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Abstract

In this paper we aim at empirically testing cross-country impacts of commodity price shocks to aggregate TFP growth for a sample of emerging economies. Under a growth accounting framework, we estimate country-specific TFP growth (1992-2014) and select the attendant robust determinants by means of a Bayesian Model Averaging (BMA) approach. To identify the effects of structural shocks, we propose a Bayesian panel VAR model and calculate cyclically adjusted TFP growth net of demand shocks (i.e. output gap) and commodity prices. Our results suggest that: i) the relationship of commodity prices to TFP growth has been very high in small commodity-exporting economies (i.e. an increase of 10% in commodity prices is associated with a sizable expansion of TFP growth in a year for an average commodity exporter); ii) although our evidence is not sufficient to empirically distinguish among theoretical explanations, our results favour an interpretation that weights short-term effects of commodity prices on productivity, either through transitional dynamics to the manufacturing sector or through mismeasurement of TFP; and iii) cyclically adjusted TFP growth highlights the importance of negative supply shocks in commodity-exporting countries. All in all, much of the increase in TFP growth in the last decade was related to a favourable cyclical environment, a result with potentially significant policy implications for commodity-dependent economies.

Keywords: total factor productivity, commodity prices, Bayesian model averaging, panel VAR.

JEL classification: O47, Q02, C11, C23.

Resumen

El objetivo de este trabajo es contrastar empíricamente el impacto entre países de *shocks* de precios de materias primas en el crecimiento de la PTF agregada en una muestra de economías emergentes. En un contexto de contabilidad de crecimiento, estimamos crecimientos de la PTF específicos por país (1992-2014) y seleccionamos sus determinantes más robustos mediante técnicas bayesianas de promediado de modelos. Para identificar los efectos de *shocks* estructurales proponemos un modelo VAR bayesiano en panel y calculamos el crecimiento de la PTF ajustada del ciclo, neta de *shocks* de demanda (brecha de producto) y precios de materias primas. Nuestros resultados sugieren que: i) la relación entre los precios de materias primas y el crecimiento de la PTF ha sido muy elevada en economías pequeñas exportadoras de materias primas (p. ej., un incremento del 10 % en los precios de materias primas se asocia con una expansión considerable del crecimiento de la PTF en un año para un exportador promedio de materias primas); ii) si bien nuestra evidencia no es suficiente para distinguir empíricamente entre explicaciones teóricas, nuestros resultados favorecen una interpretación en la que pesan los efectos de corto plazo de los precios de las materias primas sobre la productividad, ya sea a través de una dinámica de transición al sector manufacturero o a través de la medición errónea de la PTF, y iii) el crecimiento de la PTF ajustada del ciclo pone de relieve la importancia de los *shocks* de oferta negativos en los países exportadores de materias primas. Con todo, gran parte del aumento del crecimiento de la PTF en la última década estuvo relacionada con un entorno cíclico favorable, resultado que puede generar importantes implicaciones políticas para las economías dependientes de materias primas.

Palabras clave: productividad total de los factores, materias primas, promediado bayesiano de modelos, panel VAR.

Códigos JEL: O47, Q02, C11, C23.

Introduction

Growth in Total Factor Productivity (TFP) has been identified as the driving force of economic growth, especially once growth by means of factor accumulation, both in labor and in capital, is subdued (Easterly and Levine, 2001). In this regard, many emerging economies –particularly those whose factor endowment led them to be commodity-export intensives- are undergoing a process of adjustment of their potential output. It coincides with a decline in commodity prices, after a period in which commodity prices and economic activity both grew at high rates. This phenomenon has been documented by several related papers, either for EMEs in general (Tsounta, 2014) or for economic or geographical areas (Sosa et al., 2013, for Latin America, or Anand et al., 2014, for East Asia).

In the long run, one would expect that commodity prices should not have any effect on potential output. However, the effect on growth in the short and medium run is less clear. Shifts in commodity prices may alter investment decisions or generate labor force reallocations toward different sectors. In the case of TFP, commodity-exporting EMEs turn out to be an interesting case of study in this literature, as their TFP growth plummeted at the same time that international prices of most commodities suffered huge corrections (see Figure 1).

As far as this short-run relationship has not been tested at a macro level in a systematic manner, the first purpose of the paper is to contribute to this literature by calculating and decomposing TFP growth at an aggregate level for a panel of 9 emerging economies for the period 1992-2014[1], based on a standard growth accounting framework. To this end, we construct original series of labor and capital, both public and private, and we use this framework to identify robust determinants of TFP growth. Our main reuslts suggest that there is a strong correlation between commodity prices and TFP growth in commodity-exporting emerging economies in the short run.

Several factors may be driving the relationship between TFP growth and commodity prices. Our empirical strategy is twofold. First, we use a Bayesian Model Averaging (BMA) approach to select the most statistically significant predictors from a pool already considered by the empirical literature, in which we include cyclical and structural factors, together with commodity prices. This framework allows us to avoid variable selection problems and parameter instability. We find a high correlation between TFP growth and the change of commodity prices. The results of our estimation imply that a decrease of about 10% in commodity prices subtracts around .7 and 1.0 percentage points of TFP growth in a year for an average commodity-exporting emerging economy. In addition, we find that TFP growth is robustly correlated with the output gap. Second, we use

[1] The selection of countries is: BOL, BRA, CHL, COL, ECU, IDN, PER, ZAF and URY. In the robustness section, additional advanced economies are also included: AUS, CAN, DNK, GRE, NDL, NZL, and NOR.

this evidence to estimate a panel VAR model with cross-country heterogeneity, in order to take into account the endogeneity between the output gap and productivity in the short run. Moreover, we calculate the contributions of productivity shocks, demand shocks (as measured by the output gap) and short run movements of commodity prices to the variation of TFP growth in each country.

Our paper is related with two brands of the literature. First, with the literature testing empirically the effects of external prices swings in output and productivity. In this regard, this paper is close to De la Huerta and García Cicco (2016). It constructs TFP series at a sectoral level for Chile and estimates a VAR model relating TFP growth in different sectors with growth in commodity prices. It finds that TFP growth increases in non-tradable sectors after increases in commodity prices. We separate from this paper by calculating aggregate TFP growth for several commodity-exporting economies. Second, this paper is related with research that tries to find the determinants of productivity growth in emerging economies. We build upon the variable selection process of Danquah et al. (2014). It uses a BMA approach to find the drivers of TFP growth in the long run. Instead, we focus on commodity-exporting emerging economies, and the relationship between commodity prices and short-run productivity growth.

The main results of the paper can be summarised as follows. Before the Global Financial Crisis (GFC), commodity-exporting EMEs registered unprecedented strong TFP growth, which plummeted after the GFC. We find that this behavior is partially explained by the correlation between TFP growth and the economic cycle, in the one hand, and between TFP growth and commodity prices. Moreover, TFP growth in each country reacted heterogeneously to commodity prices changes. However, these negative short run factors cannot fully account for the slowdown in productivity, as we find that, after taking into account the variation produced by the output gap and commodity prices, TFP growth continues in a downward path, mainly due to negative supply shocks.

The structure of this paper proceeds as follows. Section 1 reviews the related literature highlighting academic and policy research with special focus on commodities and TFP alike. Sect.2 sets out the growth accounting methodology and briefly summarises the employed dataset with particular attention drawn to our commodity price export index. Sect. 3 defines our empirical strategy while Sect. 4 highlights the main empirical results. Sect. 5 and Sect. 6 are devoted to building contributions to TFP growth and provide robustness checks, respectively. Finally, Sect. 7 concludes and proposes several future lines of research.

1 How commodity prices could affect TFP in theory?

The literature on determinants of TFP growth focuses mainly on the importance of technological change to capture growth in the long run. In this sense, short-run movements of prices may have little to no effects in the technological capacity of a country. Alternatively, in this section, we review four possible channels that will lead to correlation between commodity prices and TFP growth.

