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Fluctuations in emerging economies: regional and global factors.

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Abstract

Discrepancies in output fluctuations between emerging and developed economies are well-documented in the literature. Differences however within developing economies have not been sufficiently scrutinised. This paper argues that global and regional shocks primarily drive the business cycle in emerging economies, and provides estimated results for cycle variance decomposition. The paper also offers a theoretical framework to check on the set of stylised facts common and specific to emerging economies. It finds that the proposed model is robust in accounting for region-specific features.
JEL Codes: **E32, E37, F44**.

1 Introduction

Lucas' (1977)[27] assertion that *one is led by the fact to conclude that [...] business cycles are all alike* is a pretty strong statement as far as emerging market economies (EMEs) are concerned. A first hand look at macroeconomic aggregates cast doubt as to the existence of consistent patterns in those economies. Agénor, McDermott & Prasad (1999)[2] point out that macroeconomic indicators in developing countries behave somewhat erratically, as they are prone to sudden crises and unpredictable policy changes. These fluctuations do not seem to exhibit patterns consistent with the definition of cycles. Nonetheless, in their attempt to describe stylised facts in emerging economies, Agénor & *al* offer a promising research program for business cycles in EMEs.

Numerous papers have sought to document and replicate stylised facts in small open economies. For instance, Mendoza (1991)[31] attempt to replicate the fluctuations of a small open economy (Canada) and finds that a Real Business Cycles (RBC) model manages quiet well in mimicking the country's salient stylised facts. For emerging economies, Kydland & Zarazaga (2002)[21] offer a neo-classical model to account for the *Lost Decade* in Argentina, and it performs well despite its simple setting.

Standard RBC framework however are not wholly adequate to capture core stylised facts in EMEs. The pioneering work of Aguiar & Gopinath (2004) [3] investigates strong counter-cyclical current accounts and large fluctuations in consumption among emerging markets, two key stylised facts standard RBC models fail to replicate. Their conclusions take the RBC-based research program on fluctuations in emerging economies a step further: they offer a model that concludes shocks to trend productivity are behind a stylised fact common to many EMEs: they point out that fluctuations of household consumption exceed those of output. In their expanded RBC model, Aguiar & Gopinath offer an alternative measure of exogenous shocks, one that has been reprised in Schmitt-Grohé & Uribe (2003)[44] as they compute a variant to keep it stationary, while Garcia-Cicco, Pancrazi & Uribe (2010) [14] offer a comprehensive review of the extended RBC model to describe fluctuations in Latin American economies and replicate stylised facts in some of them.

The mainstream view in EME business cycles assumes that all exogenous shocks can be consolidated into a composite technology shock with a stochastic trend. This means a shock to trend productivity would increase present and future output. Households anticipate this and increase their consumption at a higher rate than output. This additional demand is satisfied with increased imports, hence the negative correlation between trade balance and output on the one hand, and excess consumption fluctuations relative to output on the other.

Although the trend shock hypothesis solves for many stylised facts the standard theoretical framework fails to account for, it still fails to account for a host of other features. Specifically, while the literature agrees EME macroeconomic variables fluctuates a lot more than those of wealthier economies, little has been said about differences within emerging economies themselves. Given the literature's focus on Latin American economies, many stylised facts derived from that region are believed to be common to *all* EMEs, or have been extended to other developing nations, a rather strong hypothesis. This paper argues there are significant differences in stylised facts between emerging economies, and as a result it disputes conclusions that have been drawn from features specific to Latin America and not shared by other EMEs. The paper highlights in particular the fact that there are many common features between EMEs and developed economies, but also differences among EMEs themselves in some stylised facts. This means any generalisation of regional properties to all emerging economies may provide a distorted picture of how fluctuations behave in the latter.

In contrast to the literature mentioned above, the proposed model in this paper defines itself with the terms of Backus, Kehoe & Kydland (1992) [5]. Their multi-country RBC model attempts to account for consumption correlation among wealthy economies, and results led them to conclude models that seek to capture international business cycles would be more accurate when additional sources of exogenous shocks are incorporated. This stand against the trend shock hypothesis professed in the literature above, which is unable to account for the diverse set of stylised facts in EMEs. It contradicts Aguiar & Gopinath's argument that multifarious exogenous shocks can be consolidated into an aggregate shock to productivity with a trend component. On the contrary, this paper argues the RBC model performs much better when shocks are identified separately and can account for different stylised facts in different economies.

This paper seeks to provide answers to two questions: first why do EMEs fluctuate more than developed economies? And second, what are the factors driving differences within EMEs? They are, by and large, small and open economies, subjected to domestic and foreign shocks. These exogenous sources of fluctuations affect them at varying degrees however. We argue that fluctuations are driven by global, regional and country-specific shocks, and each country group is affected differently by those factors. This differentiated impact accounts for heterogeneity of stylised facts between EMEs on the one hand, and for the larger magnitude of fluctuations on the other.

The proposed model is a modified Backus & *al* specification, with three entities rather than the original two. The domestic economy trades with a global and regional component, and all three incorporate three exogenous shocks, productivity, demand and investment efficiency. We find that while EMEs are more sensitive to country-specific shocks than developed economies, the differences are much smaller in our estimate than in the literature. We also find the proposed model to replicate well the contributions of global, regional and country-specific factors to output fluctuations, as well as a host of stylised facts common and specific to region groups. It finds a model whose exogenous components are diversified accounts well for fluctuations in different region groups better than the literature's mainstream position on trend shock hypothesis.

The paper is delineated as follows: in the first section, we offer as exhaustive as possible a review of stylised facts common and specific to EME region groups. We focus in particular on those facts the literature attempts to account for when dealing with international business cycles. It offers ample evidence that emerging economies are different from each other in many aspects, particularly those regarding output and consumption fluctuations. The second section deals with global and regional factors; the purpose is to provide a variance decomposition for output fluctuations on the basis of those. As they are unobserved components, we offer a two-step econometric specification designed to account for their respective contribution to volatility in country groups. The estimation is based on a parsimonious econometric specification of factor components, and proves to be statistically robust and significant. The third section describes is devoted to the theoretical model offered to replicate the stylised facts discussed in the first section. It concludes the research program advocated by Backus & *al* is more apropos to account for heterogeneity in stylised facts among emerging economies. The fourth and last section concludes the research program for fluctuations in emerging economies would be better off incorporating additional sources of exogenous shocks in their models as pointed out in Backus & *al*. It also shows the policy implications for estimation of imported and domestic shocks' contributions to fluctuations. Benefits from cycle smoothing in EMEs are large and significant, yet ill-designed policies that do not take into account accurately may ending up exacerbating, rather than smoothing the cycle.

2 Descriptive statistics & stylised facts

2.1 Data description

We use annual data from the World Development Indicators (2013) of the World Bank (WDI) which runs from 1960 to 2013, and the Penn World Table (PWT) from the University of Pennsylvania (2014) which runs from 1950 to 2011. As it is recouped and consolidated, we obtain enough data points on 102 countries that are gathered into five geographically-based regional groups: Sub-Sahara Africa, Latin America, Middle-East & North Africa and South Asia. The fifth group is an extended OECD sub-sample. The dataset is used to extract a set of stylised facts, and then for regressions to provide an exhaustive overview of the stylised facts common and/or specific to region groups, and finally to build estimates for the regional and global factors. Individual countries are listed in table 1. With regards to the standard World Bank classification, we introduce some changes to keep with a regional grouping, which explains why Mexico and Chile have been allocated to Latin America from the OECD group, while Turkey and Israel were consolidated into the Middle-East & North Africa region.

As regional groups exhibit various degrees of heterogeneity, so should the OECD sub-sample; there are significant differences within a given group of wealthy economies. This is justified by the point made in Blanchard & Giavazzi (2002) [6] about countries like Portugal and Greece and their interactions with the rest of the European Monetary Union (EMU) they argue consumption patterns affect growth rate. When it is out of step with the average levels of their trading partners, the over-growing economies stard to generate a current account deficit, an outcome not unlike that observed in emerging economies. Neumeyer & Perri (2005)[33] for instance compare Canada and Mexico in that regard, and provide further vindication for the need to offer a broad definition of wealthy economies in the extended OECD sub-sample. In addition, South Africa, Lithuania, Cyprus and Russia have been added to the OECD group. This extended sample is meant to incorporate wealthy and/or large economies.

