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Emerson Fernandes Marçal
Beatrice Zimmermann
Diogo de Prince
Giovanni Merlin
Oscar R. Simões

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# Assessing global economic activity linkages: An empirical exercise based on Global Autoregressive Regression

Emerson Fernandes Marçal*

Beatrice Zimmermann†

Diogo de Prince‡

Giovanni Merlin§

Oscar R. Simões¶

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**Abstract**

Economic performance increasingly relies on global economic environment due to the growing importance of trade and financial links among countries. Literature on growth spillovers shows various gains obtained by this interaction. This work aims at analyzing the possible effects of a potential economic growth downturn in China, Germany and United States on the growth of other economies. We use global autoregressive regression approach to assess interdependence among countries. Two types of phenomena are simulated. The first one is a one time shock that hit these economies. Our simulations use a large shock of -2.5 standard deviations, a figure very similar to what we saw back in the 2008 crises. The second experiment simulate the effect of a hypothetical downturn of the aforementioned economies. Our results suggest that the United States play the role of a global economy affecting countries across the globe whereas Germany and China play a regional role.

JEL Codes: C52, F41, F47, F43, F62.

Key Words: Economic growth, Linkages, Global VAR.

## 1 Introduction

Economic growth is a topic of intense research and debate in Economics. Although growth dynamics is strongly related to domestic issues, we can not neglect that the global environment and its linkages play a central role in

*Head of Center for Applied Macroeconomic Research at Sao Paulo School of Economics and CSSA-Mackenzie. Corresponding author: emerson.marcal@fgv.br

†PhD Candidate at Sao Paulo School of Economics

‡Researcher at Center for Applied Macroeconomic Research at Sao Paulo School of Economics

§PhD Candidate at Sao Paulo School of Economics

¶PhD Candidate at Sao Paulo School of Business - FGV and Professor of Economics and Finance at ISE Business School

explaining growth and economic cycles. For that matter, it is essential that policy makers and practitioners have good estimates of the magnitude of those economic interdependencies across nations.

Trade and financial ties across regions are essential to explain why there might be significant linkages in the world economy. Recent events such as the subprime crisis in the United States and Euro crisis have raised questions of how these events spilled over onto the economic performances of countries around the world. China's emergence and, particularly, its apparent relative growth slowdown have raised concerns about the magnitude of its relevance in helping the sustenance of world growth. The dependency of the Euro Zone members on German's economic performance is another point of concern that has been raised recently, specially in critical moments of the Euro crisis.

To assess these economic linkages is not an easy empirical task. Based on a global autoregressive regression approach, similar to the work of Pesaran, Schuerman, and Wiener (2004), we want to investigate if and how big is the dependence of a selected sample of countries to shocks in 3 major economies: United States, Germany and China.

Two types of events are analyzed. The first one is an impulse shock originated in each of these three economies. The second event is a downturn in the long-run growth trend. The first can be seen as an abnormal one-shot shock whereas the second can be characterized as a permanent change.

Aside from this introduction, the paper is organized in four additional sections. The second provides the motivation for the analysis. The third presents the applied methodology, and the fourth section describes the data and presents the results of the empirical exercise. Finally, the fifth section provides the final remarks.

## 2 Motivation and Literature Review

During the last decades, with a growth model driven by investments and exports, China contributed to boost commodity boom prices and, as a consequence, other emerging market's growth rates. China's average growth in the last three decades was approximately 10% per year, which led the country to the top of the list of biggest economies of the world. However, the Chinese pace of economic expansion has changed in the last three years, when the recorded GDP growth was of 7.8%, 7.7% and 7.4% for 2012, 2013 and 2014 respectively. For the future, it is expected that the Chinese growth will be driven by increases in household spending, but for analysts the growth should be lower than achieved in previous decades. This change might affect the economies around the world as well.

At the same time, it is not just China's economy that makes the markets fear a global slowdown. Many experts have raised the theory of secular stagnation in the U.S. In addition, the European Union has experienced problems recently. Examples may include the situation of the Greek economy and the migratory flow that could have economic effects in the medium term.

Looking at this new international scenario, this paper intends to analyze the possible effects of Chinese economic growth downturn on other countries involved in world trade. Considering the importance of the United States economy to the rest of the world and the relevance of the German economy to the European continent, we also examine what would happen if they suffer a downshift in their growth rate as well. In order to achieve this goal, we have opted to work with a Global Autoregressive Regression approach, an adaptation of the Global VAR (GVAR), of Pesaran et al. (2004), to an univariate case.

Recently, researchers started using the GVAR modeling as an effective tool to understand regional and world economic linkages. As per Pesaran et al. (2004), Sun et al. (2013) uses both trade and financial weights to capture the link between Central Eastern and Southeastern Europe (CESEE) and advanced Europe countries. This close link among these countries is responsible for a boom and bust cycle in the CESEE countries that enabled them to join the advanced countries markets not only as consumers but also as part of their production chain. Authors find strong co-movements in inflation and credit growth. Authors also find some interesting results in regards to financial shocks. A UK long term interest rate shock reverberates strongly to the euro area, as well as to Nordic countries, but they have a small effect on CESEE countries. Effects to the inflation of the CESEE countries are small when a shock is made to the euro area inflation. The same happens to the credit growth of the CESEE countries when a shock is applied to the credit growth of the euro area. They also apply shocks directly to the CESEE countries in order to understand the effects on Western European partners. They document that the rise in size of the CESEE economies have increased the importance of a shock made to these economies onto the Western European countries.

Bussiere et al. (2009) use a 21-country GVAR to investigate the effects of shocks on global trade flows. Their main findings are that world exports have a much higher response to a shock in U.S. output than to a shock in the U.S. real effective exchange rate. Although the focus of the authors is to identify the effects of trade flows, imposing theoretical restrictions on long-run relationships, they also estimate the effects of shocks on output. They look only to the short-run effects, but qualitatively their results are similar to those that we present in this article.

# 3 Methodology

## 3.1 Global Auto-Regressive Model

We start the analysis by modeling a reduced form for the logarithm of Gross Domestic Product per Capita (LGDPPC).[1] We adapt the Global Vector Autoregressive Regression (GVAR) methodology to an univariate case, as proposed by Pesaran et al. (2004). In this framework it is possible to link domestic performance to the performance of external variables. Since the log of per capita GDP is non-stationary, we opt to built a model based on the first

[1] Log of oil price is also included in the model in section 4.3.3, as a global exogenous variable, that is common to all countries.

differences of LGDPPC. To derive the Global Autoregressive Model, GAR, consider the following equations for a set of $i = 1, 2, ..., N$ countries:

$$\Delta x_{i,t} \quad = \quad a_i + \phi_{i,1}\Delta x_{i,t-1} + \theta_{i,0}\Delta x^*_{i,t} + \theta_{i,1}\Delta x^*_{i,t-1} + \varepsilon_{it} \tag{1}$$

where $x_{it}$ is the endogenous variable, $x^*_{it}$ is the external variable of the country $i$, and $\varepsilon_{it}$ is the idiosyncratic random shock, $\varepsilon_{it} \sim N(0, \sigma_i^2)$ . The remaining Greek letters refers to the autoregressive and external variables parameters, and $a_i$ is a drift related coefficient. The external variable, $x^*_{it}$, is constructed using the trade weights (imports plus exports), $w_{i,j}$:

$$x^*_{i,t} = \sum_{j=1}^{N} w_{i,j} x_{j,t} \tag{2}$$

$$\sum_{j=1}^{N} w_{i,j} = 1, \quad and \quad w_{i,i} = 0, \; for \; \forall i = 1, ..., N. \tag{3}$$

We define $\tilde{x}^*_{i,t} = \begin{pmatrix} x_{i,t} \\ x^*_{i,t} \end{pmatrix} = W_i x_t$ and rewrite (1) as:

$$A_i \Delta \tilde{x}_{i,t} \quad = \quad a_i + B_i \Delta \tilde{x}_{i,t-1} + \varepsilon_t \tag{4}$$

where $A_i = \begin{pmatrix} I_1 & , -\theta_0 \end{pmatrix}$ and $B_i = \begin{pmatrix} \phi_{i,1}, & \theta_{i,1} \end{pmatrix}$.

Now let $W_1 = \begin{pmatrix} 1 & 0 & 0 & ... & 0 \\ 0 & w_{12} & w_{13} & ... & w_{1N} \end{pmatrix}$, $W_2 = \begin{pmatrix} 0 & 1 & 0 & ... & 0 \\ w_{21} & 0 & w_{23} & ... & w_{2N} \end{pmatrix}$... $W_N = \begin{pmatrix} 0 & 0 & 0 & ... & 1 \\ w_{N1} & w_{N2} & w_{N3} & ... & 0 \end{pmatrix}$.