A potential, intuitive channel is based on the notion that commodity prices fluctuation is, in fact, the result of relative productivity changes across sectors. This potential relationship was neglected by Singer (1950), given that, in order to explain the declining path of commodity prices observed in the early 1900's, it was not plausible to assume that productivity could have been increasing in the commodity industry more than in the manufacturing industry. However, the increasing path of prices seen in the last 15 years (recently interrupted) could be driven by decreasing productivity in the commodity sector, in a way that productive but exhausted investments would have been substituted by less productive ones. More formally, following Basu and Fernald (2009) let us assume that there are two sectors in the economy, one devoted to produce normal goods N and other to produce a commodity C whose proceeds (after being sold) are fully consumed. Let us assume as well that their production functions could be defined by the following equations:

$$N = AK_N^{1-\alpha}(L_N)^\alpha \tag{1}$$

$$C = AQK_C^{1-\alpha}(Lc)^\alpha \tag{2}$$

where A is a labor-augmenting technology, K and L are capital and labor in each sector and Q is a commodity-specific term, which in turn could be interpreted as a technological term or an additional production factor (i.e., land). By assuming perfect competition, cost minimization would lead to:

$$\frac{P_N}{P_C} = \frac{MC_C}{MC_N} = Q \tag{3}$$

where MC denotes marginal cost. It is therefore straitghforward to see that, in such a simple model, increasing relative commodity prices would come hand in hand with decreasing technology developments. As a result, the (Granger) causality relationship would flow from productivity shocks in the commodity sector to the relative price of commodities.

This first channel, however, assumes that prices of commodities are determined within a country. This assumption is unlikely to hold in a small, open economy. In this regard, let us assume now that the term $Q > 1$, but albeit perfect competition is present in the production of non-commodity goods, the economy is a price-taker in the production of the commodity. In that case, if the international price p^* is higher than the marginal cost MC_N the economy will produce both goods, and, defining sector shares as w_n, w_C TFP will be measured as:

$$TFP = A(w_N + Qw_C) > A \tag{4}$$

where w_n, w_C are the weights in the economy of production of N and C, respectively. In this case, the economy will reallocate resources to a sector where measured TFP is higher than in the rest of the economy.

A second channel has previously been highlighted by Ferraro and Peretto (2015). They study an endogenous growth model in a small, open economy, where the commodity importer/exporter status is endogenous and commodity prices affect aggregate TFP in the short run. Yet, the rate of economic growth in the long run is unaltered. In such DSGE model, the short-run correlation of TFP growth and commodity prices would be driven by the substitutability of the manufacturing and commodity sectors. For the sake of clarity, in their model, three forces may affect welfare in a commodity price boom: (i) the "windfall" effect, as the exporting quantity provides more proceeds; (ii) a "cost of living" effect, as the consumer price index (CPI) increases; and (iii) a "curse/blessing" effect, which will depend on the global substitute/complements status of manufacturing and commodity sectors. This third factor would affect TFP in the short run. In case both sectors were complements, higher mark-ups in the manufacturing industries would lead to an expansion in the varieties produced, and then higher TFP, which in turn would be sterilised in the long run due to the entry of new firms in the market. Empirically, the well-known "Dutch Disease" effect[2] means that the effect of commodity prices booms on other sectors of the economy would be negative (i.e. both sectors would be substitutes). Yet, recent studies show that some sectors (especially non-tradable sectors) are being positively affected (De la Huerta and García Cicco, 2016).

A third possible channel arises from the procyclicality of TFP whenever the measure is not adjusted by capacity utilization (Basu et al., 2006). Although there is an open debate about whether the procyclicality is a consequence of labor hoarding or real business cycle shocks (Field, 2010), both effects could be, in principle, correlated with commodity prices. Capital or labor utilization in the commodity sector may be higher when commodity prices are higher.[3] Moreover, commodity prices could be driven by real business cycle shocks in other economies.

[2] This is the name generally used to describe a situation where, after a commodity boom that generates capital inflows and appreciation of the currency, productive resources tend to be relocated away from the manufacturing industry (contraction) towards both, the commodity and non-traded sectors (expansion).

[3] In the empirical arena, it is worth highlighting that we have considered a country-specific output gap measure to explore this particular channel, see Section 3.

Finally, a fourth channel would be the access of commodity exporting countries to cheaper financing conditions (either public or private) in times in which commodity prices are higher, translated in the form of higher tax revenues for the public sector, which may ease resources to raise investments in infrastructures, health or education; or in the form of access to external credit for private companies, providing resources to invest in R&D projects and to acquire new foreign technologies.

In our empirical investigation, we postulate that the first and second channels would dominate. Under such a setting, we add variables to control for the effects arising from the third and fourth channels. In any case, it is worthy to mention that the expected sign of the effect with regard to the second channel is ambiguous, while the first and third channels would unanimously generate a positive correlation, given that we have decided not to adjust our TFP measure by input utilization.[4]

2 Growth accounting methodology and data

Traditional growth accounting models characterise (real) Gross Domestic Product (GDP) of the economy (Y) by means of a Cobb-Douglas production function, relating the inputs used to generate it (capital K and labor L), while a third variable is included to capture the part of observed production that is not explained by the recorded accumulation levels of the primary inputs (Solow, 1956). This last factor proxies the technical efficiency with which the productive factors are used and its behaviour is often related to technological progress. It is commonly known as Total Factor Productivity (TFP, denoted by A).

$$Y = AF(K, L) \tag{5}$$

assuming constant returns to scale and perfect competition in the input and product markets, it can be written as

$$\Delta y = (1 - \alpha)\Delta k + \alpha \Delta l + \Delta a \tag{6}$$

where the lower-case letters represent the natural log of the corresponding upper-case variables, Δ is the difference operator and α is the share of labour income in nominal production. The calculation of the rate of growth of TFP using Eq. (5) requires data on labor quantity, capital stock and GDP. Hence, GDP was obtained in constant terms from national accounts and transformed into 2005 PPP - using GDP PPP from the International Comparison Program.

[4] Bear in mind that one caveat of our empirical strategy has to do with sectoral data constraints. We are not able to construct TFP series at a sectoral level but an aggregate, country-specific level, observing the output of resource reallocation (if any).

Regarding the labor component, we have obtained total hours worked in the economy combining different international sources. Our primary source for the number of persons employed is the International Labor Organization (ILO). When not available, we have relied on data of the Total Economy Database (TED). In order to calculate the average hours worked per year, we have used data from TED.

The (time-varying) share of labor in the economy, α, is drawn from Penn World Tables (version 8.1). For the more recent observations, we leave α time-invariant. The capital component is calculated as the sum of the public and the private capital stock per year. Each stock is calculated using the perpetual inventory method:

$$K_{t+1} = (1-\delta)K_t + I_t \tag{7}$$

The gross fixed capital formation I_t is taken from national accounts data, compiled by UNDATA. The data is transformed using the price level of investment as a deflator and GFCF specific PPP's. The depreciation rates are increasing from 1970 to 2010 and constant thereafter, taken from Arslanalp et al. (2010).

For the initial capital stock, we take the first year available in the Penn World Tables and calculate its corresponding public and private capital stock by applying the average shares of each sector over all the covering period. With such initial capital, we calculate each capital stock until the last period using the previous formula. For the years where no public/private disaggregation is available, we use the depreciation rate provided by the Penn World Tables.

The dataset employed in this paper covers 16 countries from 1992 to 2014.[5] Initial country-specific growth accounting results indicate that there are serious grounds for considering high levels of heterogeneity between countries. As mentioned before, commodity-exporting EMEs registered an unprecedented strong TFP growth in the before the GFC. Afterwards, international commodity prices plummeted, and so did TFP growth. Most of commodity-exporting economies experienced huge rises in TFP growth during the first decade of the century, which have not been sustained in the more recent period, consistent with the calculations on Sosa et al. (2013).

Regarding the relatively wide potential set of indicators that could be selected in the analysis, we have only considered those usually employed in the related literature. Precise definitions of the covariates, how are they measured and sources are included in Table 1.

[5] The emerging countries included are BOL, BRA, CHL, COL, ECU, IDN, PER, ZAF and URY. In addition, advanced economies under consideration for robustness checks are: AUS, CAN, DNK, GRE, NDL, NZL, and NOR.

2.1 Commodities Export Price Index (CEPI)

In order to build the Commodities Export Price Index (CEPI), we have considered commodities defined by the UNCTAD classification. Each country-specific weights are calculated in annual basis over the value of total exports. To maintain weights constant, the final weight for each category in the index is the average of each product's weight for all years in the country.[6] We adjust the index for the US deflator (base 2005). Thus, CEPI is calculated as follows:

$$CEPI_{k,t} = \prod_{j} \frac{w_j * p_{j,t}}{Def_{US,t}} \tag{8}$$

where $w^E_{j,k}$ denotes the weight of each subindex j and $p_{j,t}$ is the value of the subindex at each time t.