As this paper is interested in aggregate fluctuations, we are looking for a cycle/trend decomposition of macroeconomic variables. The literature relies heavily on the Hodrick & Prescott (HP) filter, where mid-frequency levels are more usually associated with business cycles.

In addition to its easy implementation, some caution needs to be exercised: Harvey & Jaeger (1993)[16] explain that HP-filtered data may display spurious cyclical properties, and state correlations where there are none. From the paper's perspective, that particular filter is better suited to annual data; a comparison with the Baxter-King (BK) filter similar to that in

Agénor & *al.*[2] shows cycles to be dampened. The BK filter however discards data points at both extremities of the time sample. It may well be of no particular import as far as quarterly data goes; yet with annual frequency there are issues of business cycle components that are dependent on time period length. This is why this paper sticks with the Hodrick-Prescott filter, and uses the Ravn & Uhlig (2002)[40] calibration for annual data, $\lambda = 6.24$, where λ is the smoothing parameter.

Table 1: Country sample groups.

Group	Countries
Sub-Saharan Africa	Gabon, Mauritius, Zimbabwe, Botswana, Côte d'Ivoire, Swaziland, Namibia, Senegal, Sierra Leone, Cameroon, Benin, Rwanda, Kenya, Central African Republic, Tanzania, Niger, Mozambique, Lesotho, Burundi, Togo.
South-East Asia	Macao, Hong Kong, Taiwan, Singapore, Malaysia, Philippines, Fiji, Indonesia, Kazakhstan, Thailand, Sri Lanka, Mongolia, India, China, Tajikistan, Kyrgyzstan.
Latin America	Trinidad & Tobago, Barbados, Mexico, Venezuela, Chile*, Panama, Guatemala, Costa Rica, Uruguay, Dominican Republic, Colombia, Ecuador, Brazil, Peru, Paraguay, Jamaica, Argentina, Honduras, Bolivia.
MENA	Kuwait, Qatar, Saudi Arabia, Bahrain, Turkey*, Egypt, Israel*, Iraq, Iran, Tunisia, Jordan, Morocco, Mauritania.
OECD	Luxembourg, Switzerland, Canada, France, Austria, United Kingdom, Germany, Spain, Italy, Ireland, Belgium, Netherlands, Iceland, Norway, Sweden, Australia, Denmark, South Africa*, Finland, New Zealand, Portugal, Greece, Lithuania*, Japan, Slovenia, Cyprus*, Slovakia, Czech Republic, Malta, South Korea, Estonia, Poland, Latvia, Hungary, Russia*.

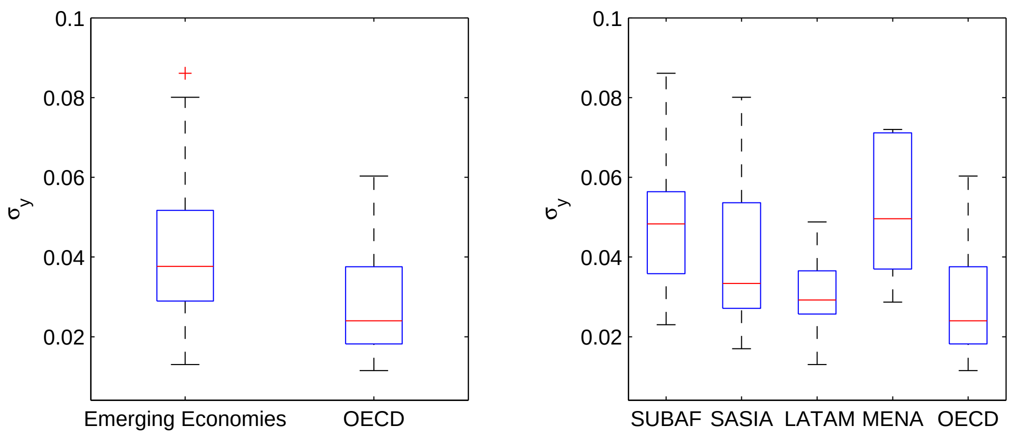

Figure 1: Standard deviation of output fluctuations whisker-plot for Sub-Sahara Africa, South Asia, Latin America, MENA and the OECD.

Figure 1 offers a first-hand illustration of this heterogeneity in comparison between developed and developing nations on the one hand, and within the emerging countries group. It shows that output in emerging economies fluctuates more than that of rich countries, an observation confirmed by statistical testing. Output fluctuations per country group however is somewhat more nuanced, which suggests stylised facts, related to output or otherwise, are likely to vary from one group to the other.

2.2 Stylised facts

Stylised facts are important to the RBC literature: Prescott (1986) prefaces his investigation of properties of technological change in the United States with a table listing standard deviations and lagged correlations for relevant macroeconomic time series. Once the data has been de-trended, the focus is on a set of moments for an array of relevant macroeconomic aggregates, which the model then seeks to replicate; these moments have their importance as they describe the essential properties of relevant aggregate time series.

Table 2 displays summary statistics for all five region groups: de-trended output and consumption standard deviations are the main indicators for fluctuations, as well as current account balance expressed as a percentage of GDP, and average annual GDP per capita growth for comparison. In addition, correlation of output with total factor productivity (TFP) and consumption are included in the model. Productivity data is derived from PWT. It shows emerging economies to exhibit a larger degree of fluctuations compared to the OECD sample: on average, output is about 61% more volatile in the former than the latter. There are however large differences among the emerging economies sample group: it can be close to the OECD sample as it is the case in Latin American economies, whose levels are the lowest in the non-OECD sample, with 3.1%, whereas MENA and Sub-Sahara Africa exhibit almost double that figure at respectively 6.5% and 5.3%. The differences in fluctuations are significant between OECD and emerging economies in all but Latin America.

Table 2: Aggregate volatility: descriptive statistics

Region	σ_y	σ_c	CA	g_y	$\rho_{z,y}$	$\rho_{c,y}$	$\rho_{tb,y}$	ρ_{tb}
OECD	2.85%	2.40%	-1.00%	2.60%	.222	.705	-.006	.520
	(.013)	(.019)	(.041)	(.011)	(.131)	(.193)	(.179)	(.203)
MENA	6.50%	5.10%	1.30%	1.80%	.241	.426	-.050	.562
	(.044)	(.022)	(.088)	(.015)	(.092)	(.406)	(.121)	(.177)
Latin America	3.10%	3.90%	-2.70%	1.80%	.216	.711	-.010	.466
	(.009)	(.015)	(.031)	(.007)	(.127)	(.176)	(.119)	(.203)
Sub-Sahara Africa	5.30%	7.90%	-4.60%	1.30%	.217	.581	-.018	.366
	(.029)	(.069)	(.044)	(.017)	(.091)	(.301)	(.188)	(.253)
South Asia	4.00%	4.80%	.40%	3.20%	.271	.643	-.054	.415
	(.019)	(.026)	(.095)	(.020)	(.147)	(.200)	(.124)	(.227)
World	4.00%	4.80%	-1.50%	2.20%	.230	.637	-.019	.469
	(.026)	(.038)	(.06)	(.015)	(.121)	(.262)	(.156)	(.221)

Correlation levels of output with either household consumption or productivity seem to be uniform across country groups. A stylised fact that seems to be widely shared among the country in our sample is that consumption and output are relatively well correlated: figures for $\rho_{c,y}$ show there is little dispersion around the global average correlation level of .637, with high levels in Latin America and OECD at respectively .711 and .705, and low levels in Sub-Sahara Africa, at .581. Only the MENA region group displays a low correlation level of .426. Additionally, levels of correlation between output and productivity $\rho_{z,y}$ seem to be closely similar in all five region groups, where the global average correlation of .230 is almost universal among the region groups. A similar observation can be made as to the persistence of trade balance ρ_{tb}, comparatively strong and almost uniformly distributed among the region groups. OECD and MENA both exhibit the highest persistence levels at respectively .520 and .562.

Correlation of output with trade balance $\rho_{tb,y}$ appears to be slightly negative. However given the standard deviations attached to the figures in table 2 further data analysis is needed.