We can use the fact that $\begin{pmatrix} x_{i,t} \\ x^*_{i,t} \end{pmatrix} = W_i x_t$ and obtain:

$$A_i W_i \Delta x_t \quad = \quad a_i + B_i W_i \Delta x_{t-1} + \varepsilon_{it} \tag{5}$$

Finally, it is possible to stack all equations in a single vector:

$$G \Delta x_t \quad = \quad a + H \Delta x_{t-1} + \varepsilon_t \tag{6}$$

where $a = \begin{pmatrix} a_1 \\ a_2 \\ \vdots \\ a_N \end{pmatrix}$, $\varepsilon_t = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \vdots \\ \varepsilon_{Nt} \end{pmatrix}$, $G = \begin{pmatrix} A_1W_1 \\ A_2W_2 \\ \vdots \\ A_NW_N \end{pmatrix}$, and $H = \begin{pmatrix} B_1W_1 \\ B_2W_2 \\ \vdots \\ B_NW_N \end{pmatrix}$.

Since $G$ is a $NxN$ full rank matrix, pre-multiplying by it's inverse we get:

$$\Delta x_t = G^{-1}a + G^{-1}H\Delta x_{t-1} + G^{-1}\varepsilon_t \tag{7}$$

Equation (7) shows that, if we have $a$, $G$ *and* $H$ (whose parameters can be consistently estimated equation by equation under the hypothesis of weak exogeneity), we can forecast as a traditional VAR(1) model.

In the long run, if the system is stationary (in our case, if GDP growth rates converges to a stable path), we can rewrite (7) as:

$$(I - G^{-1}H)\Delta\bar{x}_t = G^{-1}a + G^{-1}\varepsilon_t \tag{8}$$

pre-multiplying both sides by $(I - G^{-1}H)^{-1}$, we obtain the expected long-run growth rate of vector $x$:

$$E[\Delta\bar{x}] = \Theta_a = (I - G^{-1}H)^{-1}G^{-1}a \tag{9}$$

Equation 9 shows that the stationary long-run growth rate of countries are linked through G, H and a matrices, whose contains parameters of every country in the model, besides the trade weights.

## 3.2 Modeling a hypothetical downturn

Since the focus of this paper is to assess the effects of changes in per capita income, our exercise relies on hypothetical changes in $\Theta_a$ vector, more precisely, on the coefficient vector $a$. One can estimate the effect of a permanent Chinese downturn, e.g., on the rest of the countries by changing permanently $a_7$ drift parameter in Chinese equation[2] in such a way that the Chinese long-run growth equals the value chosen by the analyst. Note that it is different from a traditional impulse response analysis.

Suppose that we want to estimate the effect of a 1 p.p. slowdown in Chinese long-run growth. Defining $k = \begin{pmatrix} 0 & 0 & ... & -0.01 & 0 & ... & 0 \end{pmatrix}'$, the new constant coefficient can be calculated as, $\tilde{a}_i = a_i + k_i/diag_i((I -$

[2] In our case, i=7 refers to China.

$G^{-1}H)^{-1}G^{-1}$), with i=7 in Chinese case. The new long-run growth vector, $\Theta_{\tilde{a}}$, can be recalculated using (9). Note that, although only the constant coefficient on the Chinese equation has changed, all expected long-run growth rates change due to the interdependence among countries. However, if we are interested in addressing the short-run effects of a one-period shock in a specified country, we can directly impose this shock for one period in the specified country equation.

# 4 Data and Results

## 4.1 Data

The data covers the period of 1970 to 2013 and 38 countries (which covers, in average, 88% of world GDP in that period). Frequency of the data is annual. Gross Domestic Product per capita growth rate is obtained from World Bank website. Trade data (Exports plus Imports) are obtained at the International Financial Statistics maintained by International Monetary Fund (IFS-IMF).[3] Only data for the last ten years were considered to calculate the weights to be used in the global model. [4]

Since the average share of United States on its trade partners is high (average of 17.9% of total trade) and their great impact in the rest of the world economies, we assume that United States is a dominant unit. This is similar to Chudik & Smith (2013). Given a substantial weight on other countries (10.1% on average) and the strong relevance on other European countries, we also consider Germany as a dominant country.[5] This implies that GDP per capita growth of USA and Germany should be considered as endogenous variables with respect to their external variables, and then parameter $\theta_0$ in both equations are assumed to be zero. Besides this, GDP per capita growth (contemporaneous and lagged) of USA and Germany also enters in other countries equations as a global variable.

## 4.2 The model

### 4.2.1 Autometrics: Empirical Model Discovery

Empirical model discovery is based on the idea that abstract theory, although important, plays a restrict role in understanding economic data. A quote from Hendry (2011) captures the idea perfectly: "When a theory model is simply imposed on the evidence, little can be learned – reaching outside is essential to reveal phenomena that were not originally conceived ... Rather than being imposed, theory formulations should be retained when modeling as

[3] Oil Prices (end of period) are used in section 4.4.2, and are also from IFS-IMF.

[4] In section 4.3.3 we use last twenty years and the main results did not change significantly.

[5] In section 4.3.1 we also did the analysis by adding China as a dominant country. Without considering USA and Germany as dominant countries, the results do not seem reasonable and are very unstable.

part of the process of evaluating them, jointly with discovering what additional features are substantively relevant".

The object of interest of any researcher is to unveil the true data generating process (DGP). As this could, in theory, involve all the economy variables, theory usually restricts the important ones to a set of independent variables ($\mathbf{x}_t$) that are most capable to unveil that true DGP. The derivation of the DGP in the space of m+1 variables $\mathbf{x}_t$ being modeled is called local DGP (LDGP). Thus, the LDGP is then a reduction of the true DGP to a subset of variables believed to sufficiently explain most of its relevant behavior. But it would be a naive assumption to think that only a linear model containing $\mathbf{x}_t$ would be sufficient to explain all of the dependent variable variation. A broader formulation that could allow relations between its components (the independent variables), longer lags, wider range of possible functional forms, and multiple shifts and outliers are probably necessary. The ability to add all this possibilities may considerably increase the number of variables to be estimated, and that could impose a tough challenge to finding the LDGP. In this context, it would not be uncommon to have more variables to be estimated than observations. At this point, automatic selection algorithms that efficiently searches for the simplest acceptable representation of the LDGP are used. They do so by conducting a mixture of general-to-simple and block expanding searches in all possible model candidates. This selection method should be efficient at a point as to present a small probability of retaining irrelevant variables, and a large probability of retaining variables similar to the LDGP when conducting inference at the same significant levels. Having found an "acceptable parsimonious" selection that would characterize the target LDGP (also called the terminal model), a set of external evaluation tests are performed in order to validate the model.

In sum, this empirical recipe for model discovery uses theory to choose the important variables that could be explaining the dependent variable behavior, and at the same time, it analyzes a much larger set of possibilities that are way beyond those individual variables. Autometrics, embedded in OxMetrics PcGive software, is one tool that could be used for this computationally intense empirical model search and selection.

#### 4.2.2 The Baseline Model

Given the limited number of observations in our model, we choose to perform an automatic model selection via Autometrics, developed by Hendry & Doornik (2014).[6]

The general unrestricted system (GUM) to be estimated for non-dominant country is:

[6] Autometrics automatic model selection was performed with target size of 0.1 and unrestricted constant.

$$\Delta LGDPPC_{i,t} = a_i + \begin{bmatrix} \theta_{i,0} \\ \psi^1_{i,0} \\ \psi^1_{i,0} \end{bmatrix}' \begin{bmatrix} \Delta LGDPPC^*_{i,t} \\ \Delta LGDPPCUSA_t \\ \Delta LGDPPCGER_t \end{bmatrix} + \begin{bmatrix} \phi_{i,1} \\ \theta_{i,1} \\ \psi^1_{i,1} \\ \psi^2_{i,1} \end{bmatrix}' \begin{bmatrix} \Delta LGDPPC_{i,t-1} \\ \Delta LGDPPC^*_{i,t-1} \\ \Delta LGDPPCUSA_{t-1} \\ \Delta LGDPPCGER_{t-1} \end{bmatrix} + \varepsilon_{it} \quad (10)$$

For dominant countries, United States and Germany, we estimate the following system:

$$\begin{bmatrix} \Delta LGDPPC_{i,t} \\ \Delta LGDPPC^*_{i,t} \end{bmatrix} = \begin{bmatrix} a_i \\ a^*_i \end{bmatrix} + \begin{bmatrix} \phi_{i,1} & \phi^*_{i,1} \\ \theta_{i,1} & \theta^*_{i,1} \\ \psi^1_{i,1} & \psi^{1*}_{i,1} \end{bmatrix}' \begin{bmatrix} \Delta LGDPPC_{i,t-1} \\ \Delta LGDPPC^*_{i,t-1} \\ \Delta LGDPPCDOM_{i,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i,t} \\ \varepsilon^*_{i,t} \end{bmatrix} \quad (11)$$

where $\Delta LGDPPCDOM_{i,t-1}$ is the lagged change in per capita GDP of Germany in United States equation, and vice-versa. Note that only the first equation in the system given by (11) is relevant to solve (7), but we need to jointly estimate the system for inference purposes.

Table 1 shows the estimated coefficients for all equations. We can note that the external variable seems relevant for most of the countries. For Australia, China, Greece, Hong Kong, Mexico, New Zealand and Norway the external variable is not relevant, but United States or German growth rates are. Turkey was the only country that the model selection did not choose any variable at all. The reader can note that for most European countries the external/dominant variable is relevant. This fact can be seen by the R-squared in the regressions. Austria, Belgium and UK models do not contain any lagged variable, but external variables explains, respectively, 0.63, 0.76 and 0.64 of the variation of per capita GDP. It is also important to highlight that in many equations, coefficient estimates of USA and Germany are negative, but it does not mean that the impact of these countries are negative. There is a direct effect of the variable of these countries and an indirect effect given that they are part of external variable.