For the sake of motivation, as one may observe in Figure 1 we present the evolution of TFP growth and the change of commodity prices in a sample of emerging economies. As one may observe, there exists a high correlation between both variables, becoming a potential source of disruption to be tested and analyzed with further details in the empirical results' section.

2.2 Alternative TFP determinants

The related empirical literature highlights other factors behind TFP growth, which could affect short and long-run productivity growth. The determinants considered in the estimation to control for short-run growth –and therefore, for the correlation explained in the third channel in Sect. 1 based on cyclicality arguments– are: (i) the output gap, in order to capture the procyclicality of TFP growth; and (ii) the credit gap, to account for the process of development of financial markets in most economies[7]. To test for the determinants of productivity growth in the long run –which may be important drivers of the fourth channel already mentioned in Sect. 1 based on the improvement of structural factors-, a wide range of structural variables based on Durlauf et al. (2005) are included. Some TFP growth potential drivers covering social dimensions (income inequality, dependency ratios), transmission and absorption of knowledge (FDI inflows as a % of GDP, trade openness, human capital in terms of % of population with secondary studies), factor

[6] Four different price indexes have been employed based on IMF Global Commodities Watch. Each product has been allocated into every single price category: [1] PFANDB: index of food and beverages (base 2005). It includes cereals, vegetables, fruits, oils, meat, sea products, sugar, coffee, tea and cacao. [2] PRAWM: index of raw agricultural materials (base 2005). Includes wood, cotton, wool, rubber and leather. [3] PMETA: metals index (base 2005). Includes copper, aluminum, iron, tin, nickel, zinc, lead and uranium. [4] PNRG: energy index (base 2005). It includes prices for petroleum, natural gas and coal. Consistent data on both prices and export shares are available from 1992 onwards.

[7] Both variables are computed by applying a two-sided HP filter with a λ parameter of 100 over the annual GDP, in the case of the output gap; and over the credit-to-GDP, in the case of the credit gap.

supply and efficient allocation (investment, government expenditure) and the easing of financial restrictions related to commodity prices growth already described in Sect. 1 (credit); and finally, other dimensions as institutions (government quality). In any case, some variables were not considered due to data limitations. For instance, R&D as a % of GDP became not available for the whole covering period. In order to tackle this issue, we instrumented this determinant with a proxy such as the Economic Complexity Index (ECI) developed in Hidalgo and Hausmann (2009),[8], given its high correlation.

Finally, in some countries, productivity growth may have shrunk due to their speed of convergence, since a protracted period of strong growth and educational developments would have led to closer proximity to the growth frontier. Accordingly, we measure the distance to the frontier as:

$$Dist_{k,t} = TFP_{k,t-1} - TFP_{frontier,t-1} \tag{9}$$

where A denotes TFP in levels using the following approximation:

$$TFP_t = \frac{Y_t}{L_t^{\alpha} K_t^{1-\alpha}} \tag{10}$$

In order to compute the frontier, we have considered the average of the TFP level for the three countries with the highest TFP values in levels at the reference year 2005, CHE, USA and GBR. In this sense, the distance to frontier as well as the distance multiplied by the percentage of population with secondary education achieved at age 25[9] are added to the model, in order to capture an investment-led strategy of absorption of knowledge (Acemoglu et al., 2006), in the spirit of Benhabib and Spiegel (1994).

3 Econometric strategy and results

The econometric specification of TFP growth in the static model set-up responds to the following equation:

$$\Delta A_{it} = \nu + \tau_t + \mu_i + \beta X_{i,t,t-1} + \zeta CEPI_t + u_{it} \tag{11}$$

[8] The Economic Complexity Index (ECI) is a holistic measure of the production characteristics of a country. The goal of this index is to explain an economic system as a whole rather than the sum of its parts. The ECI aims at explaining the knowledge accumulated in a country's population and that is expressed in the country's industrial composition. To achieve this goal, it combines metrics of the diversity of countries and the ubiquity of products to create measures of the relative complexity of a country's exports. For further details, see Hidalgo and Hausmann (2009).

[9] In order to obtain yearly data, we fix the value of the series in 5-year rolling windows.

where A_{it} represents TFP growth at year t, ν is a constant, μ_i are country fixed effects, $X_{i,t,t-1}$ is a vector of potential TFP determinants, $CEPI_t$ is a vector including commodity prices level and growth as described in the previous section and τ is a common yearly shock (time fixed effect).

The model specification may suffer from several potential limitations. On the one hand, the presence of several predictors in the vector of TFP determinants with low time variation would hinder and bias the results under the presence of country-specific fixed effects. To solve this drawback, the model without country fixed effects has been considered, too. On the other hand, the estimation of the coefficients corresponding to the vector $X_{i,t,t-1}$ is also prone to face a variable selection bias. The economic growth literature is very prolific in finding potential determinants of growth (see Durlauf et al (2004) for a survey). Against this background, we address this issue by using an agnostic method of variable selection: Bayesian Model Averaging (BMA). By model averaging, we are able to correct for potential uncertainty problems (with the risk of overfitting and overparametrization) and eventually select an optimal model specification, as in Danquah et al. (2014). The variables included in $X_{i,t,t-1}$ are summarised in Table 1.

3.1 Bayesian Model Averaging (BMA)

We conduct a BMA approach based on Hoeting et al. (1999) to weight variable inclusion[10]. For the sake of simplicity, let us assume a combination of predictors such that: $y = \alpha_i + x_i\beta_i + \epsilon$ where $\epsilon \sim N(0, \sigma^2 I)$ and for each model, i, the parameter space is defined by α and β. Thus, the posterior distribution of the dependent variable, Z, given data D is:

$$p\left(Z|D\right) = \sum_{k=1}^{K} p\left(Z|M_k, D\right)\left(M_k|D\right) \tag{12}$$

This is an average of the posterior distributions under each of the $M_1, ..., M_k$ models under consideration. Therefore, the posterior probability for model M_k is given by:

$$p\left(M_k|D\right) = \frac{p\left(D|M_k\right)p\left(M_k\right)}{\sum_{l=1}^{K} p\left(D|M_l\right)p\left(M_l\right)} \tag{13}$$

where $p\left(D|M_k\right) = \int p(D|\delta_k, M_k)p(\delta_k|M_k)c\delta_k$ is the integrated likelihood of model M_k, δ_k. It assumes that the posterior distribution is proportional to the marginal probability by the prior probability assigned to each model, in our case, a uniform variable. As a result, we obtain the

[10] For an overview of model averaging methods in the field of economics, see Moral-Benito (2015).

cumulative model probabilities of our predictor's selection based on the whole space of model combinations.

In Table 2 we summarise the main results of the BMA estimation to select robust TFP growth determinants, accounting for random effects and fixed effects. Given that we use a *prior* inclusion probability of 50%, our threshold for variable selection in the model is that the posterior inclusion probability (PIP) should be above 50%.

The results suggest that there exists a strong cyclical behavior in TFP, characterised by the substantial role of the output gap. Moreover, fluctuations of commodity export prices in commodity-exporting countries become a robust predictor of TFP variation. The empirical results imply that a decrease of about 10% in commodity prices is associated with a drop of around 0.7-1.0 percentage points of TFP growth in a year for an average commodity-exporting emerging economy. This result is robust to the inclusion in the model of additional variables measuring the incorporation of new and innovative ideas and the cyclical behavior of TFP growth, which rules out two of those reasons mentioned in Sect. 1 on the high correlation of TFP growth and commodity prices growth. This finding points to sectoral developments (transitional dynamics) behind the high correlation of TFP growth and commodity prices in EMEs, similarly to the evidence showed in De La Huerta and García-Cicco (2016). Other predictors arising as robust determinants under a random effects estimation are discarded once the existence of fixed effects is taken into account. Finally, our benchmark results are employed to break down both the effect of business cycle shocks and commodity prices fluctuation into TFP growth by using a Panel VAR.