Since those stylised facts are delineated by region, it would make sense to check whether differences in those indicators (as well as others) exist, or are significant. Consequently we use ANOVA techniques to pinpoint differences within EMEs with respect to the OECD country group, which is treated as the base level. In addition to the indicators displayed in table 2, we also introduce persistence of the trade balance.

ANOVA regression results in table 3 show there are significant differences between individual region groups of EMEs and the OECD country sample and vindicate the observation made in figure 1 . Output in MENA and Sub-Saharan Africa fluctuates a lot more than OECD, whereas no significant differences can be observed in the relationship of the latter with Latin America and South Asia respectively. This lack of proof that larger fluctuations prevail in Latin America cuts right into the literature's use of the region as a proxy for EMEs. In comparison, growth standard deviation cuts an even clearer picture: all emerging economies but Latin America experience higher fluctuations in growth rate in comparison with OECD.

Table 3: ANOVA regression: OECD as base level.

Variable	σ_y	σ_c	σ_g	$\rho_{c,y}$	$\rho_{tb,y}$	$\rho_{z,y}$	ρ_{tb}
MENA	.036***	.017	.027***	-.278***	-.043	.018	.042
	(.007)	(.011)	(.007)	(.081)	(.053)	(.039)	(.069)
Latin America	.003	.005	.006	.005	.017	-.006	-.054
	(.007)	(.01)	(.006)	(.071)	(.049)	(.034)	(.061)
Sub-Sahara Africa	.024***	.046***	.02**	-.124	-.011	-.005	-.153*
	(.006)	(.01)	(.006)	(.070)	(.046)	(.034)	(.060)
South Asia	.012	.014	.017*	-.062	-.046	.048	-.105
	(.007)	(.011)	(.007)	(.075)	(.051)	(.036)	(.064)
Intercept	.029***	.034***	.034***	.705***	-.006	.222***	.521***
	(.004)	(.006)	(.004)	(.042)	(.028)	(.020)	(.036)
R2	.248	.188	.189	.128	.021	.025	.092
RMSE	.023	.035	.021	.250	.158	.122	.214
RSS	.052	.122	.044	6.143	2.215	1.466	4.520

Legend p-value: * 10% ** 5% ***≤1%

Group heterogeneity is not observed with the same consistency in household consumption fluctuations: Only the Sub-Sahara Africa region group displays significant differences with the OECD base comparison. It suggests household consumption fluctuations are no different in the other emerging economies in comparison to wealthier ones. This is additional evidence to doubt the literature's wisdom in focusing on Latin America as a benchmark for developing economies and to extend its results.

There are other stylised facts more widely shared among all regions: apart from MENA, levels of correlation between consumption and output are not significantly different from one region to the other in comparison to OECD. Still, correlation between output and consumption remains positive and fits into the core predictions of the RBC model.

We would like however to further check on the levels of correlations between output and the selected macroeconomic variables. Multivariate testing is carried out over the five groups is carried out to check whether their respective moments are homogeneous.

Testing for correlation between output and consumption compels us to reject the assumption of homogeneous correlation across region groups. This result however does not contradict those earlier discussed in table 3 since the testing included MENA, an outlier whose correlation is substantially lower than that of the OECD reference group. A subsequent multivariate testing with MENA excluded yields results in line with the ANOVA regressions, where the assumption that correlations are homogeneous across region groups is not rejected.

A similar observation can be made as to the persistence of trade balance: Sub-Sahara Africa is the only country group whose persistence levels are significantly lower (albeit at a confidence threshold of 10%) and as a result the null hypothesis of homogeneous correlation among group regions is rejected. However, when the Sub-Sahara Africa group is excluded from the test, the null hypothesis stands.

Table 4: Multivariate testing - all region groups.

Test	Indicators	$\rho_{c,y}$	$\rho_{tb,y}$	$\rho_{z,y}$	ρ_{tb}
Wilks' Lambda	Statistic	.872	.979	.975	.907
	F	3.610	.460	.640	2.510
	pval	.009	.767	.636	.047
Pillai's Trace	Stat	.129	.021	.025	.093
	F	3.610	.460	.640	2.510
	pval	.009	.767	.636	.047
Lawley-Hotelling Trace	Stat	.148	.022	.026	.102
	F	3.610	.460	.640	2.510
	pval	.009	.767	.636	.047
Roy's Largest Root	Stat	.148	.022	.026	.102
	F	3.610	.460	.640	2.510
	pval	.009	.767	.636	.047

Testing for output correlation with trade balance as well as technological progress are much more robust, where all five region groups exhibit essentially the same levels, which are in line with those obtained from ANOVA.

This initial investigation of stylised facts among emerging economies has provided important evidence to the paper: it shows that while output fluctuates significantly more in emerging economies than it does in wealthier ones, other macroeconomic aggregates behave in a much more ambiguous fashion. We find that output correlation with variables such as household consumption, trade balance and technological progress are much more homogeneous than expected.

We have introduced in tables 2, 3 and 4 trade balance persistence as an indicator. We also are interested in its auto-correlation function and what its behaviour might be in all five regions. Figure 2 plots trade balance-to-output ratio individual auto-correlation functions for countries consolidated into their respective region groups, and a LOWESS regional estimate. It shows what Garcia-Cicco & *al* observed in their investigation of business cycles in emerging economies: strong first order autocorrelation gradually converges to zero. All regions show convergence to zero autocorrelation, though at varying speed.

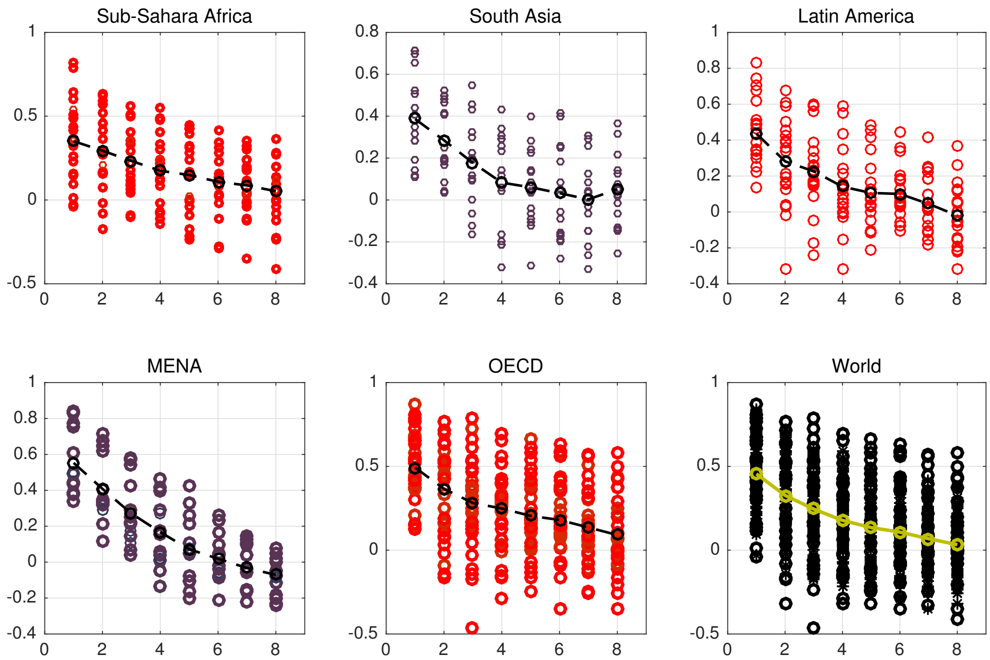

Figure 2: Trade Balance autocorrelation - country groups and world sample.