Figure 1 plots the roots of the system. Since we estimated an single variable system with annual frequency and one lag only, the dynamics are not rich, but it is very stable (the automatic model selection procedure helps to simplify the system). It is also possible to see that, since there are no roots close to the unit circle, the convergence after a shock is quite fast. In most simulations performed, 5 periods (years) after a shock, the system is already stabilized.

### 4.3 Impulse Response for Different Scenarios

In the first exercise we try to identify the impacts of a one-period shock on a selected country. Particularly

| Country | Constant | Contemporaneous Coefficients | | | Lagged Coefficients (t-1) | | | | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|
| | | GDP* | GDP USA | GDP GER | GDP | GDP* | GDP USA | GDP GER | |
| Argentina | -0.018 | 1.803 | - | - | - | - | -0.923 | - | 0.23 |
| Australia | 0.013 | - | - | - | - | - | 0.591 | -0.323 | 0.47 |
| Austria | 0.003 | 0.891 | - | - | - | - | - | - | 0.63 |
| Belgium | -0.003 | 1.725 | -0.315 | -0.323 | - | - | - | - | 0.76 |
| Brazil | -0.010 | 0.828 | - | - | 0.363 | - | - | - | 0.26 |
| Canada | -0.003 | 0.868 | - | - | 0.324 | - | - | -0.182 | 0.75 |
| Chile | -0.026 | - | 0.776 | - | 0.287 | 0.941 | - | - | 0.28 |
| China | 0.047 | - | - | -0.260 | 0.450 | - | - | - | 0.25 |
| Colombia | 0.008 | 1.399 | -0.762 | - | - | - | - | - | 0.35 |
| Denmark | -0.001 | 1.101 | - | - | 0.260 | -0.516 | - | - | 0.65 |
| Finland | -0.027 | 2.914 | -0.488 | -0.723 | 0.289 | - | - | - | 0.77 |
| France | -0.005 | 0.857 | - | - | 0.181 | - | - | - | 0.79 |
| Germany | 0.015 | - | - | - | 0.027 | -0.092 | 0.287 | - | 0.07 |
| Greece | -0.006 | - | 0.681 | - | 0.440 | - | -0.093 | - | 0.37 |
| Hong Kong | 0.019 | - | 0.566 | 0.691 | - | - | - | - | 0.30 |
| India | 0.053 | - | - | - | - | -0.590 | - | - | 0.09 |
| Indonesia | -0.019 | 2.060 | -0.909 | - | - | - | -0.674 | 0.826 | 0.48 |
| Ireland | 0.000 | 0.844 | - | - | 0.486 | - | - | - | 0.52 |
| Italy | -0.012 | 1.697 | -0.261 | - | 0.395 | -0.423 | - | - | 0.78 |
| Japan | -0.012 | 0.547 | - | 0.618 | - | - | - | - | 0.50 |
| Korea | 0.025 | 0.811 | - | - | - | - | - | - | 0.12 |
| Mexico | 0.002 | - | - | 0.650 | - | - | - | - | 0.15 |
| Netherlands | -0.005 | 0.874 | - | - | 0.516 | - | - | -0.237 | 0.82 |
| New Zealand | 0.004 | - | 0.680 | -0.401 | 0.348 | - | - | - | 0.34 |
| Norway | 0.002 | - | - | 0.301 | 0.649 | - | - | - | 0.56 |
| Paraguay | 0.000 | 0.826 | - | - | 0.317 | - | - | - | 0.34 |
| Peru | -0.027 | 2.226 | -1.435 | - | 0.408 | - | - | - | 0.32 |
| Portugal | -0.010 | 1.687 | - | - | 0.384 | -1.021 | - | 0.483 | 0.70 |
| Singapore | 0.007 | 1.743 | - | - | 0.322 | -1.084 | - | - | 0.61 |
| South Africa | -0.015 | 0.610 | - | - | 0.506 | - | - | - | 0.26 |
| Spain | -0.004 | 1.259 | -0.150 | -0.274 | 0.503 | - | - | -0.172 | 0.83 |
| Sweden | 0.001 | 0.938 | - | - | 0.351 | - | - | -0.534 | 0.69 |
| Switzerland | -0.011 | 0.653 | - | - | - | - | 0.364 | - | 0.48 |
| Turkey | 0.024 | - | - | - | - | - | - | - | 0.00 |
| United Kingdom | 0.001 | - | 0.767 | - | - | 0.592 | - | -0.464 | 0.64 |
| Uruguay | -0.021 | 1.752 | - | -0.636 | 0.479 | - | - | - | 0.60 |
| United States | 0.026 | - | - | - | 0.778 | -0.821 | - | -0.111 | 0.27 |
| Venezuela | -0.046 | 2.675 | -2.313 | 1.042 | - | - | - | - | 0.17 |

Table 1: Estimated coefficients in baseline specification

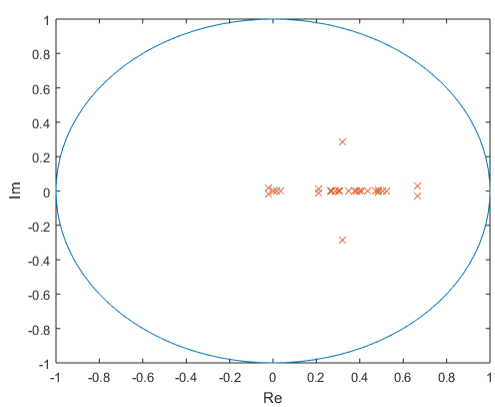


Figure 1: Roots of the estimated system

we are interested in addressing the effects of shocks applied to the United States', Germany's and China's growth rates on other countries. From our estimated model for United States, we obtained a residual in 2009, the first year after the subprime crisis, of -4.44%, which represents roughly 2.5 standard deviations. Since we are interested in addressing a effect of crisis in United States, a value near of this magnitude is not quite common and can be seen as a low probability negative shock. We also opt to simulate a shock of 2.5 standard deviations in Germany and China as well. Figure 2 to 4 shows the estimated cumulative effect in t=0, 1, 2 and 5 periods ahead of a negative shock in each country. We construct bootstrapped ranges for estimates using a 68% and 95% confidence intervals.

#### 4.3.1 United States

In the United States case, a shock of -4.4 p.p. in GDP per capita significantly reduces the GDP growth in most countries contemporaneously. Besides the impact on Commonwealth members (Canada, UK, Australia, New Zealand and Singapore), most of European and South American countries also suffer significant impacts of the shock. Even after five periods of the shock, the estimated effect is still significantly statistically different from zero in some countries. Our estimates suggest a great impact on Finland, Chile, Uruguay and Portugal, Greece, Spain.

#### 4.3.2 Germany

The scenario is similar in the German case. A shock of -4.8 p.p. in GDP per capita also significantly reduces other economies growth contemporaneously, but it has a positive impact in China and New Zealand. The shock, however, dies out faster than United States' shock. The final effect is stronger on oil producers countries such as Indonesia, Venezuela, Norway and Mexico. On the opposite side are New Zealand, China, UK, Canada, Australia and USA. They are positively affected by a German negative shock..

#### 4.3.3 China

The effects of a Chinese negative shock is notably smaller compared to the previous ones. One possible reason is that China is not considered as dominant unit in the baseline model, which limits the reaches of its shock to having only indirect effects on other countries.[7] China is a emerging market country, and although nowadays China is the second largest economy in world, twenty years ago the scenario was quite different. The volatility of China's growth has been reduced a lot during the last two decades [8]. Shocks applied to China have stronger impact in South American and Asian countries. In Asia, the examples are Indonesia, Singapore and South Korea. Maybe the effect of China is a regional one.

[7] In section 4.3.1 we add China as a dominant country, but the results did not change much for most countries.

[8] The overall sample residual standard deviation for China is 2.9. Considering the last 20 years, these values changes to 1.5. In the simulations we considered the value of 1.5.

#### 4.3.4 Assessing the of a permanent of downturn in growth

By doing the procedure described in section 3.2, we address the effects of hypothetical 2% reduction in the stationary steady-state growth rate of the US, Germany and China. The results are plotted in Figures 5 to 7. Although long-run effects are, by construction, qualitatively similar to the final effect of a one-period shock, the dynamics in first periods are different.

The results of our estimates suggest that a United States downturn would be more deleterious to world growth compared to a Chinese or a German downturn. Germany has a long-run per capita growth estimate close to 2% per year based on our model. China has an estimate of a 7.5% per capita growth rate per year. Basically, our results suggest that only a downturn in United States tend to generate relevant effects on a wider set of countries.

### 4.4 Robustness Check and Alternative Specifications

Given that we are working with narrow information set, it is possible to state that some equations may suffer from misspecification bias due to outliers or structural breaks. Furthermore, the choice of dominant countries and the time spam considered to calculate the trade shares are also arbitrary. To check the sensitivity of our results to these choices some robustness checks are performed.

