}}^2}{\sigma_{Y,\mathrm{EM}}^2 - \sigma_{Y,\mathrm{DEV}}^2}}_{\text{granular contribution}} \\
& + \underbrace{\frac{\sum_{s\in\mathcal{S}_T}\left(b_{s,\mathrm{EM}}^2 - b_{s,\mathrm{DEV}}^2\right)\sigma_{p_s}^2}{\sigma_{Y,\mathrm{EM}}^2 - \sigma_{Y,\mathrm{DEV}}^2}}_{\text{international prices contribution}} \\
& + \frac{\text{residual}}{\sigma_{Y,\mathrm{EM}}^2 - \sigma_{Y,\mathrm{DEV}}^2},
\end{aligned}
$$

where $\sigma_{Y,c}^2 = Var\left(\mathrm{d}\log Y_c\right)$ and the residual term is

$$
\begin{aligned}
\text{residual} = & \underbrace{\Lambda_{\mathrm{EM}}^2\sigma_{A,\mathrm{EM}}^2 - \Lambda_{\mathrm{DEV}}^2\sigma_{A,\mathrm{DEV}}^2}_{\text{macro}} \\
& + \underbrace{\sum_{s\in\mathcal{S}} \Lambda_{s,\mathrm{EM}}^2\left(\sigma_{\tilde{A}_s,\mathrm{EM}}^2 - \sigma_{\tilde{A}_s,\mathrm{DEV}}^2\right)}_{\text{sectoral residual}} \\
& + \underbrace{\sum_{i\in\mathcal{I}_{\mathrm{EM}}} \lambda_{i,\mathrm{EM}}^2\left(\sigma_{A_i,\mathrm{EM}}^2 - \sigma_{A_i,\mathrm{DEV}}^2\right)}_{\text{granular residual}}.
\end{aligned}
$$

Finally, notice that if $\sigma_{\tilde{A}_s,\mathrm{EM}}^2 = \sigma_{\tilde{A}_s,\mathrm{DEV}}^2\ \forall s\in\mathcal{S}$ and $\sigma_{A_i,\mathrm{EM}}^2 = \sigma_{A_i,\mathrm{DEV}}^2$ then the residual equates the macro component. Moreover, in the data, we have that $\Lambda_{\mathrm{EM}} \approx \Lambda_{\mathrm{DEV}}$, then the residual component would identify the excessive volatility of macro shocks in emerging economies, i.e., $(\sigma_{A,\mathrm{EM}}^2 - \sigma_{A,\mathrm{DEV}}^2)$.

B Additional Exercises

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

B.1 Structural Transformation and Business Cycle Volatility

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

Table B.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.

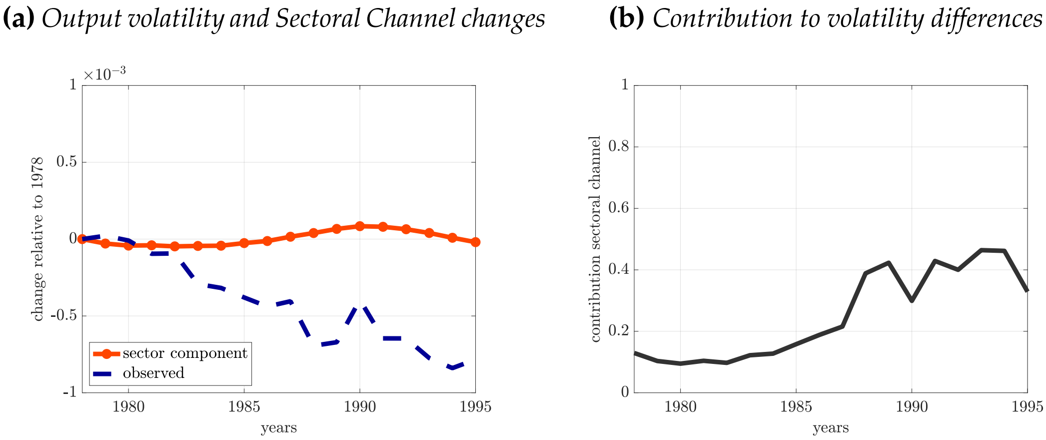
Table B.2: Changes in Volatility Differences: Sample Robustness

	sample		
	baseline	long-run	large*
$\left(\sigma^2_{\text{EM},1978} - \sigma^2_{\text{DEV},1978}\right)$	1.20	0.74	0.97
$\left(\sigma^2_{\text{EM},1995} - \sigma^2_{\text{DEV},1995}\right)$	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 B.1: Sectoral Channel and Relative Decline in Volatility