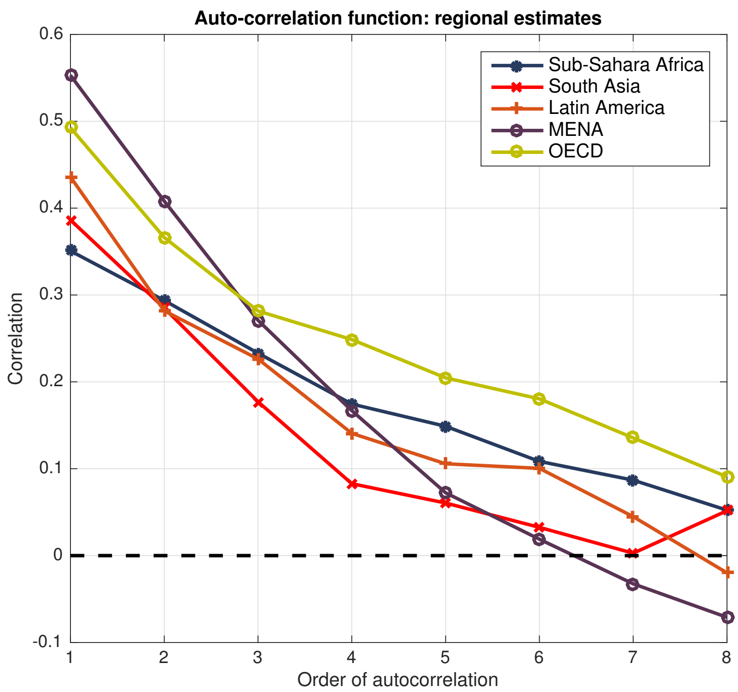

Figure 3: Trade balance autocorrelation - regional estimates.

There are few differences between region groups: trade balance autocorrelation is slightly more persistent in OECD as it converges at a slower rate in comparison to MENA for instance, whose initial autocorrelation at .552 quickly reaches .072 at the fifth order. In comparison, OECD trade balance ACF starts out at .492 but remains at .204 five periods afterwards.

In addition to those stylised facts, we are also interested in the properties on international and regional synchronisation. We compute average correlation of individual countries' business cycles with their regional partners as well as the whole world as defined in the country sample.

Table 5: Regions stylised facts: macroeconomic aggregate matching moments.

Region	$\rho_{y,W}$	$\rho_{y,R}$	ρ_y	ρ_c	intrade
South Asia	.402	.301	.193	.298	19.10%
Latin America	.242	.194	.215	.078	25.77%
MENA	.342	.398	.156	-.147	11.53%
OECD	.731	.576	.271	.430	78.07%
Sub-Sahara Africa	.429	.286	.024	-.033	31.39%

Countries with a strong correlation between their cycles and the global economy's also display high correlation among their geographical group: OECD displays the highest correlation with the global cycle, although this may be discounted due to their economic prominence, and they also exhibit the highest intra-group correlation twice as large as that of emerging economies, with .731 against an average of .364. Levels of correlation are not homogeneously distributed, though, nor does it imply a strong intra-regional correlation. The Sub-Saharan economies synchronise well enough with the global cycle at a correlation level of .429 do not perform well in their respective correlation levels, nearly twice as low at around .286, a fact that may be explained by their reliance on commodities, a discrepancy partially confirmed when one looks at countries in South Asia, whose level of synchronisation with the global cycle is almost equal at .402, but whose regional synchronisation levels are almost on par at .301. The MENA economies also display a strong intra-regional correlation levels at .398, possibly due to the over-representation in the sample of oil-producing economies. Latin American economies on the other hand exhibit the lowest level of synchronisation to the global cycle, and increases slightly to .245 when compared to the United States alone.

Output and consumption persistence behave differently from one region group to the other. Economies with well-known properties of large fluctuations, such as Sub-Sahara Africa, and to a lesser degree MENA both exhibit low persistence of consumption and output, both country groups register respectively .156 and .024 for output and -.147 and -.033. This stylised fact computes with their larger output standard deviation, and their levels of persistence are significantly lower when compared to the rest of EMEs region groups. Latin America can be added to them as far as household consumption is concerned: all three regions exhibit substantially lower consumption persistence in comparison with OECD.

In the latter, consumption is more persistent than output, respectively .430 *versus* .271.This suggests there are strong smoothing effects in comparison to emerging economies. Such a discrepancy is replicated at a lower level in South Asia, where consumption is also the more persistent of the two variables, .298 for the latter versus .193 for output.

We have provided in this section a wide ranging overview of stylised facts in emerging and developed economies. Results shows there are many common features to both categories, though some emerging economies retain some distinctive properties. The stylised facts can be summed up from the most common to the more specific as follows:

- Trade balance autocorrelation gradually converges to zero. Its persistence is virtually the same in all country groups.

- Output and technological progress correlation has similar levels in the country sample and its sub-set regions.
- Output and growth standard deviations in EMEs are for the most part higher than OECD country group.
- Output and consumption correlation is similar in all EMEs but the MENA region in comparison with the OECD. All regions exhibit positive correlation nonetheless.
- Household consumption fluctuations are not significantly different between EMEs and OECD. Countries in Sub-Sahara Africa have significantly higher levels of consumption volatility in comparison with the other economies.
- Only OECD and South Asia exhibit a more persistent household consumption. Countries with large fluctuations display little or no persistence.
- OECD region group has the highest share of intra-trade in the country sample, as well as the highest level of synchronisation with global and regional cycles.

We have not as yet discussed the effects of regional and global factors. This paper's main argument is that those factors drive fluctuations differently from one region to the other. We henceforth derive estimates with selected proxies and their effect on output fluctuations. To that effect, we offer the following econometric specification to estimate:

$$\sigma_i^y = \alpha_1 \sigma_i^c + \alpha_2 \rho_i^{y,g} + \alpha_3 FDI_i + \alpha_4 Trade_i + \alpha_5 Natural_i + \alpha_6^j Region_j^i + \alpha_7 + \epsilon_i \tag{1}$$

where:

1. σ^y: output standard deviation, and captures aggregate fluctuations.
2. σ^c: household consumption standard deviation.
3. $\rho_{y,g}$: output and government expenditure correlation.
4. FDI: foreign direct investment (% of GDP).
5. Intra-region Trade is the share of trade with regional partners in total commercial trade.
6. Natural Resources is the size of natural ressources rents in GDP.

Specification (1) is estimated with robust OLS, first without, then with added region factors. The model is then instrumented for each component to check on its robustness. Each model variant is described as follows:

1. (1a) and (1b) OLS estimations computed with a robust variance estimator.
2. Consumption standard deviation is instrumented with the average contribution of household expenditure to output growth. The instrument borrows the argument from Blanchard & Giavazzi (2002) [6] where economies whose growth outpaces that of its currency union partners generates current account deficits. A similar argument is extended to consumption and its contribution to growth, whereby economies that rely on household expenditure to drive GDP growth are likely to exhibit large fluctuations.
3. Consumption fluctuations are again instrumented with the correlation between output and the Solow Residual as computed in the PWT database. This specification tests whether productivity shocks drive fluctuations as it is assumed in Aguiar & Gopinath, namely that shocks to trend productivity drive consumption fluctuations higher than output's.

4. FDIs are instrumented with the openness indicator, measured by the size of exports and imports in GDP. The purpose of this instrument is to check whether an open economy can mitigate domestic cycles *via* access to foreign capital flows. An open economy with ready access to foreign investment can smooth adverse effects arising from domestic shocks for instance.

5. This specification uses two instruments on FDIs: first the previous openness indicator, and second the size of savings and domestic investment in GDP. The additional instrument is used to check whether the economy's own capital market structures can attract foreign investment and affect aggregate fluctuations.

The table lists all results from the OLS and alternative IV specifications. Estimates are reported with their standard errors in parentheses and relevant levels of statistical significance. Specification (5) tests for over-identification and rejects its null hypothesis.

Table 6: Output fluctuations determinants: OLS vs IV.

Variable	(1a)	(1b)	(2)	(3)	(4)	(5)
σ_c	.356***	.311**	.415	.595*	.303**	.310***
	(.091)	(.099)	(.275)	(.254)	(.094)	(.089)
$\rho_{y.g}$	.012	.016*	.017*	.019*	.016*	.016**
	(.006)	(.007)	(.008)	(.009)	(.007)	(.006)
FDI	.012	.029	.014	-.011	.083	.088
	(.030)	(.035)	(.049)	(.053)	(.062)	(.062)
Intra-region Trade	-.034	-.046*	-.049*	-.054	-.048*	-.049*
	(.017)	(.021)	(.021)	(.030)	(.021)	(.020)
Natural Resources	.116**	.103**	.101***	.099**	.104***	.107***
	(..035)	(.032)	(.029)	(.032)	(.031)	(.024)
Region Factor						
MENA		.013*	.012	.010	.014*	.014*
		(.006)	(.006)	(.007)	(.006)	(.006)
Latin America		.002	.002	.002	.003	.003
		(.004)	(.004)	(.005)	(.004)	(.004)
S-S Africa		.014**	.010	.002	.015**	.015**
		(.005)	(.012)	(.013)	(.005)	(.005)
South Asia		.009	.008	.007	.008	.008
		(.004)	(.005)	(.005)	(.004)	(.004)
Intercept	.014***	.011**	.008	.002	.009*	.009**
	(.004)	(.004)	(.009)	(.008)	(.004)	(.003)
R2	.582	.627	.605	.458	.621	.619
RMSE	.015	.015	.015	.017	.014	.014
RSS	.022	.020	.021	.029	.021	.021
Chi2			77.080	88.247	61.091	101.778
Fisher		6.717				
Hansen J						.140
p-value						.932

Legend p-value: * 10% ** 5% ***$\leq$1%

Household consumption's contribution to fluctuations is broadly significant and robust to some of the instruments used in 6. The Solow residual instrument suggests a larger and significant effect, but not as much as that in other specifications. The estimate is broadly consistent with many instruments introduced in the econometric specification.