We run simulations of previous sections under four different specifications given by:

a) imposing China as a dominant country, along with USA and Germany;

b) including the oil price as a global variable, that is common for all countries and;

c) changing the trade weights to mean of the last twenty years;

d) proceeding an automatic dummy selection (impulse and level) after the choice of the variables did in previous section using Autometrics software.

All the estimates are compared with the baseline model in Tables 2 and 3 in the appendix.[9]

#### 4.4.1 China as a dominant country

Given the growing importance of China in international markets during the last decades it seems reasonable to believe that China can be considered a dominant unit country. In the baseline model, we use trade weights averages from the last ten years. This might help to control this issue, but we also opt to consider China as a dominant unit. China growth seems to be important for some European and Asian countries. But for most of countries and simulations performed, however, results are quite similar to the baseline model. The major changes occurred in

[9] Automatic model selection was used in the first three cases, with the same criteria as the baseline specification. In the automatic dummy selection (IIS+SIS in Autometrics), the target size was chosen in 0.1%.

the simulation of Chinese effects on other economies, but there are also some minor second order changes in other countries simulations. The effect of a Chinese downturn seems to be weaker on Indonesia and Finland and stronger in Chile and India.

#### 4.4.2 Oil price as a global variable

In the GVAR framework it is natural to add a global variable as an explanatory variable in all equations. In this subsection we consider the oil price as an exogenous variable, that is common to all countries. The inclusion of oil prices can help to avoid possible sources of misspecification, acting as a control variable.

Suppose now that the DGP is given by:

$$\Delta x_{i,t} = a_i + \phi_{i,1}\Delta x_{i,t-1} + \theta_{i,0}\Delta x^*_{i,t} + \theta_{i,1}\Delta x^*_{i,t-1} + \psi_{i,0}\Delta z_t + \psi_{i,1}\Delta z_{t-1} + \varepsilon_{it} \tag{12}$$

where $\Delta z_t$is a global variable. We can solve the system as we did before and obtain:

$$\Delta x_t = G^{-1}a + G^{-1}H\Delta x_{t-1} + G^{-1}\psi_0\Delta z_t + G^{-1}\psi_1\Delta z_{t-1} + G^{-1}\varepsilon_t \tag{13}$$

The contemporaneous or lagged oil prices is selected in sixteen out of thirty eight equations, with positive sign in developing countries equations, possibly reflecting the commodity price dependence of this commodity. Results also did not change for most of countries. Korea, Norway, Paraguay, Venezuela and Turkey are the countries that have the results most affected by the inclusion of the oil price.

#### 4.4.3 Changing trade weights

International trade patterns changed a lot in the last decades, specially due to globalization and the emergence of many developing countries, like China, India and South Korea. Emerging countries have, nowadays, more importance in international trade than decades ago. We can opt to consider only the last few years to deal with this. However, by doing so, our estimates of weights may reduce the importance of developed countries. In this subsection we change the weights by using a twenty year average[10] to address if and how recent changes in trade patterns alter our results. Results remained quite unchanged for almost all countries, with a small reduction of

[10]Given data availability on trade flows, we could not use a longer period.

Chinese effect and an increase of USA effect. Variables selected to be part of the model using Autometrics are different from baseline case only for Canada, Italy, Greece, Portugal, Chile and Venezuela.

#### 4.4.4 Searching for structural break/misspecification in the mean using Autometrics

Finally, permanent structural change in the growth rates may had happened during the period of the sample. This can be a possible source of misspecification. Emerging market countries during the time span of our sample suffered from at least one domestic crisis in the sample period. It is clearly in Table 1 that R-squared for developing countries are rather lower. To handle with this fact, in this subsection we perform another automatic model selection procedure. Now we include level and impulse dummies using Autometrics to control for structural changes and instability in the Data Generator Process.

Since we want to incorporate only huge changes that have occurred we opt to work with a very tight target p-value criteria of 0.1% to selected a variable in the final model. In nineteen out of thirty eight countries equations, at least one dummy was selected. The effects of a one period shock in China on other economies changes only slightly. For United States and Germany, the effects of one period shock are, in many cases, stronger, possibly due the fact that outlier was disturbing the estimates of the parameters of the equations. Nonetheless, the effect of a slowdown in Germany does not change with respect to the baseline specification.

## 5 Final Remarks

The impacts of another crisis in USA or Europe and a possible Chinese slowdown concerns all countries and policy makers. In this work we tried to assess the effect of those scenarios, using an ex ante counterfactual analysis within a global AR framework. The global linkages seems to be relevant and strong for European, South-american and Commonwealth countries, but more discrete for asian countries. The results suggest that the United States still play the role of a global economy, affecting countries across the globe, whereas Germany and China play a regional role. A closer look at individual models can help to improve the significance of the results, but even with a simple one variable reduced form, some interesting and reasonable results can be obtained.

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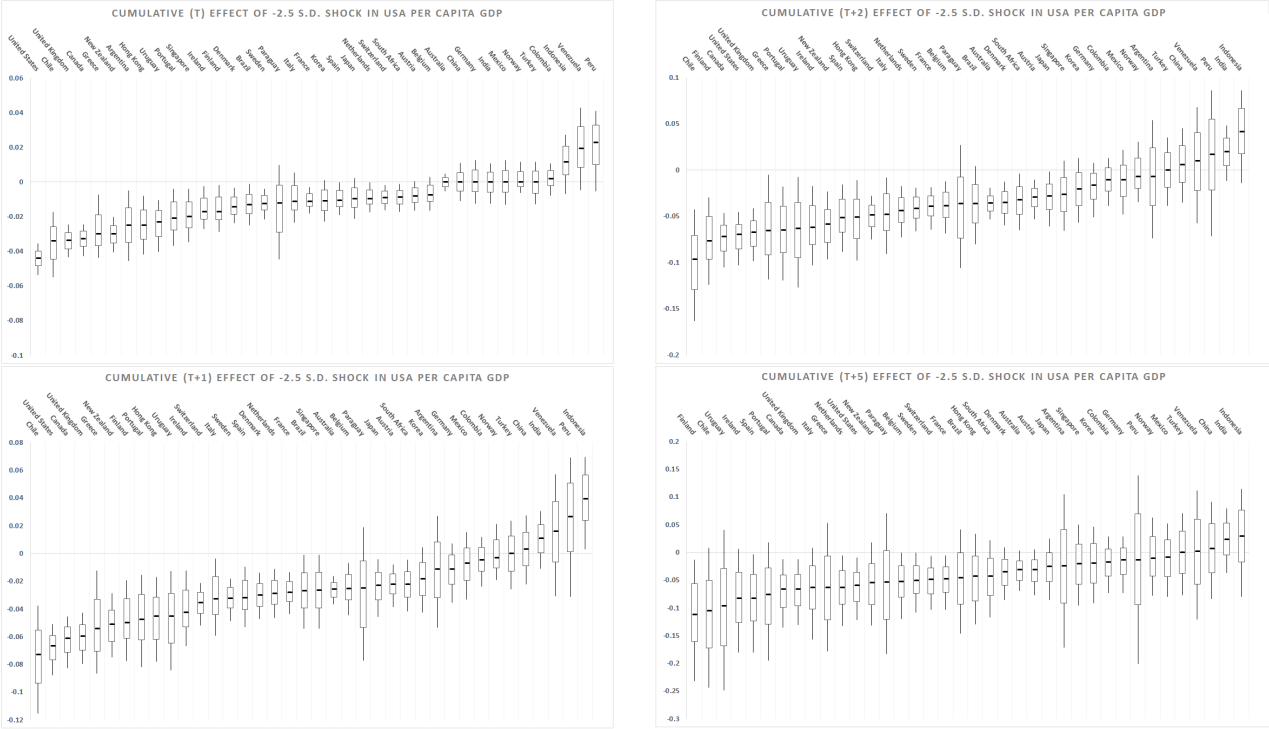


Figure 2: Cumulative effect in T, T+1, T+2 and T+5 of a 2.5 S.D. shock in United States GDP per capita