Notes: panel (a) shows the change of the sectoral channel $\left(\boldsymbol{\Lambda}'_{\mathbf{EM,t}}\Omega_{\tilde{A}}\boldsymbol{\Lambda}_{\mathbf{EM,t}} - \boldsymbol{\Lambda}'_{\mathbf{DEV,t}}\Omega_{\tilde{A}}\boldsymbol{\Lambda}_{\mathbf{DEV,t}}\right)$ and the observed $(\sigma^2_{\mathrm{EM},t} - \sigma^2_{\mathrm{DEV},t})$ 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.

B.2 Intrinsic Volatility

In addition to the standard assumptions, if we assume that $\sigma_A \to 0$ and $\sigma^2_{A_i,\mathrm{EM}} \neq \sigma^2_{A_i,\mathrm{DEV}}$ then rearranging terms in equation (13) we have

$$\begin{aligned}\left(\sigma^2_{A_i,\mathrm{EM}} - \sigma^2_{A_i,\mathrm{DEV}}\right) = & \left(\sum_{i\in\mathcal{I}_{\mathrm{EM}}} \lambda^2_{i,\mathrm{EM}}\right)^{-1} \underbrace{\left(\sigma^2_{Y,\mathrm{EM}} - \sigma^2_{Y,\mathrm{DEV}}\right)}_{\text{observed output volatility differences}} \\ & - \left(\sum_{i\in\mathcal{I}_{\mathrm{EM}}} \lambda^2_{i,\mathrm{EM}}\right)^{-1} \underbrace{\left(\sum_{s\in\mathcal{S}} \Lambda^2_{s,\mathrm{EM}} - \sum_{s\in\mathcal{S}} \Lambda^2_{s,\mathrm{DEV}}\right)\sigma^2_{\tilde{A}_s,\mathrm{DEV}}}_{\text{sectoral}} \\ & - \left(\sum_{i\in\mathcal{I}_{\mathrm{EM}}} \lambda^2_{i,\mathrm{EM}}\right)^{-1} \underbrace{\left(\sum_{i\in\mathcal{I}^{\mathrm{top}}_{\mathrm{EM}}} \lambda^2_{i,\mathrm{EM}} - \sum_{i\in\mathcal{I}^{\mathrm{top}}_{\mathrm{DEV}}} \lambda^2_{i,\mathrm{DEV}}\right)\sigma^2_{A_i,\mathrm{DEV}}}_{\text{granular}} \\ & - \left(\sum_{i\in\mathcal{I}_{\mathrm{EM}}} \lambda^2_{i,\mathrm{EM}}\right)^{-1} \underbrace{\sum_{s\in\mathcal{S}_T} \left(b^2_{s,\mathrm{EM}} - b^2_{s,\mathrm{DEV}}\right)\sigma^2_{p_s},}_{\text{international prices}} \end{aligned} \tag{19}$$

where $\sigma^2_{Y,c} = Var\left(d\log Y_c\right)$ and $\Lambda_{s,c} \equiv \sum_{i\in\mathcal{I}_{s,c}} \lambda_{i,c}$. Thus, we can backup indirectly from the accounting equation the intrinsic differences in firm's volatility. For the specification with correlations, we estimate the covariance matrix of sectoral TFP $\Omega_{\tilde{A}}$ without removing the common component (i.e., assume common component of TFP volatility $\sigma_{A,\mathrm{EM}} = \sigma_{A,\mathrm{DEV}}$ is the same in both types of economies).

C Data Appendix

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

C.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.

International Prices Channel. 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.

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

$$\text{dlog}(A_{st}) = \alpha_t + \text{dlog}(\tilde{A}_{st}),$$

where $\text{d}x_t = x_t - x_{t-1}$, A_{st} are the observed sectoral TFPs, α_t time (year) FE, and the residual $\text{dlog}(\tilde{A}_{st})$ 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 Section 4.1 — 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).

Granular Channel . We use the Worldscope dataset to compute the firm's Domar weights λ_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 C.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 C.1 shows our sample selection criteria in Worldscope.

C.2 Countries and Sectors

Table C.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 C.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	