Output correlation with government expenditure becomes significant in the OLS specification when the regional factor is taken into account. Its significance is robust and the estimate is essentially replicated by all instruments. The positive sign for the estimate is an illustration of Hakura's (2007) [15] point about pro-cyclical fiscal policies, as these contribute to output fluctuations.

In addition to those domestic, or country-specific factors, we also notice the significant contribution of natural resources in output fluctuations: the estimate is consistently significant across all specifications, it shows a country's reliance on commodities to have a strong impact on its output fluctuations. A country whose economic activity relies on commodity exports is therefore likely to exhibit high output fluctuations. By contrast, FDIs do not seem to play an important role in shaping fluctuations, one way or the other: all specification allocate statistically insignificant estimates to the latter.

Intra-regional trade appears to contribute negatively to output fluctuations: all model variants apart from specification (1a) suggest a consistent and significantly negative contribution to output standard deviation. Given the fact that region factors have been already included in the model, it is reasonable to assume that countries with significant commercial ties to their neighbours can engage in mutual risk-sharing which allows them either to smooth domestic shocks, or to distribute more efficiently imported ones.

The model specification embeds factor variables designed to capture region-specific effects; model specification considers region groups to be factor variables, and estimation results compute region effect relative to the OECD base sample: the Sub-Sahara Africa and MENA country groups have a higher standard deviation cycles compared to OECD and the other regions, which shows that there are other factors specific to these regions the specification does not adequately capture.

2.3 Global, regional and country-specific volatilities

As the previous section fairly demonstrates, fluctuations in EMEs are larger in comparison with those in OECD. We do not know as yet whether the discrepancy is due to pure domestic shocks, or global and regional shocks these economies have difficulty mitigating.

There is also an additional challenge: while it is accepted that exogenous shocks affect, we do not observe global and regional shocks. Observed fluctuations are a mixture of these as well as domestic shocks, so there is a need for variance decomposition of unobserved components.

Kose & *al* (2003)[20] investigate the contribution of global, regional and country-specific factors in growth fluctuations among G7 economies and compare them to a selected sample of emerging economies. They find economies with low growth volatility to be more sensitive to world factor, *i.e.* those more attuned to international business cycles. Hakura (2007) [15] investigate the effects of foreign and domestic factors in emerging economies, and draws policy recommendations to benefit from smoothing output fluctuations. It finds domestic factors to be quite significant in accounting for growth volatility in EMEs.

This literature uses standard deviation for real output per capita growth to carry out its computations, which may misrepresent the magnitude of aggregate fluctuations. GDP growth encompasses both cyclical and trend components, and will tend to exaggerate fluctuations as far as EMEs are concerned. Indeed, growth trend in those economies is not as smooth as that of their wealthier counterpart, which may lead to distorted estimates of domestic and imported shocks' contribution to fluctuations. To check on this claim, we plot a 10-year rolling standard deviation of real GDP per capita from 1960 to 2011 against similarly computed 10-year rolling standard deviation of HP-filtered log real GDP per capita as graph 4 shows.

Only among OECD countries is growth less volatile than cycles. All four regions selected as benchmarks for emerging markets exhibit a larger degree of magnitude in growth than magnitude

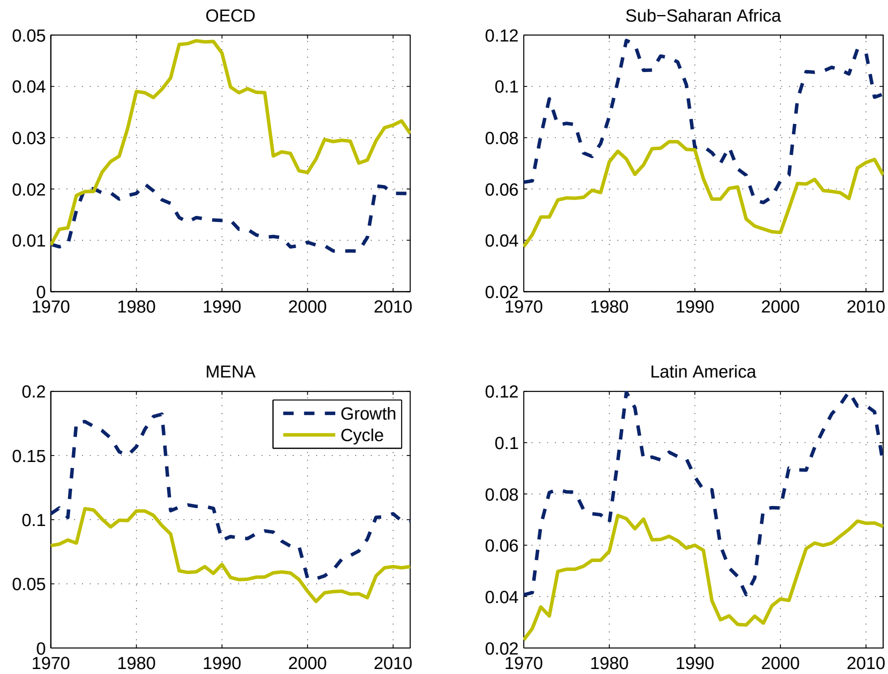

Figure 4: Aggregate volatility: Cycle versus GDP per Capita growth

of fluctuations, and that provides a *prime facie* case to gainsay results admitted in the literature: a significantly more volatile output may fail to capture the proper components' respective contributions to cycles. In addition, OECD economies exhibit a relatively low correlation of .214 between output and the cyclical component, in contrast with the other country groups, in Sub-Saharan Africa, Latin America and the MENA economies, respectively .737, .848 and .915.

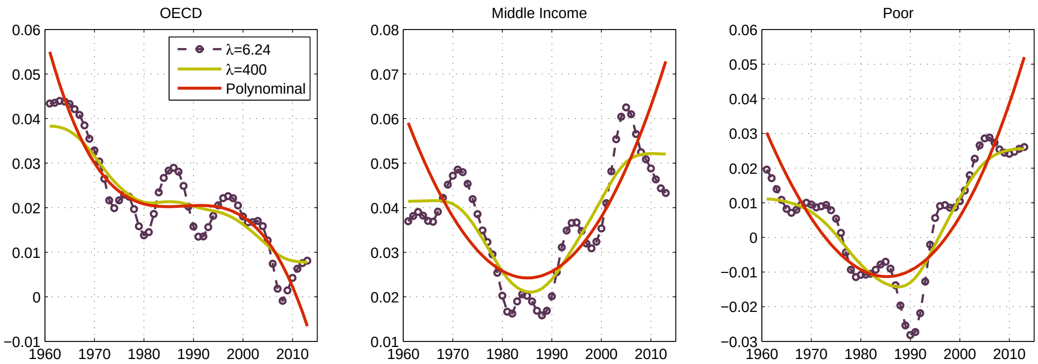

Figure 5: Trend log GDP per capita: HP and polynomial filters.

The effects of trend growth in emerging economies is significant and can be readily observed in figure 4. Unfiltered GDP per capital growth overstates fluctuations in emerging economies, and as a result will overestimate country-specific factors. Figure 5 shows growth trend to be more volatile in developing economies.

Besides, this paper is interested in the factors behind the discrepancies in output fluctuations between developed and developing economies. It will conform with the use of filtered aggregates, include those needed to estimate unobserved regional and global components.