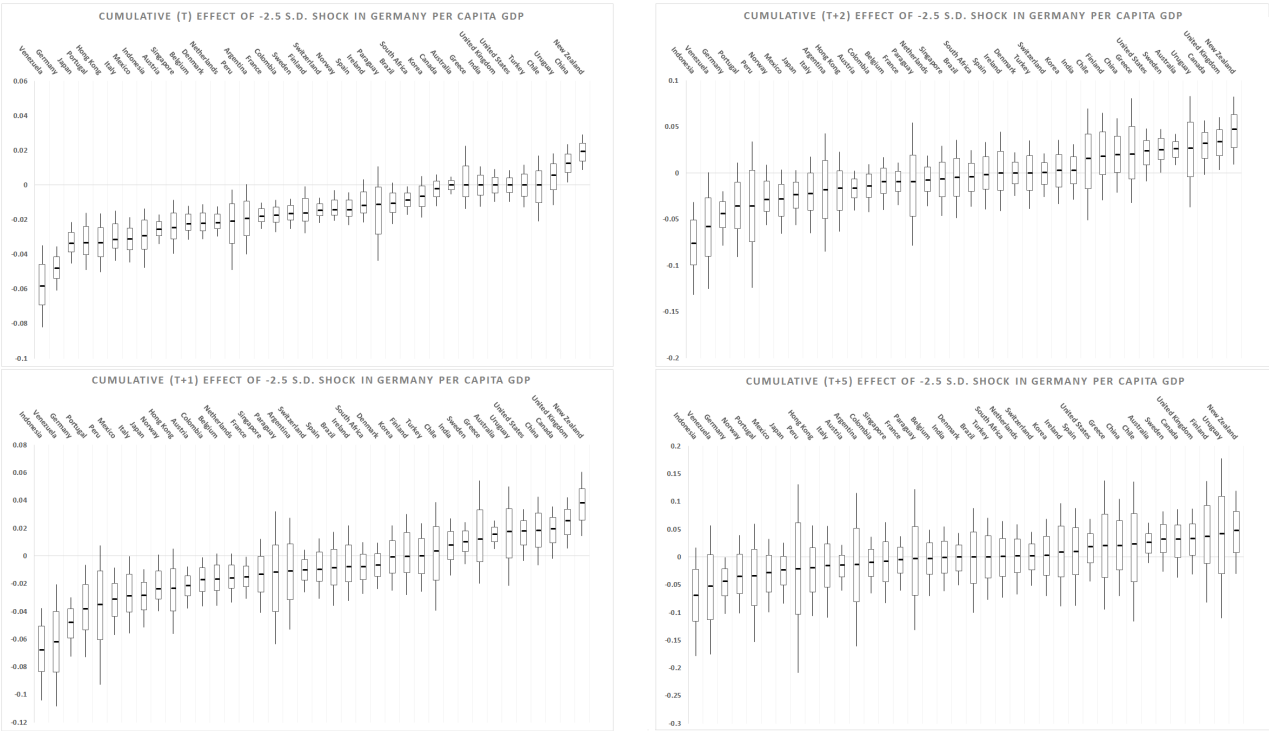


Figure 3: Cumulative effect in T, T+1, T+2 and T+5 of a 2.5 S.D. shock in German GDP per capita

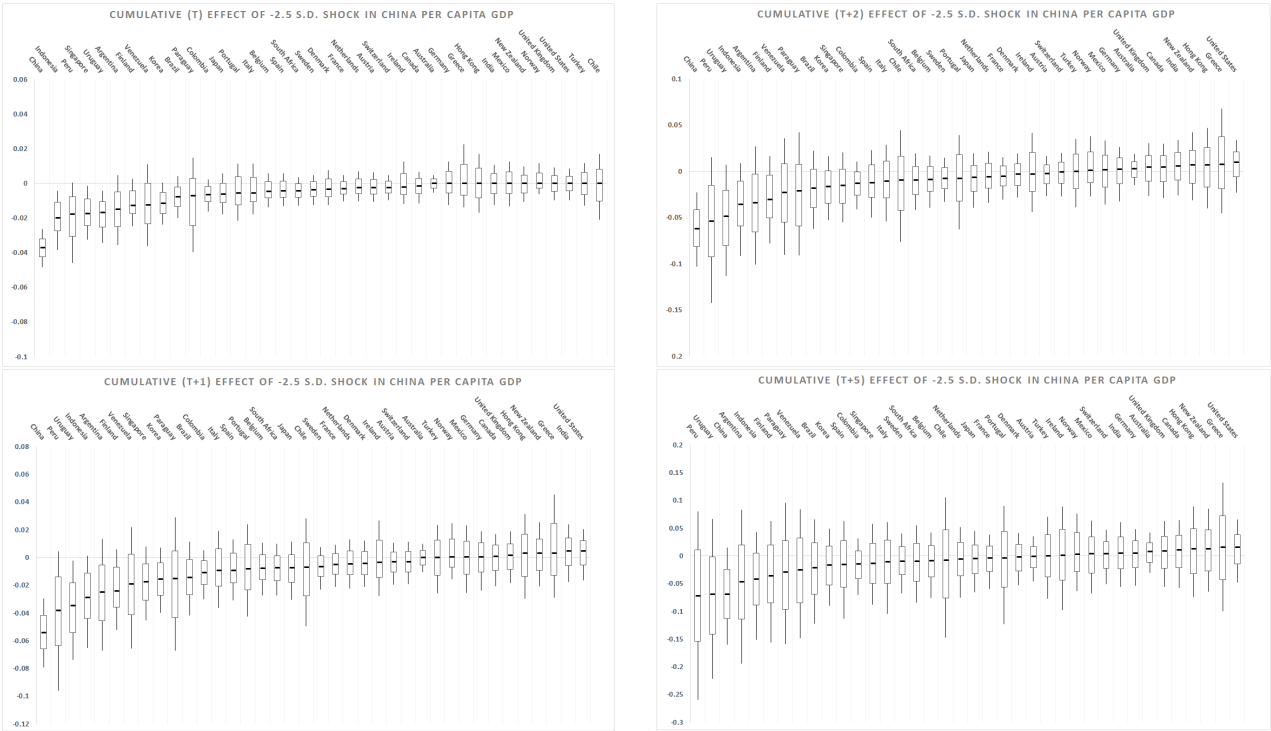


Figure 4: Cumulative effect in T, T+1, T+2 and T+5 of a 2.5 S.D. shock in China GDP per capita

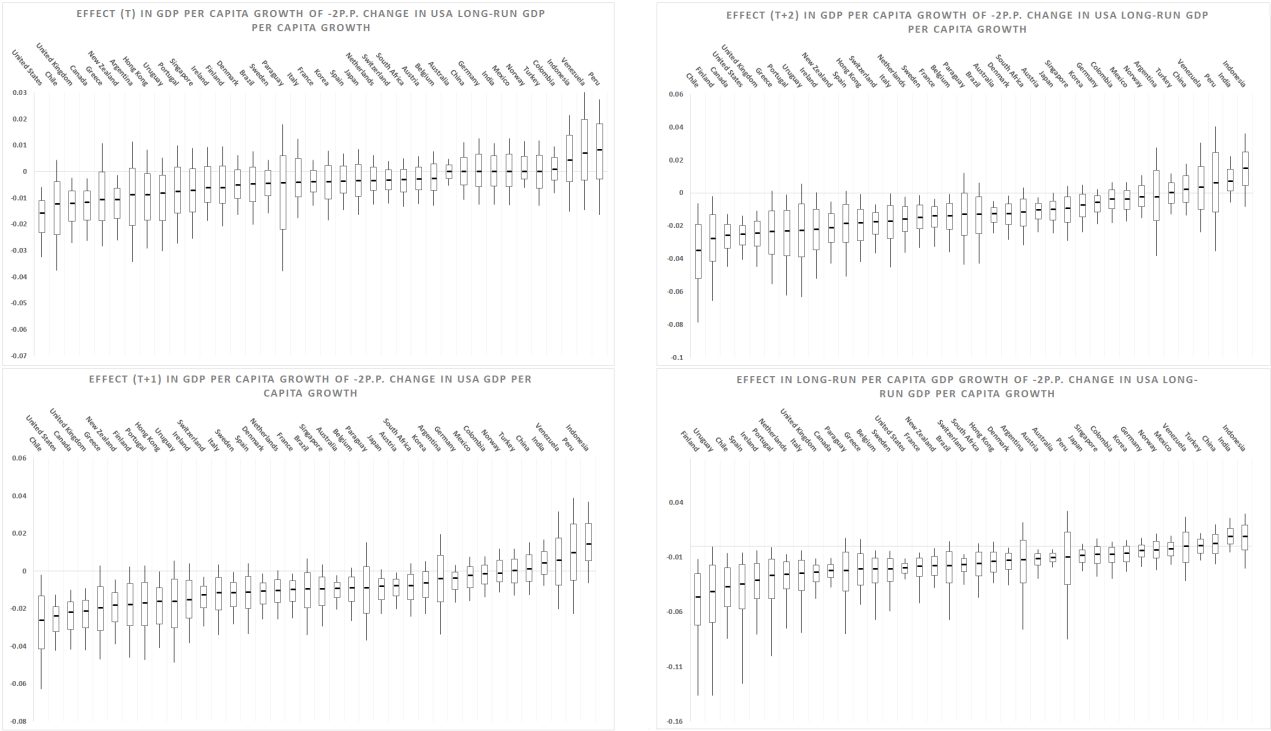


Figure 5: Cumulative effect in T, T+1, T+2 and in steady-state of a 2 p.p. slowdown in United States GDP per capita