3.2 Panel Bayesian VAR Model

The empirical Bayesian Panel VAR approach is based in the general framework summarized in Canova and Ciccarelli (2013). However, the endogenous behaviour between the output gap and TFP growth raises the need to distinguish between demand and supply shocks. To this end, we add cross-subsectional heterogeneity in our dynamic model by means of a random effects model, which rely on a hierachical prior identification scheme as of Jarocinski (2010). The reason behind is to capture supply and demand dynamics, using a Cholesky decomposition to identify these shocks. First, let us consider the general panel VAR form for unit i (with $i = 1, 2, ..., N$):

$$y_{i,t} = \sum_{j=1}^{N}\sum_{k=1}^{p} A_{i,j,t}^{k} y_{j,t-k} + C_{i,t}x_t + \varepsilon_{i,t} \tag{14}$$

where $y_{i,t}$ denotes a $nx1$ vector comprising the n endogenous variables (TFP growth and output gap) of unit i at time t, while $y_{j,t-k}$ is the j^{th} endogenous variables of unit i. Plus, $A_{i,j,t}^{k}$ is a

n x n matrix of coefficients providing the response of unit i to the k^{th} lag of unit j at period t. The m x 1 vector of exogenous variables (average of CEPI), and $C_{i,t}$ is the n x m matrix relating the endogenous variables to these exogenous variables. For $C_{i,t}$, the coefficient $C_{i,j,l,t}$ gives the response of endogenous variable j of unit i to the l^{th} exogenous variable. Finally, $\epsilon_{i,t}$ denotes a n x 1 vector of residuals for the variables of unit i, with the following properties:

$$\varepsilon_{i,t} = N(0, \Sigma_{ii,t}) \tag{15}$$

$$\text{where} \quad \Sigma_{ii,t} = E \begin{pmatrix} \varepsilon_{i,1,t} \\ \varepsilon_{i,2,t} \\ . \\ . \\ . \\ \varepsilon_{i,n,t} \end{pmatrix} \begin{pmatrix} \varepsilon'_{i,1,t} & \varepsilon'_{i,2,t} & . & . & . & \varepsilon'_{i,n,t} \end{pmatrix}$$

and $\varepsilon_{i,t}$ is assumed to be non-correlated, so that $E(\varepsilon_{i,t}\varepsilon'_{i,t}) = \Sigma_{ii,t}$, while $E(\varepsilon_{i,t}\varepsilon'_{i,s}) = 0$ when $t \neq s$.[11]. However, since we are interested in the introduction of cross-subsectional heterogeneity, we build a richer model based on random effects whereby one now may obtain country-specific VARs. By considering country units i:

$$y_{i,t} = A_i^1 y_{i,t-1} + ... + A_i^p y_{i,t-p} + C_i x_t + \varepsilon_{i,t} \tag{16}$$

$$\varepsilon_{i,t} = N(0, \Sigma_i) \tag{17}$$

We can reformulate the previous specification as:

$$y_i = \bar{X}_i \beta_i + \varepsilon_i \tag{18}$$

$$y_i = \underbrace{vec(Y_i)}_{nT \text{ x } 1}, \quad \bar{X}_i = \underbrace{(I_n \otimes X_i)}_{nT \text{ x } q}, \quad \beta_i = \underbrace{vec(B_i)}_{q \text{ x } 1}, \quad \varepsilon_i = \underbrace{vec(\epsilon_i)}_{nT \text{ x } 1},$$

The random coefficient model assumes that each unit i, β_i can be expressed as $\beta_i = b + b_i$ with b a k x 1 vector of paremters and $b_i \sim N(0, \Sigma_b)$. As a result: $\beta_i \sim N(b, \Sigma_b)$.It implies that the coefficients of the VAR will differ across units, but are drawn from a distribution with similar mean and variance. Under such a setting, our identification strategy will rely on the hierachical

[11] Note that in this general setting the variance-covariance matrix for the VAR residuals is allowed to be period-specific, which implies a general form of heteroskedasticity.

prior approach (in multiple levels) in order to derive the posterior distribution as in Jarocinski (2010). The sub-models combine to form the hierarchical model, and the Bayes' theorem is used to integrate them with the observed data, and account for all the uncertainty that is present.

To investigate the effects of commodity prices shocks on TFP growth of emerging economies we estimate a reduced form Panel VAR model, which assumes that these economies are small open economies who are not able to influence the evolution of global commodity export prices. To this end, our identification strategy relies on a Cholesky ordering of the output gap and TFP growth. In principle, the output gap should capture business cycle fluctuations more related with demand shocks, which usually fade away in the medium run. By contrast, TFP growth ought to capture supply shocks. However, the theoretical literature does not provide clear evidence to guide through the exogeneity ordering of the variables. To solve this drawback, we address this issue by performing panel Granger-Causality tests. The results shed light on the direction of this relationship and are summarized in Table 3. Hence, Granger-causality goes from output gap to TFP growth, confirming the hypothesis of a high procyclicality of TFP growth. As a consequence, the ordering of the variables proceeds as follows: [1] output gap and [2] TFP growth. Against this background, TFP shocks will only affect the output gap after one year, while shocks to the output gap would affect contemporaneously TFP growth.

In what follows, the Panel Bayesian VAR analysis is restricted to nine countries in our sample of commodity-exporting emerging economies (BRA, BOL, CHL, COL, ECU, IDN, PER, ZAF and URY). Two are the main reasons. First, whenever N is large, accounting for country heterogeneity under a panel Bayesian VAR framework is far from computationally straightforward. Second, our modelling approach generates a common steady state for all country units, which makes really important the selection of countries with relatively large similarities (see Figure 2).

The model includes two lags of the endogenous variables based on the AIC tests and features only commodity prices as structural shocks. As expected for small, open economies, commodity prices growth enter the model as an exogenous variable affecting contemporaneously both the output gap and TFP growth. Table 4 shows the Panel VAR pooled coefficients, which are common to all countries except for exogenous variables (i.e., constant and commodity export prices index). At first sight, one may observe that in a single level an increase on 10% in commodity prices is associated to an aggregate TFP expansion of about 0.4 percentage points, once endogeneity is taken into account.

However, the high degree of heterogeneity is evidenced when it comes to the estimation of a random effects model. Table 5 summarizes the Panel VAR random effect model, under a hierarchical prior framework. Our results suggest that commodity prices growth is not homogeneously significant in the country-specific estimations (i.e., positive and significant for BRA, ECU and PER, and not significant for the other countries).

For the sake of clarity, Figure 3 displays impulse response functions of both macroeconomic variables to a unit shock for the nine countries (structural identification based on Cholesky ordering). After a positive shock in the output gap, TFP growth increases contemporaneously, whereas decreases markedly afterwards, more than offsetting the initial positive effect. By contrast, TFP growth shocks affect positively the output gap for around five years.[12]

That said, a matter of interest within our Panel Bayesian VAR model is to establish the contribution of each structural shock to the historical dynamics of the TFP growth[13]. Hence, Figure 4 depicts historical decomposition of the three shocks under consideration (i.e., demand, supply, and commodity prices) for the case of PER and BRA - based on the Cholesky identified structural model. In this case, our findings suggest that the recent slowdown in productivity in both countries has to be mainly attributed to both negative demand and supply shocks. The contribution of the commodity prices shock to TFP growth after the Global Recession was not enough to avoid the more recent falling path.

Finally, to illustrate the influence on TFP growth of a favourable cyclical environment over the last decade, in Figure 5 we depict cyclically-adjusted TFP growth by subtracting the contibutions of cyclical components.In light of these results, two relevant points emerge. First, it is worth highlighting the importance of negative supply shocks on TFP variation. Secondly, the positive TFP growth performance in the last decade in most emerging, commodity-exporter economies was mainly related to a favourable cyclical context. This encourages both policymakers and scholars to back-check the bulk of TFP estimates which are published without considering cyclical adjustments.

4 Robustness

In this section we provide a sensitivity analysis of the results presented in the previous section.

4.1 Advanced vs. Emerging Commodity-exporters

Since there have been important changes in the share of commodity groups over the sample period, it might be important to test for the stability of our main results whether we include advanced, commodity-exporters in the sample. In this sense, determinants and patterns of development of

[12] Though not reported, but available upon request, the (median) variance decomposition for other countries are qualitatively similar to those found for the whole sample.

[13] Further details on how to generate historical decomposition of shocks are summarized in the Computational Appendix.

advanced, commodity-exporters may differ in the short run from those of emerging economies. To provide robustness checking, we extend the countries of our sample and split it into two groups in order to repeat the analysis for the two subsamples[14]. In Table 6 we present those robust determinants of TFP growth for emerging, commodity-exporter countries (columns 1, 2, and 3) and advanced economies (columns 4, 5, and 6). We estimate this sensitivity analysis in the static framework, given that the high differences between advanced and emerging economies would lead to counterintuitive results in the Panel VAR framework.The first interesting result emerging from Table 6 is that the output gap, commodity price growth, economic complexity and credit levels are robustly correlated with TFP growth in both subsamples (advanced and emerging commodity-exporters). However, the economic effects of commodity price growth and the output gap are lowered, but they are still sizable.