2.4 Non-parametric smoothing and regression

Non-parametric estimation pioneered in Rosenblatt (1956)[42] and expanded in Parzen (1962)[37] Nadaraya (1965)[32] and implemented in Racine (1997)[38] offers a versatile tool to apprehend unobservable global trends among all countries, and region-specific factors in the selected groups. Model specification does not impose on the data a parametric functional form, it seeks instead to divide it into chunks known as *bandwidths* akin to the histogram. Data smoothing is carried out with a weighting function whose properties are defined below, while bandwidths are computed to balance optimally between how much information it embeds and accurate estimation.

Formally, the observed data $x_1, x_2, ...x_n$ is treated as a sample following a distribution f. The first step is to delineate the data sample by means of a histogram. the size of bins is determined by how much data is at hand, and how much information can be contained within. In their introduction of smoothing methods, Casella, Fienberg & Olkin (2006)[10] stress the importance of these bandwidths in view of the compromise needed to be achieved between on the one hand data quality in these bins, and smoothing that may bring about the proper distinction between the hidden signal and observed noise in the sense of Silver (2012)[45]. Over-smoothing - that is, too few bins into which the data is ordered, leads to a biased estimator with a small variance, while under-smoothing with numerous and small bins leads to an estimator with small bias but large variance.

In this case, a measure of mean squared error is proposed to achieve the optimal bandwidth. MSE denoted $\mathbb{E}\left[\mathfrak{L}(f(x), \hat{f}_n(x))\right]$ writes:

$$(\mathfrak{L}) = \left[f(x) - \hat{f}_n(x)\right]^2 \tag{2}$$

where f is the theoretical distribution, and $\hat{f}$ its estimated counterpart from a sample size n. The mean square error may be broken down into two components:

$$MSE = \mathbb{E}\left(\hat{f}_n(x) - f(x)\right)^2 + \mathbb{V}\left[\hat{f}_n(x)\right] \tag{3}$$

where the first term $\mathbb{E}\left(\hat{f}_n(x) - f(x)\right)$ denotes squared bias and the second variance. Optimal smoothing therefore seeks to minimise average risk in the bias-variance tradeoff.

We now turn to the properties of the smoothing function, the **Kernel** is basically a weighting function $K(u)$ with the following conditions to satisfy:

$$\int K(u)d(u) = 1 \tag{4}$$

$$\int uK(u)d(u) = 0 \tag{5}$$

$$\forall u, K(-u) = K(u) \tag{6}$$

$$\sigma_K^2 = \int u^2K(u)d(u) < \infty \tag{7}$$

The Kernel function estimation should result in a probability density function zero-centered with equal weightings on either side with a finite positive variance.

Non parametric regression therefore establishes a covariate relationship between pairs (x_i, Y_i) and writes:

$$Y_i = r(x_i) + \epsilon_i \tag{8}$$

$r(.)$ is a non-specified function whose estimation will be carried out with relaxed assumptions, by means of smoothing denoted $\hat{r}_n(x)$. Two different methods will be used on country groups: the fist step is to estimate a global factor among *all* countries, then a regional factor for the geographical groups. The second step is to estimate the relationship between individual countries, their respective regional, then global factors. Finally, the residual can be choked up to country-specific or idiosyncratic shocks.

Non-parametric regression does not impose upon the data constraints of specifications. Estimation of regional and global factors is used instead of the standard dynamic factor model favoured by the literature due to the latter's inability to generate a suitable common trend for countries in the sample. We proceed in two steps: first, the factors are computed with a *robust* LOWESS (Locally WEighted Scatterplot Smoothing) estimation on all 102 countries for the global factor. Each country group is taken separately, and their regional common trend is estimated likewise. Robust LOWESS is best in dealing with outliers as it allocates them smaller weightings, in comparison with other polynomial smoothing methods. Regional factors are then computed with the global trend reincorporated into each region group to minimise the bias embedded in individual observations.

Due to the existence of significant outliers on the sample, a robust LOWESS is more practical and adapted as a smoothing tool. We denote r_i the residual at observation i, and w_i its weight in the estimated polynomial. The former writes:

$$w_i = \begin{cases} \left[1 - \left(\dfrac{r_i}{6\sigma_m}\right)^2\right]^2 & |r_i| < 6\sigma_m \\ 0 & \text{otherwise} \end{cases} \tag{9}$$

where σ_m refers to median standard deviation. This means outliers are all observations 6 standard deviations away from median and are therefore eliminated from the smoothing polynomial.

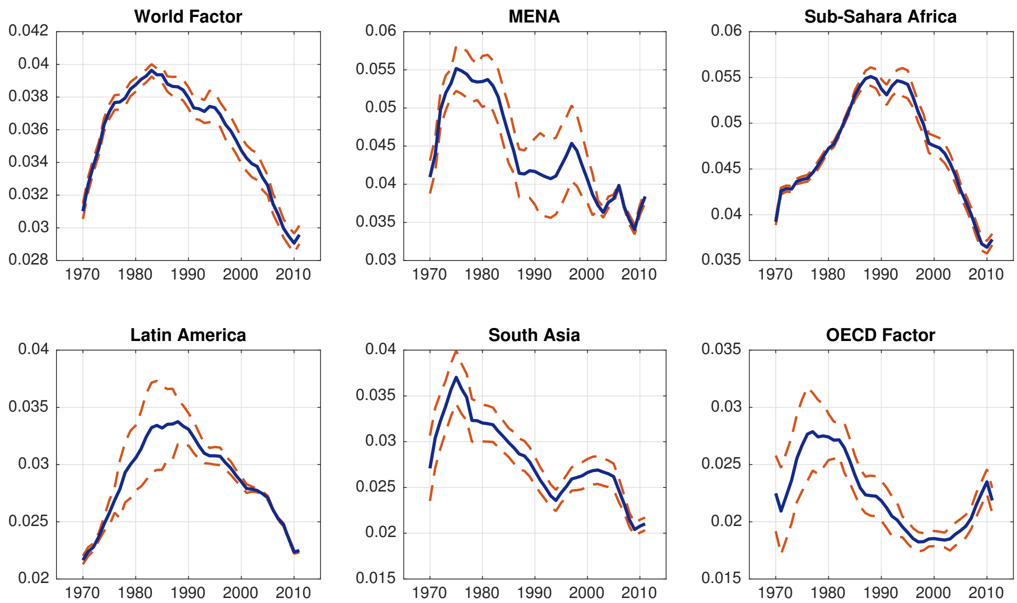

Figure 6: Global and regional factors: a robust LOWESS estimate.

Long-run fluctuations illustrated in figure 6 capture global and region-specific volatility, and fits well with time periods of significant economic importance: global fluctuations kept rising in the 1970 until they peaked in the early 1980. *The Great moderation* can be observed with the downward slope of long-run fluctuation, steadily decreasing to reach its lowest point right before the 2008-2009 financial crisis.

Latin America and OECD groups both share similar features: fluctuations start to rise between the 1970s and 1980s, and then gradually decrease, though at a lower pace for the former. Latin America continued to experience high volatility well into the early 1990, until it subsided. The OECD sample follows a similar pattern, but the 2008 financial crisis sent long-run fluctuations soaring as the subsequent recession settled in.

Latin America is not the only region group with a virtuous decline in long-run fluctuations: Sub-Sahara Africa also managed to halve its regional output fluctuations, though the double hump around the 1990s shows the great moderation did not take effect as smoothly as it was the case in other EMEs. Still, there is a steep decline in fluctuations well into the late 2000s.

MENA and South Asia exhibit different patterns: although both regions observed a decline in their fluctuations as well, the former is made up of many oil-producing economies, and the second had to absorb the effects of the 1997 crisis. MENA economies are resource-rich, and their output is highly sensitive to commodity prices. As a result, the 1990s have been turbulent, due to a myriad of factors, among which the geopolitical context of the region. Countries in South Asia shed their high-level fluctuations of the 1970s pretty quickly, and were well on track to catch up with OECD-levels of fluctuations. However the financial crisis that affected many countries there in 1996-1997 generate a recession that kept fluctuations high well into the mid-2000s.