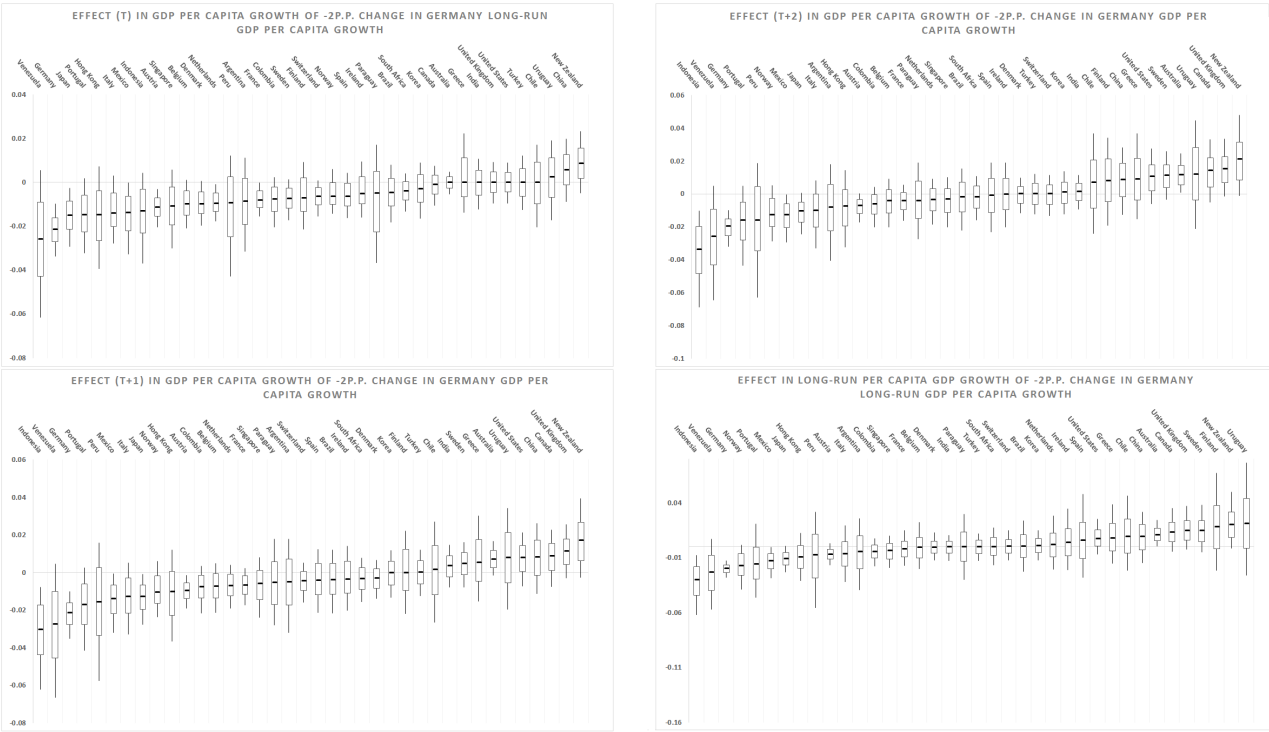


Figure 6: Cumulative effect in T, T+1, T+2 and in steady-state of a 2 p.p. slowdown in Germany GDP per capita

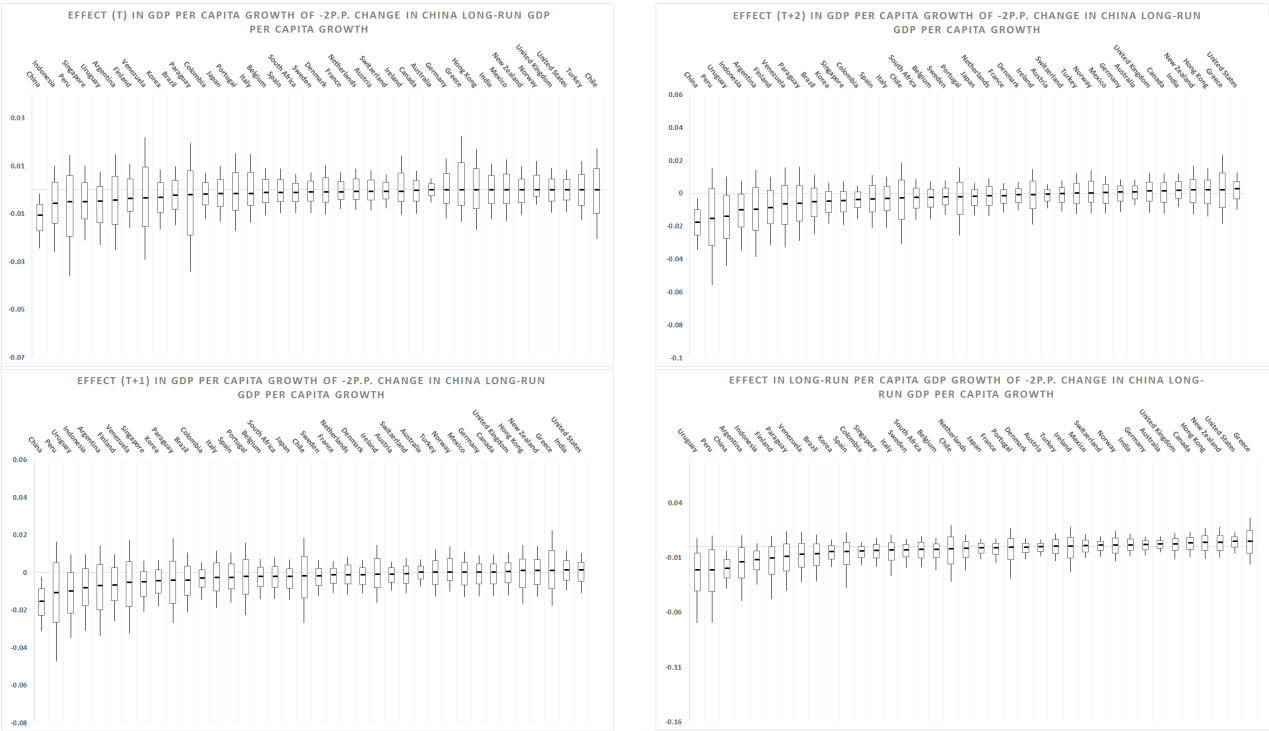


Figure 7: Cumulative effect in T, T+1, T+2 and in steady-state of a 2 p.p. slowdown in China GDP per capita

| Country | 2.5 S.D. shock on USA GDP per Capita Growth | | | | |
|---|---|---|---|---|---|
| | Baseline | China as dominant | OIL | 20 years | Dummy |
| Finland | -12.9% | -11.4% | -15.3% | -14.7% | -11.2% |
| Uruguay | -11.6% | -10.4% | -13.1% | -13.7% | -14.0% |
| Chile | -10.3% | -2.2% | -10.1% | -6.8% | -4.2% |
| Spain | -9.7% | -8.2% | -10.7% | -12.1% | -11.5% |
| Ireland | -8.8% | -7.8% | -9.0% | -8.9% | -10.0% |
| Portugal | -7.5% | -6.8% | -7.6% | -12.2% | -9.4% |
| Netherlands | -7.2% | -6.4% | -7.6% | -8.0% | -7.9% |
| Italy | -7.0% | -6.9% | -7.4% | -8.2% | -6.4% |
| United Kingdom | -6.7% | -5.2% | -6.9% | -6.6% | -10.1% |
| Canada | -6.3% | -6.2% | -5.9% | -5.6% | -9.3% |
| Paraguay | -6.2% | -5.1% | -3.3% | -7.5% | -6.6% |
| Greece | -5.8% | -6.1% | -6.7% | -5.4% | -14.1% |
| Belgium | -5.8% | -4.7% | -6.3% | -6.8% | -6.0% |
| Sweden | -5.8% | -5.2% | -7.2% | -6.4% | -7.8% |
| United States | -5.6% | -5.7% | -5.4% | -5.0% | -7.3% |
| France | -5.1% | -4.2% | -5.2% | -5.7% | -4.9% |
| New Zealand | -5.1% | -4.7% | -5.3% | -4.6% | -9.7% |
| Brazil | -5.0% | -4.7% | -5.2% | -6.3% | -3.9% |
| Switzerland | -4.7% | -3.1% | -4.6% | -4.7% | -5.2% |
| South Africa | -4.5% | -4.5% | -2.8% | -4.8% | -4.7% |
| Hong Kong | -3.9% | -5.0% | -3.4% | -3.6% | -2.9% |
| Denmark | -3.6% | -3.3% | -4.0% | -3.7% | -3.4% |
| Argentina | -3.6% | -2.0% | -4.0% | -4.6% | -0.6% |
| Austria | -3.2% | -3.1% | -3.1% | -3.5% | -1.9% |
| Australia | -2.9% | -2.1% | -3.0% | -2.6% | -5.4% |
| Peru | -2.8% | -0.8% | -3.5% | -4.6% | -1.7% |
| Japan | -2.4% | -3.2% | -1.8% | -2.8% | -0.9% |
| Singapore | -2.1% | -6.1% | -1.3% | -3.0% | -2.3% |
| Colombia | -2.1% | -2.2% | -4.1% | -3.2% | -1.9% |
| Korea | -1.9% | -4.9% | 0.2% | -3.1% | -1.3% |
| Germany | -1.1% | -1.2% | -0.5% | -1.1% | 3.4% |
| Norway | -1.0% | -1.1% | -4.2% | -0.9% | 2.8% |
| Mexico | -0.7% | 0.0% | -0.2% | -0.7% | 2.2% |
| Venezuela | -0.1% | -4.5% | -3.1% | -4.8% | 5.5% |
| Turkey | 0.0% | 0.0% | -3.2% | 0.0% | 0.0% |
| China | 0.5% | 0.0% | 0.2% | 0.5% | -0.3% |
| India | 2.3% | 2.5% | 2.3% | 2.7% | 2.6% |
| Indonesia | 2.4% | -5.4% | 2.2% | 0.8% | 2.5% |