4.2 Alternative TFP measure

An important question arises from the calculation of TFP. Although our estimates are similar to traditional data sources for TFP, we compute the Panel VAR with TFP taken from the Penn World Tables 8.1, for the 1996-2011 period. The results presented in the previous section are more powerful with the PWT measure. Tables 7 and 8 present the results of the estimation in the pooled VAR and the hierarchical model, respectively. Commodity price growth median effect on TFP is almost two times higher than in the estimation with our estimated TFP measure in the pooled VAR. The results of such estimation are confirmed by the hierarchical model, in which commodity price growth has now a positive effect in each of the panels, and in particular reports a higher correlation with TFP growth in COL and ZAF.

4.3 Alternative Output Gap filtering

As an additional robustness exercise, we follow Hamilton (2016) and test alternative ways to Hodrick and Prescott (1981, 1997) method to filter country-specific output gap measures. They proposed a method for separating an observed series y_t into components typically labeled *trend* and *cycle*. The pitfalls to the approach have been known for some time. Yet, such methodology continues today to be very widely adopted in academic research and policy studies. For this reason it seems reasonable to test an alternative, superior detrending method for the output gap estimates. First, let us summarize why we should take into account this issue as a robustness test to our results. Three are the main reasons based on Hamilton (2016): i) the HP filter produces series

[14] Table 6 shows the list of selected countries in both subsamples.

with spurious dynamic relations that have no basis in the underlying data-generating process; ii) a one-sided version of the filter reduces but does not eliminate spurious predictability and moreover produces series that do not have the properties sought by most potential users of the HP filter; iii) a statistical formalization of the problem typically produces values for the smoothing parameter vastly at odds with common practice, e.g., a value for λ far below 1600 for quarterly data.To tackle these drawbacks, Hamilton (2016) proposed an alternative method based on the regression of the variable at date $t+h$ on the four most recent values, as of date t, which offers a robust approach to detrending. To assess the robustness of our empirical results we estimate country-specific output gaps with $h = 4$, which turned out to yield a much deeper cyclical dynamics. Table 9 summarises the Panel VAR coefficients controlling for heterogeneity. [15] As can be observed, the size of country-specific, median responses of TFP growth to commodity export prices are even larger than those using the HP filtering to compute the output gap.

5 Concluding remarks

A correct measurement of TFP growth is paramount for developing economies, as it has been identified as the driving force of economic growth in the long run. However, the impact of short-run developments could lead to biased diagnostics on the sustainability of current growth. To shed light on this issue, in this paper we propose an empirical framework based on the estimation of robust determinants of TFP growth (1992-2014) by means of model averaging techniques. Subsequently, we rely on a panel Bayesian VAR model accouting for cross-country heterogeneity to identify the effects of structural shocks.

Our main results suggest that the recent behavior of TFP growth in commodity-dependent economies is partially explained by: (i) the correlation between TFP growth and the business cycle; and (ii) the correlation between TFP growth and commodity prices. Moreover, TFP growth in each country reacted heterogeneously to commodity prices changes. Robustness checks with alternative TFP measurement (PWT) and output gap filtering confirm even larger productivity responses to commodity prices. However, these negative short-run factors cannot fully account for the slowdown in productivity. After considering the variation produced by the output gap and commodity prices, TFP growth continues in a downward path, mainly due to negative supply shocks. Finally, albeit our evidence is not sufficient to empirically distinguish among theoretical explanations, we favor an interpretation that highlights short-term effects of commodity prices

[15] Impulse response estimates of pooled Panel VAR model are qualitatitely very similar to those controlling for random effects In fact, the CEPI median coefficient when output gap and TFP growth are endogenously estimated are 0.072 and 0.077, respectively.

on TFP growth, either through transitional dynamics to the manufacturing sector or through mismeasurement of TFP in economies dependent on natural resources.

All in all, our results raise questions about productivity measurement in commodity-dependent economies. If traditional TFP measures are influenced by changes in commodity prices in the short run, it would make it hard to estimate the effects of structural reforms in such economies. Nevertheless, our main results suggest that the higher productivity levels achieved in emerging, commodity-exporting economies before the GFC would not have been sustained.in an alternative environment characterised by lower commodity prices. As a result, improving structural factors becomes paramount to recover the convergence path towards advanced economies.

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6 Computational Appendix

A matter of interest within our Panel BVAR model is to establish the contribution of each structural shock to the historical dynamics of the TFP growth. Precisely, for every period of the sample, one may want to decompose the TFP growth into its different drivers, each components being due to one structural shock of the model as described above. This identifies the historical contribution of each shock to the observed TFP growth data sample. Thus, this measure can be separated into two parts: one due to deterministic exogenous variables (*Commodity Export Prices Index*) and initial conditions, and one due to the contribution of unpredictable structural disturbances affecting the dynamics of the model. For the sake of simplicity, one may obtain a representation of the impulse response functions in terms of structural shocks as follows:

$$y_i = \underbrace{\sum_{j=1}^{p} A_j^{(t)} y_{1-j} + \sum_{j=0}^{t-1} C_j x_{t-j}}_{\text{historical contribution of deterministic variables}} + \underbrace{\sum_{j=0}^{t-1} \theta_j \eta_{t-j}}_{\text{historical contribution of structural shocks}} \tag{19}$$

This equation summarizes the historical decomposition of TFP growth in terms of present and past structural shocks along with its exogenous components. That said, in order to obtain draws from the posterior distribution with respect to the VAR coefficients, we integrate the historical decomposition into a Gibbs sampler framework.