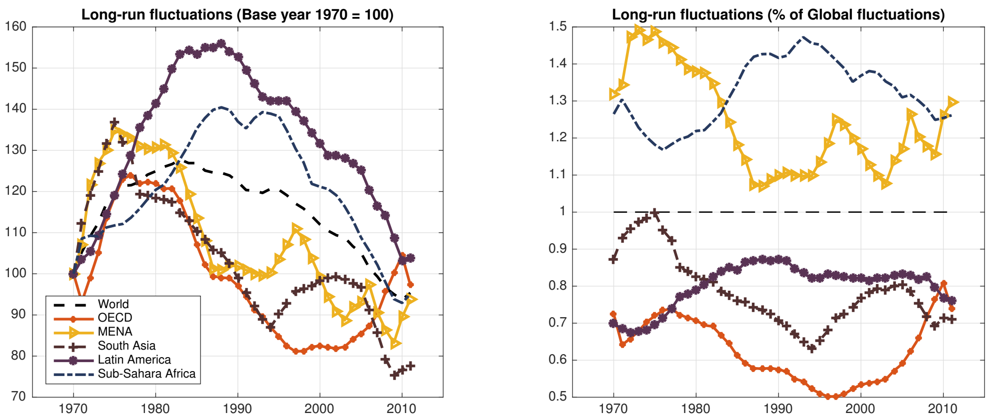

Figure 7: Regional and Global factors: country and region samples

Figure 7 shows two aspects of the behaviour of regional factors: first, while many EMEs have managed to halve their fluctuations near to their initial values in the 1960s, their behaviour with respect to global fluctuations is heterogeneous. Second, regions that have already started out with high levels of fluctuations remain so: MENA annd Sub-Sahara Africa remain respectively 24% and 32% more volatile than global factors, whereas the other regions remain 24% less volatile, 20% less when the OECD group is excluded.

The two-step robust LOWESS provides a measure of goodness of fit similar to that of parametric linear models. Per Racine & Hayfield (2013) the alternative R^2 writes:

$$R^2_{np} = \frac{\left[\sum_{i=1}^{n}(y_i - \bar{y})(\hat{y}_i - \bar{y})\right]^2}{\sum_{i=1}^{n}(y_i - \bar{y})^2 \sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2} \tag{10}$$

which is similar to the parametric R^2 when the model OLS-fitted, linear with an intercept. Given the non-parametric estimates embedded in the regional and global factors, the alternative R^2 is therefore likely to be more efficient given the local weighting estimation than its linear parametric counterpart, although there is always the risk that its superior goodness of fit may be due to over-fitting rather than a more adequate specification. Therefore the non-parametric regression carried out after the two-step LOWESS estimation seeks to provide an estimation for this specification:

$$\sigma^i_y = \alpha_1\sigma_w + \alpha_2\sigma^i_r + \alpha_3\sigma^i_c + \varepsilon_i \tag{11}$$

where $\sigma_w, \sigma^i_r, \sigma^i_c$ are respectively world, region and country-specific factors for country i. As a result, the fraction of volatility due to world factor for instance would write:

$$\frac{\alpha_1^2\sigma_w}{\sigma^i_y} \tag{12}$$

and more generally:

$$\forall z \in \{C, W, R\}\ \sigma_{z\%} = \frac{\alpha_z^2\sigma_z}{\sigma^i_z} \tag{13}$$

It is worth pointing out that we do not need to find the best estimate $\hat{\alpha}_z$ for (13). Rather, the non-parametric specification of (11) becomes:

$$\sigma^i_y = r(\sigma_w, \sigma_r,) + u(\epsilon_i, +\sigma^i_c) \tag{14}$$

where the error term u(.) incorporates country and idiosyncratic factors. We are interested in fact in apprehending how best each component contributes to observed variance, which means the R^2 measure takes over as a proxy for the contribution of each component. It is worth pointing out that estimates for the global and region-specific factors invariably exhibit some degree of covariance even when non-parametric estimation for regional factors include the global trend in the LOWESS regression. To that effect, we check the validity of both variables on group samples, first by comparing them against standard OLS estimation, and then by carrying out a battery of tests discussed in Racine (1997)[38] and Racine & *al* (2006)[39]. The point for such tests being not to check whether the proposed estimation does better than its parametric counterparts, but rather if the non-parametric fitting does not over-explain the data and provide biased estimates for global and regional trend.

As a result, we carry out non parametric-specific tests on specifications, whose chief argument is to check whether the explanatory variables included in the non-parametric regression are significant. It is the equivalent of a standard F-test in a regular regression setting, as documented Racine, Hart & Li (2006)[39] and Racine (1997). Significant bandwidth levels suggest the smoothed data is meaningful, and in the context of factor contribution to long-run volatility, the selected factor is significant and well-specified.

Table 7 lists partial R^2 for all region groups, as well as the residual country-specific contribution[1]. It also provides the median p-values for the World and Region factors bandwidths. These

[1] The absence of asterisk does not mean the country-specific factor is statistically insignificant. It is treated as a residual to the partial R^2 whose significance has been tested and displayed.

results from the two-steps non-parametric estimations are compared against results in Hakura (2007) [15] derived from a Bayesian dynamic factor model.

Differences with results in the literature are multifarious: as mentioned before, the literature deals with growth volatility rather than cyclical fluctuations. Previous discussion about the shortcomings of GDP growth standard deviation as a measure for business cycles showed significant discrepancy between emerging and developed economies. The dynamic factor model adopted in the literature may overstate one factor over the other; the discussion concluded to the need for the use of de-trended aggregates, which is the case in this paper.

Furthermore, the time frames are different, this paper's dataset is larger, more recent and more exhaustive as it draws from more up-to-date sources. A case in point is the comparison of the South Asia group, whose time frame is restricted to 1970-1996 as a way to isolate the 1997-1998 crisis. The non-parametric estimation is sensitive to the split time sample in a way the literature does not show, particularly so in the regional factor, who accounts for nearly half the long-run volatility in this paper, against 20% in Hakura (2007) [15]. Conversely, its contribution declines to 30% against a closer figure to the long run estimate of 15.8%. It shows indeed that non-parametric regression is not only more robust, but it reflects readily this region-specific event. This may indeed account for the large differences in country-specific shocks among the OECD, the 2007-2008 credit crunch crisis and the ensuing global downturn has had a significant impact on the global factor and its contribution in volatility among developed nations.

It is also worth pointing out that while non-parametric estimation yields lower square errors, it can also have a tendency to over-smooth. We note however that robustness checks in the form of bandwidth significance tests, as well as the South Asia experiment with different time frame put the matter to rest.

Table 7: Variance decomposition per global, regional and country-specific factors for output fluctuations.

Country group	World	Region	Country
Sub-Saharan Africa	37.3%***	34.6%**	27.9%
	(.00)	(.03)	
	6.2%	14.2%	79.1%
MENA	48.7%**	39.4%***	11.7%
	(.01)	(.00)	
	3.8%	15.9%	80.3%
Latin America	45.52%*	32.22%***	22.22%
	(.09)	(.00)	
	12.6%	13.7%	73.7%
South-East Asia	37.3%**	53.6%***	8.4%
	(.01)	(.00)	
	15.6%	20.6%	63.8%
(NP 1970-1996)	41.7%	30.3%	27.9%
(Hakura)	18.0%	15.8%	66.3%
OECD	49.7%**	42.8%***	7.45%
	(.01)	(.002)	
	24.3%	21.7%	54.0%

Legend p-value: * 10% ** 5% ***$\leq$1%

The fact that fluctuations in OECD are mainly driven by regional and global factors does not come at a surprise: Kose & *al* (2003)[20] did mention that wealthier economies are well synchronised with international business cycles, and thus are more sensitive to global shocks. Furthermore, the fact that these economies exchange a large share of their trade among each other also accounts for the large contribution of regional factors. The discrepancy with the literature is to be found in the extent to which imported factors account for fluctuations.

Each region group for EMEs displays a peculiar aspect: South Asia traces back almost half its fluctuations from regional factors, the highest among EMEs. It can readily be explained by the impact of the region-specific crisis of 1997-1998, and it shows in the comparison carried out for 1970-1996. The Sub-Sahara Africa region group displays the largest contribution of country-specific shocks to fluctuations, followed by Latin America. MENA economies on the other hand, are primarily affected by global factors, something that may be due to their reliance on commodities for export.