| | -2 p.p. slowdown on USA GDP per capita growth | | | | |
|---|---|---|---|---|---|
| | Baseline | China as Dominant | OIL | 20 years | Dummy |
| Finland | -4.7% | -4.0% | -5.8% | -5.9% | -3.0% |
| Uruguay | -4.2% | -3.6% | -4.9% | -5.5% | -3.8% |
| Chile | -3.7% | -0.8% | -3.8% | -2.7% | -1.1% |
| Spain | -3.5% | -2.9% | -4.0% | -4.8% | -3.1% |
| Ireland | -3.2% | -2.7% | -3.4% | -3.5% | -2.7% |
| Portugal | -2.7% | -2.4% | -2.8% | -4.9% | -2.5% |
| Netherlands | -2.6% | -2.2% | -2.9% | -3.2% | -2.1% |
| Italy | -2.5% | -2.4% | -2.8% | -3.3% | -1.7% |
| United Kingdom | -2.4% | -1.8% | -2.6% | -2.6% | -2.8% |
| Canada | -2.3% | -2.2% | -2.2% | -2.2% | -2.5% |
| Paraguay | -2.2% | -1.8% | -1.2% | -3.0% | -1.8% |
| Greece | -2.1% | -2.1% | -2.5% | -2.1% | -3.8% |
| Belgium | -2.1% | -1.7% | -2.4% | -2.7% | -1.6% |
| Sweden | -2.1% | -1.8% | -2.7% | -2.5% | -2.1% |
| United States | -2.0% | -2.0% | -2.0% | -2.0% | -2.0% |
| France | -1.8% | -1.5% | -2.0% | -2.3% | -1.3% |
| New Zealand | -1.8% | -1.6% | -2.0% | -1.8% | -2.6% |
| Brazil | -1.8% | -1.6% | -2.0% | -2.5% | -1.1% |
| Switzerland | -1.7% | -1.1% | -1.7% | -1.9% | -1.4% |
| South Africa | -1.6% | -1.6% | -1.0% | -1.9% | -1.3% |
| Hong Kong | -1.4% | -1.7% | -1.3% | -1.4% | -0.8% |
| Denmark | -1.3% | -1.2% | -1.5% | -1.5% | -0.9% |
| Argentina | -1.3% | -0.7% | -1.5% | -1.8% | -0.2% |
| Austria | -1.2% | -1.1% | -1.2% | -1.4% | -0.5% |
| Australia | -1.1% | -0.7% | -1.1% | -1.0% | -1.5% |
| Peru | -1.0% | -0.3% | -1.3% | -1.8% | -0.5% |
| Japan | -0.9% | -1.1% | -0.7% | -1.1% | -0.2% |
| Singapore | -0.8% | -2.1% | -0.5% | -1.2% | -0.6% |
| Colombia | -0.8% | -0.8% | -1.6% | -1.3% | -0.5% |
| Korea | -0.7% | -1.7% | 0.1% | -1.3% | -0.4% |
| Germany | -0.4% | -0.4% | -0.2% | -0.4% | 0.9% |
| Norway | -0.4% | -0.4% | -1.6% | -0.4% | 0.8% |
| Mexico | -0.3% | 0.0% | -0.1% | -0.3% | 0.6% |
| Venezuela | 0.0% | -1.6% | -1.2% | -1.9% | 1.5% |
| Turkey | 0.0% | 0.0% | -1.2% | 0.0% | 0.0% |
| China | 0.2% | 0.0% | 0.1% | 0.2% | -0.1% |
| India | 0.8% | 0.9% | 0.9% | 1.1% | 0.7% |
| Indonesia | 0.9% | -1.9% | 0.8% | 0.3% | 0.7% |

| Country | 2.5 S.D. shock on Germany GDP per Capita Growth | | | | |
|---|---|---|---|---|---|
| | Baseline | China as dominant | OIL | 20 years | Dummy |
| Indonesia | -6.8% | -1.3% | -6.3% | -6.1% | -3.3% |
| Venezuela | -5.2% | -5.1% | 0.2% | 0.5% | -8.6% |
| Germany | -4.5% | -4.3% | -4.7% | -4.6% | -6.5% |
| Norway | -3.9% | -3.7% | 1.2% | -3.9% | -5.6% |
| Portugal | -3.6% | -3.8% | -5.3% | -2.6% | -1.9% |
| Mexico | -2.9% | 0.0% | -2.3% | -3.0% | -4.2% |
| Japan | -2.5% | -2.1% | -2.9% | -2.2% | -2.2% |
| Hong Kong | -2.1% | -2.3% | -2.3% | -2.5% | -1.9% |
| Peru | -1.7% | -6.9% | -2.4% | -0.6% | -3.0% |
| Austria | -1.5% | -1.7% | -1.8% | -1.4% | -2.6% |
| Italy | -1.5% | -1.1% | -2.2% | -0.4% | -3.4% |
| Argentina | -1.0% | -4.6% | -1.2% | 0.1% | -3.3% |
| Colombia | -1.0% | -1.9% | 0.5% | -0.1% | -1.0% |
| Singapore | -0.8% | 1.6% | -2.6% | -0.9% | -0.4% |
| France | -0.5% | -0.3% | -1.5% | -0.1% | -1.1% |
| Belgium | -0.2% | -0.4% | -0.8% | 0.4% | -1.1% |
| Denmark | -0.1% | -0.4% | 0.1% | -0.1% | -0.9% |
| India | -0.1% | -1.0% | 0.2% | -0.1% | -0.1% |
| Paraguay | 0.0% | -2.5% | -2.8% | 0.8% | -1.9% |
| Turkey | 0.0% | 0.0% | 1.0% | 0.0% | 0.0% |
| South Africa | 0.0% | -0.5% | 2.2% | 0.1% | -0.2% |
| Switzerland | 0.1% | -1.2% | -0.2% | 0.0% | 0.1% |
| Brazil | 0.1% | -1.2% | -0.1% | 0.5% | -0.7% |
| Korea | 0.2% | -0.2% | -4.4% | 0.1% | 0.0% |
| Netherlands | 0.4% | -0.4% | -0.1% | 0.9% | -0.2% |
| Ireland | 0.9% | 0.4% | 0.3% | 0.9% | 0.9% |
| Spain | 1.3% | 0.5% | 0.2% | 2.5% | 0.4% |
| United States | 1.7% | 2.3% | 1.6% | 1.2% | 2.9% |
| Greece | 1.8% | 4.5% | 2.0% | 3.4% | 5.6% |
| Chile | 2.1% | -7.4% | 1.4% | 1.7% | 0.3% |
| China | 2.1% | 0.0% | 2.2% | 2.2% | 0.5% |
| Australia | 2.5% | 1.7% | 2.5% | 2.2% | 3.8% |
| Canada | 3.0% | 2.1% | 1.5% | 2.7% | 4.7% |
| United Kingdom | 3.3% | 1.6% | 3.1% | 3.1% | 4.8% |
| Sweden | 3.3% | 2.5% | 4.1% | 3.8% | 0.7% |
| Finland | 4.0% | 1.6% | 5.6% | 5.3% | -1.4% |
| New Zealand | 4.5% | 4.2% | 4.5% | 4.1% | 7.0% |
| Uruguay | 4.8% | 0.6% | 5.1% | 6.2% | 3.9% |

| | -2 p.p. slowdown on Germany GDP per capita growth | | | | |
|---|---|---|---|---|---|
| | Baseline | China as Dominant | OIL | 20 years | Dummy |
| Indonesia | -3.0% | -0.6% | -2.7% | -2.6% | -1.0% |
| Venezuela | -2.3% | -2.4% | 0.1% | 0.2% | -2.7% |
| Germany | -2.0% | -2.0% | -2.0% | -2.0% | -2.0% |
| Norway | -1.7% | -1.7% | 0.5% | -1.7% | -1.7% |
| Portugal | -1.6% | -1.8% | -2.2% | -1.1% | -0.6% |
| Mexico | -1.3% | 0.0% | -1.0% | -1.3% | -1.3% |
| Japan | -1.1% | -1.0% | -1.2% | -1.0% | -0.7% |
| Hong Kong | -1.0% | -1.1% | -1.0% | -1.1% | -0.6% |
| Peru | -0.8% | -3.2% | -1.0% | -0.3% | -0.9% |
| Austria | -0.7% | -0.8% | -0.8% | -0.6% | -0.8% |
| Italy | -0.7% | -0.5% | -0.9% | -0.2% | -1.1% |
| Argentina | -0.4% | -2.1% | -0.5% | 0.0% | -1.0% |
| Colombia | -0.4% | -0.9% | 0.2% | 0.0% | -0.3% |
| Singapore | -0.4% | 0.8% | -1.1% | -0.4% | -0.1% |
| France | -0.2% | -0.2% | -0.6% | -0.1% | -0.4% |
| Belgium | -0.1% | -0.2% | -0.3% | 0.2% | -0.3% |
| Denmark | 0.0% | -0.2% | 0.0% | 0.0% | -0.3% |
| India | 0.0% | -0.5% | 0.1% | 0.0% | 0.0% |
| Paraguay | 0.0% | -1.2% | -1.2% | 0.3% | -0.6% |
| Turkey | 0.0% | 0.0% | 0.4% | 0.0% | 0.0% |
| South Africa | 0.0% | -0.2% | 0.9% | 0.1% | -0.1% |
| Switzerland | 0.0% | -0.5% | -0.1% | 0.0% | 0.0% |
| Brazil | 0.0% | -0.6% | 0.0% | 0.2% | -0.2% |
| Korea | 0.1% | -0.1% | -1.9% | 0.0% | 0.0% |
| Netherlands | 0.2% | -0.2% | -0.1% | 0.4% | -0.1% |
| Ireland | 0.4% | 0.2% | 0.1% | 0.4% | 0.3% |
| Spain | 0.6% | 0.2% | 0.1% | 1.1% | 0.1% |
| United States | 0.8% | 1.1% | 0.7% | 0.5% | 0.9% |
| Greece | 0.8% | 2.1% | 0.9% | 1.5% | 1.7% |
| Chile | 0.9% | -3.5% | 0.6% | 0.7% | 0.1% |
| China | 0.9% | 0.0% | 0.9% | 0.9% | 0.2% |
| Australia | 1.1% | 0.8% | 1.0% | 1.0% | 1.2% |
| Canada | 1.3% | 1.0% | 0.6% | 1.2% | 1.4% |
| United Kingdom | 1.5% | 0.7% | 1.3% | 1.3% | 1.5% |
| Sweden | 1.5% | 1.2% | 1.7% | 1.7% | 0.2% |
| Finland | 1.8% | 0.8% | 2.4% | 2.3% | -0.4% |
| New Zealand | 2.0% | 1.9% | 1.9% | 1.8% | 2.2% |
| Uruguay | 2.1% | 0.3% | 2.2% | 2.7% | 1.2% |