7 Figures & Tables

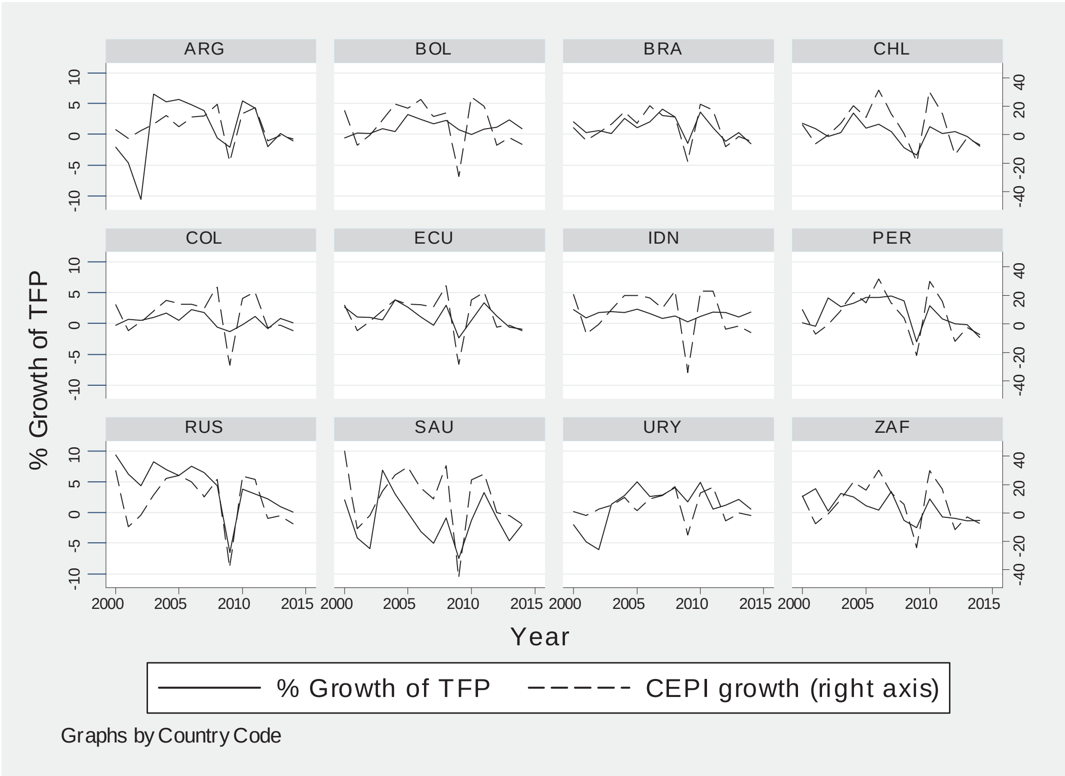

Figure 1: Growth of commodity prices and TFP

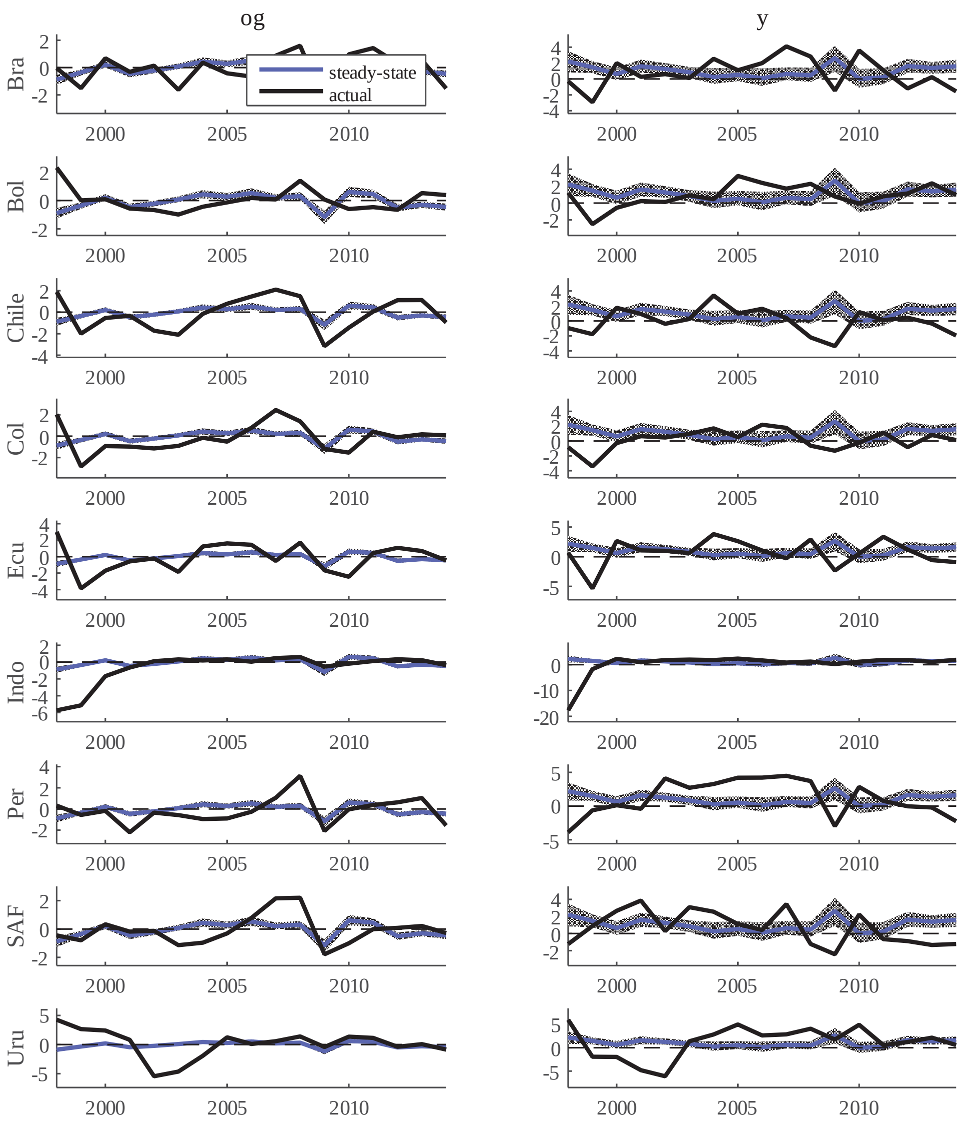

Figure 2: Steady-state Vs. actual *og* refers to output gap and *y* refers to TFP growth.

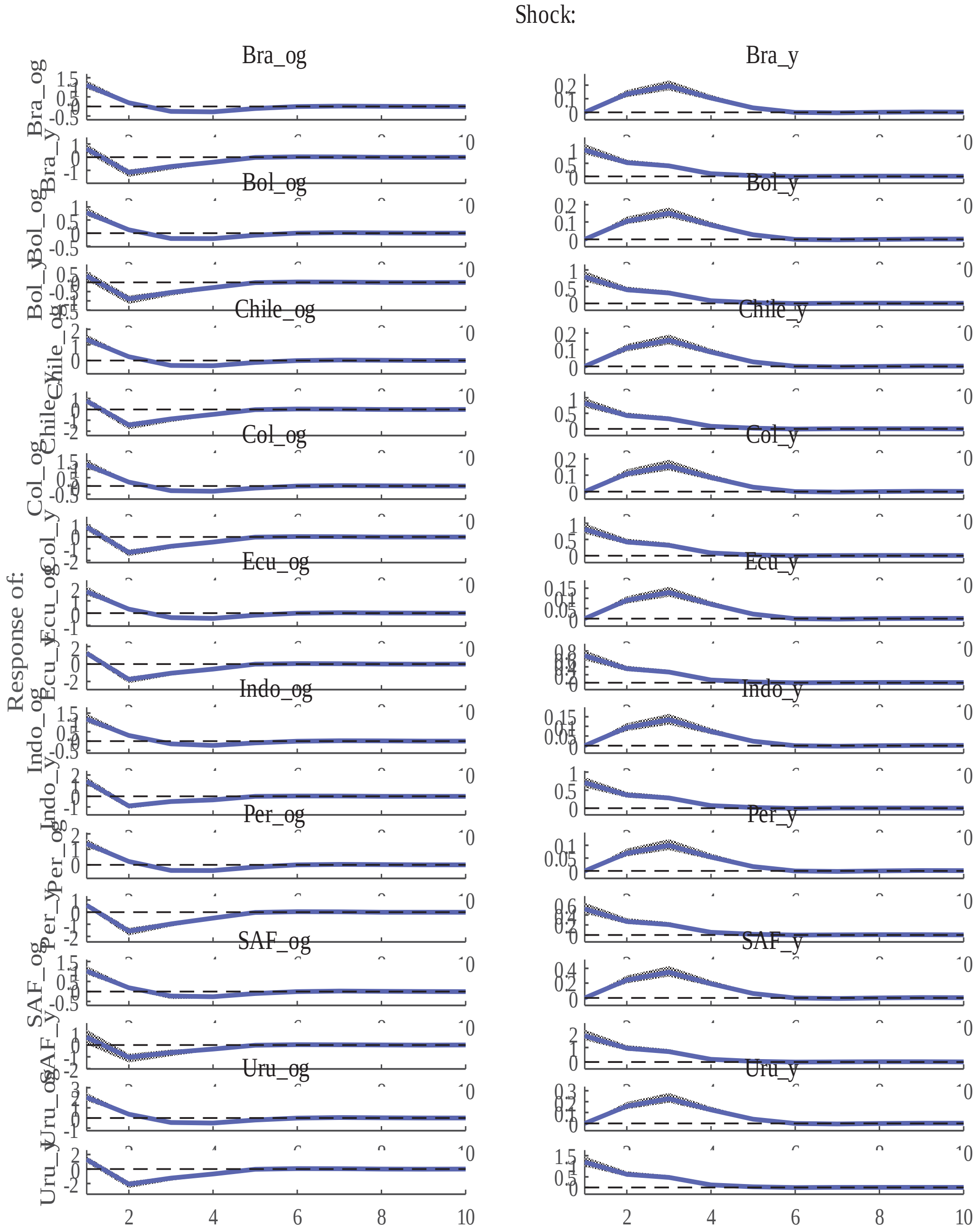

Figure 3: Impulse response functions (Cholesky structural identification). *og* refers to output gap and y refers to TFP growth