Table 2: Robustness Check and Alternative Specifications for USA and Germany simulations

| Country | 2.5 S.D. shock on China GDP per Capita Growth | | | | |
|---|---|---|---|---|---|
| | Baseline | China as dominant | OIL | 20 years | Dummy |
| Uruguay | -7.6% | -7.8% | -8.0% | -4.3% | -7.0% |
| Peru | -7.5% | -7.4% | -7.4% | -4.8% | -4.2% |
| China | -7.0% | -7.1% | -7.2% | -6.9% | -6.8% |
| Argentina | -4.9% | -5.3% | -4.9% | -2.4% | -3.9% |
| Indonesia | -4.3% | -1.5% | -5.2% | -2.9% | -0.9% |
| Finland | -3.8% | -1.7% | -2.8% | -2.1% | -2.8% |
| Paraguay | -3.2% | -3.5% | -1.0% | -1.6% | -3.6% |
| Venezuela | -2.6% | -4.6% | -3.5% | -2.9% | -1.5% |
| Brazil | -2.3% | -2.3% | -2.3% | -1.2% | -1.7% |
| Korea | -1.7% | 0.9% | 1.4% | -1.6% | -1.0% |
| Spain | -1.6% | 0.6% | -2.9% | -0.6% | -1.2% |
| Colombia | -1.6% | -1.8% | -0.3% | -1.1% | -0.6% |
| Singapore | -1.3% | 1.0% | -2.8% | -0.9% | -0.8% |
| Italy | -1.1% | 1.3% | -1.4% | -0.1% | -0.7% |
| Sweden | -1.1% | -0.2% | -1.2% | -0.6% | -0.8% |
| South Africa | -1.0% | -0.7% | -1.1% | -0.6% | -0.9% |
| Belgium | -0.9% | 1.0% | -1.4% | -0.4% | -0.7% |
| Chile | -0.8% | -5.7% | -0.5% | 1.2% | -1.2% |
| Netherlands | -0.6% | -0.3% | -0.9% | -0.2% | -0.4% |
| Japan | -0.5% | 0.6% | -0.1% | -0.5% | -0.4% |
| France | -0.4% | 1.4% | -1.1% | -0.1% | -0.2% |
| Portugal | -0.3% | 0.9% | -2.4% | 0.5% | -0.5% |
| Denmark | -0.2% | 0.1% | -0.2% | -0.1% | -0.1% |
| Austria | -0.1% | 1.2% | 0.0% | 0.0% | 0.2% |
| Turkey | 0.0% | 0.0% | 1.0% | 0.0% | 0.0% |
| Ireland | 0.1% | 1.0% | -0.1% | 0.2% | 0.1% |
| Mexico | 0.3% | 0.0% | 0.4% | 0.2% | 0.7% |
| Switzerland | 0.4% | -0.5% | 0.4% | 0.3% | 0.4% |
| Norway | 0.4% | 0.3% | 1.3% | 0.2% | 0.9% |
| India | 0.4% | -3.5% | 0.5% | 0.2% | 0.4% |
| Germany | 0.5% | 0.4% | 0.9% | 0.3% | 1.1% |
| Australia | 0.8% | 0.3% | 0.7% | 0.4% | 0.3% |
| United Kingdom | 0.9% | 0.8% | 0.7% | 0.5% | 0.3% |
| Canada | 1.2% | 1.0% | 1.3% | 1.0% | 0.6% |
| Hong Kong | 1.2% | -0.1% | 1.5% | 0.7% | 1.4% |
| New Zealand | 1.3% | -1.2% | 1.2% | 0.8% | 0.5% |
| United States | 1.6% | 1.3% | 1.7% | 0.9% | 1.1% |
| Greece | 1.6% | 1.3% | 2.1% | 0.9% | 2.1% |

| | -2 p.p. slowdown on China GDP per capita growth | | | | |
|---|---|---|---|---|---|
| | Baseline | China as Dominant | OIL | 20 years | Dummy |
| Uruguay | -2.2% | -2.2% | -2.2% | -1.2% | -2.0% |
| Peru | -2.1% | -2.1% | -2.1% | -1.4% | -1.2% |
| China | -2.0% | -2.0% | -2.0% | -2.0% | -2.0% |
| Argentina | -1.4% | -1.5% | -1.4% | -0.7% | -1.1% |
| Indonesia | -1.2% | -0.4% | -1.4% | -0.8% | -0.3% |
| Finland | -1.1% | -0.5% | -0.8% | -0.6% | -0.8% |
| Paraguay | -0.9% | -1.0% | -0.3% | -0.5% | -1.0% |
| Venezuela | -0.7% | -1.3% | -1.0% | -0.8% | -0.4% |
| Brazil | -0.7% | -0.7% | -0.6% | -0.4% | -0.5% |
| Korea | -0.5% | 0.2% | 0.4% | -0.5% | -0.3% |
| Spain | -0.5% | 0.2% | -0.8% | -0.2% | -0.4% |
| Colombia | -0.4% | -0.5% | -0.1% | -0.3% | -0.2% |
| Singapore | -0.4% | 0.3% | -0.8% | -0.3% | -0.2% |
| Italy | -0.3% | 0.4% | -0.4% | 0.0% | -0.2% |
| Sweden | -0.3% | -0.1% | -0.3% | -0.2% | -0.2% |
| South Africa | -0.3% | -0.2% | -0.3% | -0.2% | -0.3% |
| Belgium | -0.3% | 0.3% | -0.4% | -0.1% | -0.2% |
| Chile | -0.2% | -1.6% | -0.1% | 0.3% | -0.4% |
| Netherlands | -0.2% | -0.1% | -0.3% | -0.1% | -0.1% |
| Japan | -0.1% | 0.2% | 0.0% | -0.1% | -0.1% |
| France | -0.1% | 0.4% | -0.3% | 0.0% | -0.1% |
| Portugal | -0.1% | 0.2% | -0.7% | 0.2% | -0.1% |
| Denmark | -0.1% | 0.0% | -0.1% | 0.0% | 0.0% |
| Austria | 0.0% | 0.3% | 0.0% | 0.0% | 0.1% |
| Turkey | 0.0% | 0.0% | 0.3% | 0.0% | 0.0% |
| Ireland | 0.0% | 0.3% | 0.0% | 0.1% | 0.0% |
| Mexico | 0.1% | 0.0% | 0.1% | 0.1% | 0.2% |
| Switzerland | 0.1% | -0.1% | 0.1% | 0.1% | 0.1% |
| Norway | 0.1% | 0.1% | 0.4% | 0.1% | 0.3% |
| India | 0.1% | -1.0% | 0.1% | 0.1% | 0.1% |
| Germany | 0.1% | 0.1% | 0.2% | 0.1% | 0.3% |
| Australia | 0.2% | 0.1% | 0.2% | 0.1% | 0.1% |
| United Kingdom | 0.2% | 0.2% | 0.2% | 0.2% | 0.1% |
| Canada | 0.3% | 0.3% | 0.4% | 0.3% | 0.2% |
| Hong Kong | 0.4% | 0.0% | 0.4% | 0.2% | 0.4% |
| New Zealand | 0.4% | -0.3% | 0.3% | 0.2% | 0.1% |
| United States | 0.4% | 0.4% | 0.5% | 0.3% | 0.3% |
| Greece | 0.5% | 0.4% | 0.6% | 0.3% | 0.6% |

Table 3: Robustness Check and Alternative Specifications for China simulations