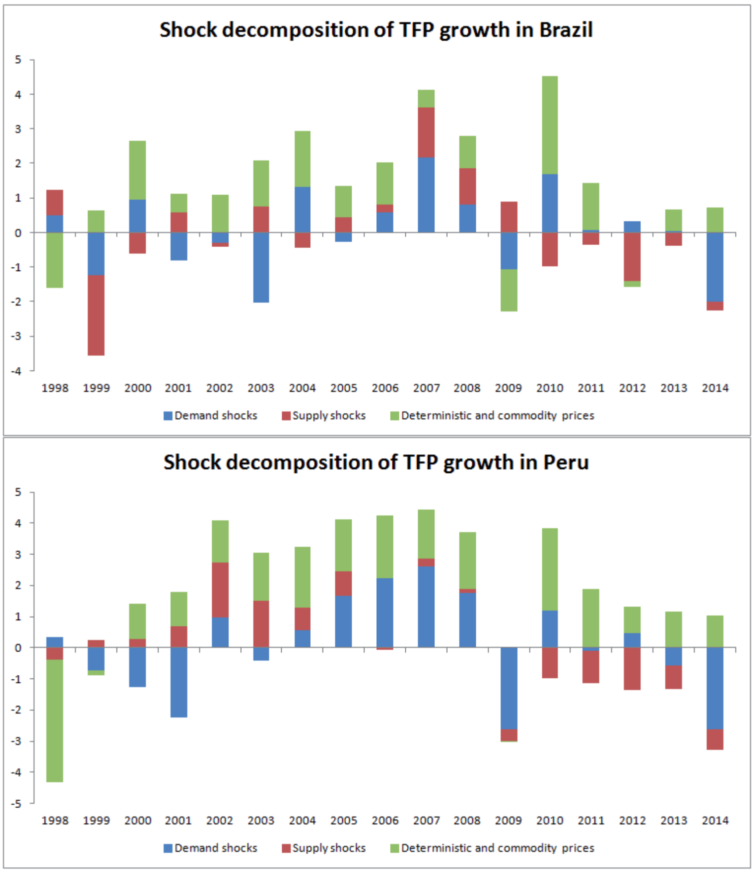

Figure 4: Country-specific shock decomposition

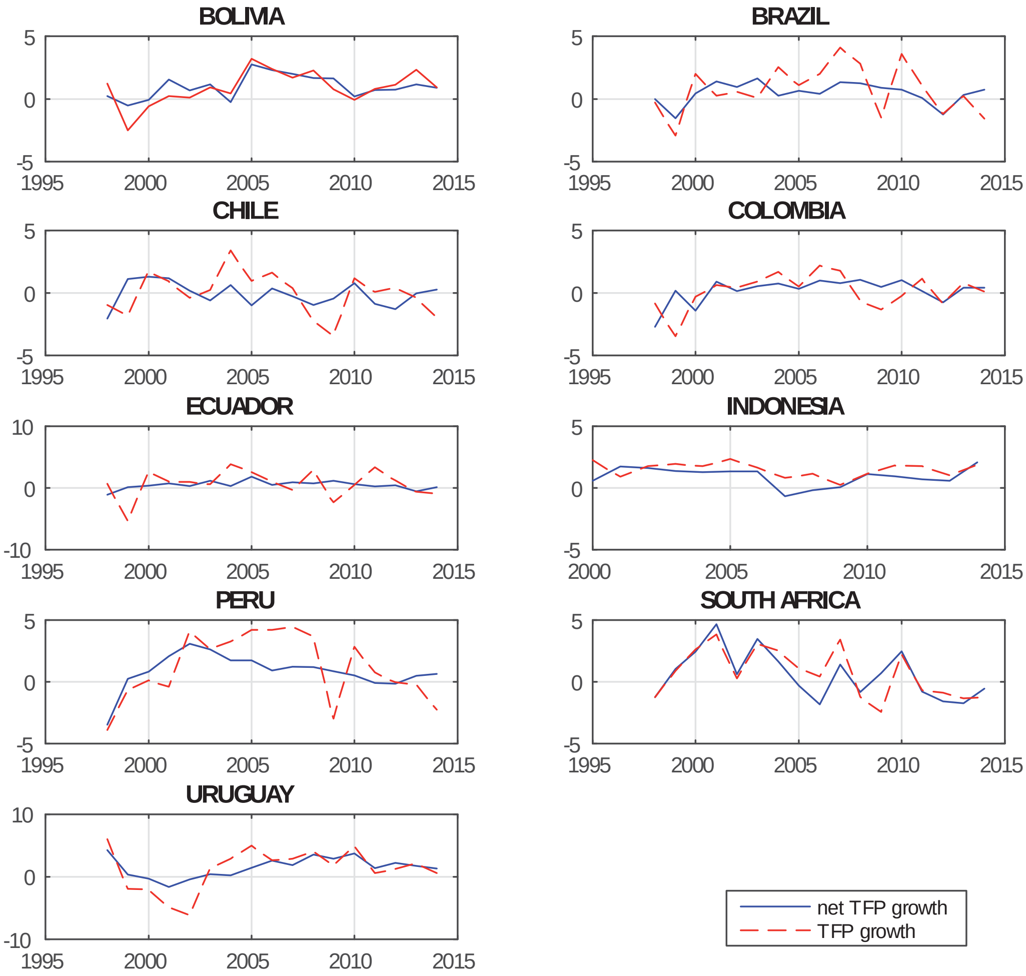

Figure 5. Cyclically-adjusted TFP growth vs. (Traditional) TFP growth

Table 1: Variable Definitions and Sources

Variables	Measure	Source
Economic Complexity Index	Index - Lagged	Atlas of Economic Complexity
IT capital growth	year-on-year growth rates	Total Economy Database (TED)
Trade openness	(X+M)/GDP	World Bank Development Indicators
Output gap	as a % of GDP	Own estimates, based on IMF, WEO Database
Credit gap	as a % of GDP	Own estimates, based on BIS Database
Credit growth	as a % of GDP	World Bank Development Indicators (WBDI)
Credit	as a % of GDP	World Bank Development Indicators (WBDI)
FDI Inflows	as a % of GDP	United Nations (UN)
Urban population	as a % of Total population	World Bank Development Indicators (WBDI)
Gini Index	Index: 2010=100	SWIID Database
Dependency ratio	as a % of Total population	World Bank Development Indicators (WBDI)
Government quality	Index	Quality of Government Database (QoG)
Investment	as a % of GDP	National accounts
Government expenditure	as a % of GDP	World Bank Development Indicators (WBDI)
Commodities Export Price Index growth		Own estimates
Commodities Export Price Index level		Own estimates
Convergence (distance to frontier)		Own estimates
Absorption	(distance*pop. aged>25 with secondary studies)	Own estimates, based on Barro-Lee Database
Population with secondary studies	as a % of Total	Barro-Lee Database

Data from Barro-Lee is available at http://www.cid.harvard.edu/ciddata/ciddata.html

Table 2: Determinants of TFP Growth of Emerging Economies

	Random Effects			Fixed Effects		
	PIP	P. Mean	P. Variance	PIP	P. Mean	P. Variance
	[1]	[2]	[3]	[4]	[5]	[6]
Output gap	**1.00**	0.73	0.10	**1.00**	0.73	0.10
Commodity prices growth	**0.99**	0.10	0.03	**0.83**	0.06	0.04
ECI	**0.93**	1.48	0.64	0.08	-0.04	0.26
Openess	**0.91**	0.04	0.02	0.09	0.00	0.01
Credit level	**0.72**	-0.01	0.01	0.14	-0.00	0.01
TFP distance to frontier	0.26	0.10	0.20	**0.96**	1.27	0.53
Government expenditure	0.09	-0.00	0.02	**0.74**	-0.15	0.11
Gini Index	0.22	0.01	0.04	**0.54**	-0.07	0.08
Government quality	0.29	-0.76	1.42	0.19	-0.45	1.19
Investment	0.27	-0.02	0.05	0.27	-0.03	0.06
TFP distance*education	0.21	0.00	0.00	0.45	-0.00	0.01
Commodity prices level	0.15	-0.00	0.01	0.08	0.00	0.01
Human capital	0.15	-0.00	0.03	0.26	-0.02	0.04
Dependency ratio	0.13	-0.00	0.02	0.10	-0.00	0.02
IT Share on capital	0.10	0.13	0.72	0.16	0.41	1.33
Credit gap	0.09	-0.00	0.01	0.12	–0.00	0.01
FDI	0.08	0.00	0.02	0.17	0.02	0.04
Credit growth	0.07	0.02	0.28	0.07	0.01	0.27
Prior Inclusion Probability		0.5			0.5	
Observations		183			183	

Notes: PIP refers to the posterior inclusion probability of a particular predictor. Given the prior inclusion probability is equal for all the variables (i.e., 0.5), those regressors with PIP above 0.5 are considered as robust drivers of TFP growth; P. Mean refers to the posterior mean conditional on inclusion of a given regressor in the empirical model, which is a weighted average of model-specific coefficient estimates with weights given by the model-specific R-squares; P. Variance refers to the posterior variance, which is a weighted average of model-specific variances.

Table 3: Granger causality tests

H_o	W-Stat	Zbar_Stat	Prob
TFP growth does not homogenously cause OG	4.12	1.34	0.17
OG does not homogenously cause TFP growth	54.74	41.80	0.00

Table 4: Panel VAR Pooled

	og (-1)		og (-2)		ΔTFP (-1)		ΔTFP (-2)		Constant (exog.)		**CEPI (exog.)**	
	Median	Std. Dev	Med	Std. Dev	Median	Std. Dev	Median	Std. Dev	Median	Std. Dev	**Median**	**Std. Dev**
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	**[11]**	**[12]**
Endogenous Output Gap												
Common to all units	0.447	0.065	-0.088	0.043	0.083	0.040	0.016	0.025	-0.442	0.127	**0.043**	**0.009**
Endogenous TFP Growth												
Common to all units	-0.766	0.086	0.022	0.056	0.597	0.052	0.045	0.033	0.012	0.167	**0.038**	**0.012**

Notes: Std. Dev. refers to standard deviation. Hyperparameters: [l_1] Overall tightness = 0.1; [l_2] Lag decay = 1; [l_3] Exogenous variable tightness =100; This estimates have been obtained by using the new "Bayesian Estimation, Analysis and Regression" toolbox provided by the ECB based on Dieppe et al (2016).

Table 5: Panel VAR Random Effect model (Hierchical)

	og (-1)		og (-2)		ΔTFP (-1)		ΔTFP (-2)		Constant (exog.)		**CEPI (exog.)**	
	Median	Std. Dev	Med	Std. Dev	Median	Std. Dev	Median	Std. Dev	Median	Std. Dev	**Median**	**Std. Dev**
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	**[11]**	**[12]**
Endogenous Output Gap												
Brazil	-0.167	0.016	0.051	0.008	0.340	0.009	0.104	0.002	-0.713	0.299	**0.044**	**0.021**
Bolivia	-0.166	0.017	0.051	0.008	0.340	0.009	0.104	0.002	-0.279	0.216	**-0.018**	**0.015**
Chile	-0.167	0.017	0.051	0.008	0.340	0.009	0.104	0.002	-0.366	0.371	**0.021**	**0.028**
Colombia	-0.167	0.017	0.051	0.008	0.340	0.009	0.104	0.002	-0.272	0.321	**0.001**	**0.024**
Ecuador	-0.168	0.017	0.051	0.008	0.340	0.009	0.104	0.002	-0.568	0.397	**0.010**	**0.032**
Indonesia	-0.168	0.017	0.051	0.008	0.340	0.009	0.104	0.002	-0.810	0.222	**0.032**	**0.016**
Peru	-0.166	0.017	0.051	0.008	0.340	0.009	0.104	0.002	-0.875	0.340	**0.013**	**0.027**
South Africa	-0.167	0.017	0.051	0.008	0.340	0.009	0.104	0.002	-0.544	0.323	**0.013**	**0.022**
Uruguay	-0.165	0.017	0.051	0.008	0.340	0.009	0.104	0.002	-0.498	0.445	**-0.010**	**0.035**
Endogenous TFP Growth												
Brazil	-1.196	0.012	-0.058	0.008	0.501	0.022	0.326	0.007	-0.180	0.320	**0.048**	**0.021**
Bolivia	-1.195	0.012	-0.058	0.008	0.500	0.022	0.325	0.007	0.281	0.242	**-0.017**	**0.017**
Chile	-1.195	0.012	-0.058	0.008	0.500	0.022	0.325	0.007	-0.172	0.283	**0.003**	**0.020**
Colombia	-1.194	0.012	0.059	0.008	0.503	0.022	0.325	0.007	0.083	0.257	**-0.017**	**0.019**
Ecuador	-1.195	0.012	-0.058	0.008	0.502	0.022	0.325	0.007	-0.157	0.321	**0.034**	**0.024**
Indonesia	-1.196	0.012	-0.058	0.008	0.501	0.022	0.325	0.007	-0.181	0.486	**0.058**	**0.034**
Peru	-1.196	0.012	-0.058	0.008	0.501	0.022	0.325	0.007	-0.122	0.205	**0.048**	**0.015**
South Africa	-1.196	0.012	-0.058	0.008	0.501	0.022	0.325	0.007	0.001	0.508	**0.007**	**0.032**
Uruguay	-1.196	0.012	-0.058	0.008	0.501	0.022	0.325	0.007	0.301	0.390	**-0.009**	**0.029**

Notes: Std. Dev. refers to standard deviation. Hyperparameters: [l_1] Cross-variable weighting = 0.5; [l_2] Lag decay = 1; [l_3] Exogenous variable tightness =100; [l_4] IG shape on overall tightness = 0.001; [l_5] IG scale on overall tightness = 0.001.

Table 6: Determinants of TFP Growth: EME vs. ADV commodity-exporters

	EME Commodity-Exporters			ADV Commodity-Exporters		
	PIP	P. Mean	P. Variance	PIP	P. Mean	P. Variance
	[1]	[2]	[3]	[4]	[5]	[6]
Output gap	**1.00**	0.73	0.10	**1.00**	0.57	0.08
Commodity prices growth	**0.99**	0.10	0.03	**1.00**	0.07	0.01
ECI	**0.93**	1.48	0.64	**0.65**	0.42	0.36
Openness	**0.91**	0.04	0.02	0.24	0.00	0.01
Credit level	**0.72**	-0.01	0.01	**0.97**	-0.01	0.00
Prior Inclusion Probability		0.5			0.5	
Observations		183			308	

Notes: Columns [1], [2], and [3] refer to the determinants of overall TFP growth of Emerging commodity-exporter countries while columns [4], [5], and [6] summarize the results of TFP determinants of Advanced commodity-exporter countires. PIP refers to the posterior inclusion probability of a particular predictor. Given the prior inclusion probability is equal for all the variables (i.e., 0.5), those regressors with PIP above 0.5 are considered as robust drivers of TFP growth. Only variables with a PIP above the threshold in one of the estimations are shown; P. Mean refers to the posterior mean conditional on inclusion of a given regressor in the empiricalmodel, which is a weighted average of model-specific coefficient estimates with weights given by the model-specific R-squares; P. Variance refers to the posterior variance, which is a weighted average of model-specific variances

Table 7: Panel VAR Random Effect model (Hierchical)

	Constant (exog.)		**CEPI (exog.)**	
	Median	Std. Dev	**Median**	**Std. Dev**
	[9]	[10]	**[11]**	**[12]**
Endogenous Output Gap				
Brazil	-0.521	0.682	**0.059**	**0.049**
Bolivia	-0.508	0.626	**0.051**	**0.046**
Chile	-0.862	0.580	**0.111**	**0.040**
Colombia	-0.480	1.326	**0.053**	**0.100**
Ecuador	-1.006	0.887	**0.103**	**0.062**
Indonesia	0.236	1.430	**-0.085**	**0.122**
Peru	-0.651	1.204	**0.100**	**0.089**
South Africa	-0.930	0.480	**0.118**	**0.033**
Uruguay	-0.426	1.513	**0.105**	**0.120**
Endogenous TFP Growth				
Brazil	0.083	0.370	**0.096**	**0.027**
Bolivia	0.559	0.300	**0.009**	**0.020**
Chile	-0.259	0.369	**0.057**	**0.027**
Colombia	-0.139	0.268	**0.021**	**0.021**
Ecuador	0.023	0.519	**0.094**	**0.039**
Indonesia	-0.440	0.851	**0.101**	**0.072**
Peru	0.450	0.560	**0.155**	**0.036**
South Africa	0.389	0.479	**0.066**	**0.035**
Uruguay	0.558	0.697	**0.013**	**0.054**

Notes: Estimates using alternative output gap filtering based on Hamiton (2016) .Std. Dev. refers to standard deviation. Hyperparameters: [l_1] Cross-variable weighting = 0.5; [l_2] Lag decay = 1; [l_3] Exogenous variable tightness =100; [l_4] IG shape on overall tightness = 0.001; [l_5] IG scale on overall tightness = 0.001.

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