The significant differences among EME country groups as to the sources of their fluctuations provide further evidence their large magnitude of fluctuations are due to imported and domestic shocks. Variance decomposition suggests that heterogeneity of the stylised facts discussed earlier can be accounted for by the differentiated impact of global, regional and country-specific factors.

3 A Model for Global and Regional factors

We recall the set of important stylised facts the model seeks to replicate: output is more volatile in EMEs than OECD. Balance-to-output ratio is weakly negative for all region groups. Trade balance autocorrelation converges fairly quickly to zero. EMEs are much less synchronised among each other and with the global cycle than OECD. Global and regional factors are important components of fluctuations in OECD, country-specific shocks have a greater role in EMEs.

The two-countries RBC model proposed in Backus & *al* (1992) [5] is expanded by assuming the existence of three *countries*: a home economy, a global entity and another regional conglomerate. The latter two form the Backus & *al* equivalent of foreign economy.

All three economies produce the same good, but they exchange them nonetheless. In the global setting, the social planner seeks to maximise aggregate utility, which is the weighted sum of each entity's consumer preferences, denoted ϕ_i such:

$$\max_{c_t^i} \mathbb{E}_0 \sum_{i=1}^{3} \sum_{t=0}^{\infty} \phi_i \beta_i^t a_t^i \frac{c_{i,t}^{1-\sigma_i}}{1-\sigma_i} \tag{15}$$

Where a_i^t is a demand shock to be defined later on. Households maximise the utility they derive from the discounted flow of expected amounts of a homogeneous consumption good. They maximise their utility subject to resource constraint. Output is either consumed or invested, and consumption is either domestic or imported, so the budget set writes:

$$\sum_{i=1}^{3} \phi_i y_{i,t} = \sum_{i=1}^{3} \phi_i (c_{i,t} + x_{i,t} + nx_{i,t}) \tag{16}$$

Where $nx_{i,t}$ are net exports. Output produced in the home economy combines domestic production as well as imported goods from regional partners or the rest of the world. Per Obstfeld & Rogoff (2000)[35] we also introduce a sunken cost τ. It can be argued that only a fraction of imported goods is used in output production due to transportation costs, deterioration during transit, or the effect of tariffs and customs. We write:

$$y_t = \left[y_{l,t}^{\gamma} + (1-\tau) y_{f,t}^{\gamma} \right]^{1/\gamma} \tag{17}$$

Since there is a cost to import goods, agents prefer to import from those commercial partners closer to home. In essence, consumers prefer to import from regional partners, since that would entail lower costs. We write the regional bias into imported goods as follows:

$$y_{f,t} = \eta(y_{r,t} - \bar{y}_{r,t})^2 + (y_{w,t} - \bar{y}_{w,t})^2 \tag{18}$$

where $y_{r,t}$ and $y_{w,t}$ denote respectively regional and global output. η denotes the bias in favour of the latter.

Output in a given economy is a combination of technological progress and capital, respectively denoted $z_{i,t}$ and $k_{i,t}$, and write $y_t^i = z_{i,t}k_{i,t}^{\alpha}$. Capital depreciates at a factor $\delta \in (0,1)$ and its law of motion is governed by investment dynamics, and writes:

$$k_{i,t} = (1-\delta^i)k_{i,t-1} + \psi(x_t, \epsilon_{i,t}^x)x_{i,t} \tag{19}$$

where $\psi(x_t, \epsilon_t^x)$ is a quadratic cost-of-adjustment function that also includes efficiency shocks, and writes:

$$\psi(x_t, \epsilon_t^x) = \frac{\phi}{2}\left[1 - \left(\frac{x_{i,t}}{\sum_{i=1}^{3}\phi_i x_{i,t}} - 1\right)^2\right] v_{i,t}^x \tag{20}$$

In Blanchard & Giavazzi (2002) [6] the poorest economies in the Eurozone during the early 2000s recorded large current account deficits. Their behaviour fits with what the theory predicts: as an economy becomes more integrated in the global (or regional) market of goods and services, it increases its household consumption and investment. It means that it has to import more, and borrow from outside to sustain its expenditure.

These conclusions in turn fit with our model: when a productivity shock occurs, the domestic economy expands its consumption as well as its investment, and make up for the shortfall in output by importing and borrowing additional resources from outside.

Furthermore, there are costs to an economy's divergence from the global trends: Blanchard & Giavazzi argue that when output grows at a faster rate than that of its trading partners, the economy will run a current account deficit. A similar argument is used as to investment: when an economy invests more than its trading partners, regional or global, it faces cost due to the current account deficit. The functional form is borrowed from Rotemberg (1982) [43] as a way to capture the cost effect of price changes.

3.1 Exogenous shocks

Similarly to Backus & *al* we specify exogenous productivity shocks for the three entities as a multivariate auto-regression, or a VAR model.

$$Z_t = AZ_{t-1} + \epsilon_t^z \tag{21}$$

A is a 3x3 matrix. Its off-diagonal coefficients represent spill-over effects from one entity to the others. Depending on their values, they signify the effects of imported productivity shocks when they occur in one economy and transmit to another.

Global and regional components for shock productivity are similarly computed to the global and regional factors in output fluctuations: LOWESS estimation over all individual economies yield the global factor for productivity, while region-based estimation offers the regional component to technological progress. The data is then fitted into a VAR model in order to extract estimated coefficients for A^z and some of its coefficients are displayed in table 8. Table 9 ranks the eigenvalues extracted for the VAR estimates.

Table 8: Estimates for productivity spill-overs and persistence.

Region	World	Regional	Country	Epsilon
Latin America	.879***	-.173	.199	.019
	(.067)	(.918)	(.912)	
South Asia	.955***	.119*	1.952	.015
	(.052)	(.067)	(1.294)	
OECD	.942***	.312***	.092***	.013
	(.038)	(.078)	(.045)	
MENA	-.198	.404*	.628***	.023
	(.138)	(.225)	(.229)	
Sub-Sahara Africa	.259**	-.431*	.278***	.028
	(.120)	(.268)	(.027)	

Legend p-value: * 10% ** 5% ***≤1%

Global spillover effects are statistically significant for all save MENA group. The latter has a large regional and country-specific effect that may have to do with the over-representation of oil-producing economies in that group. In Sub-Sahara Africa, regional shocks have a negative effect on individual economies.

Of all region groups, Sub-Sahara Africa is the only region whose regional spillovers are significantly negative. It may be due to the fact that when a regional productivity shock occurs, individual countries cannot mitigate it due to poor quality institutions and/or relative lack of openness to trade. Another explanation can be offered with respect to the size of regional trading in the area. Given the fact that many Sub-Saharan economies specialise in raw materials and commodities, a regional productivity shock will affect them negatively since foreign demand does not necessarily need the additional output put on global markets.

The assumption made by Backus & *al* stands for the other regions, shocks to productivity in one country generate commensurate effects in the other countries as well. Apart from Latin America, the other economies experience statistically significant positive spillovers from their regional partners.

We also observe that standard deviation of country-specific technological innovation do not vary significantly from one region to the other: the highest value is .028 in Sub-Sahara Africa, whereas the lowest is .013 in OECD. The figure slightly larger than that offered in Backus & *al* but falls within the range of acceptable values.

Table 9: Eigenvalues comparison for technological progress.

Region	Eigen 1	Eigen 2	Eigen 3
Latin America	.872	0	0
South Asia	.955	-.465	0
OECD	.942	.885	.379
MENA	.893	.628	0
Sub-Sahara Africa	.872	.184	-.341

Results show the largest eigenvalue in each region group is smaller than 1, which means the matrix of estimated coefficients displays the necessary and sufficient condition for the sequence of productivity shocks to converge to zero. Furthermore, we also find the results for OECD to be pretty close to those in Backus & *al* for OECD: we find the largest eigenvalues to be .942 and .885 against .994 and .818. Subsequently the estimates for A^z for each region group are on the one hand stable, and on the other in line with the literature's findings on spillover effects. Finally, we also observe the eigenvalues match the statistical significance of the estimated matrix coefficients. For Latin America, only, South Asia and MENA regions the number of non-zero eigenvalues matches the equivalent effects of spill-overs.

We also define demand and investment components as AR(1) processes. These two sources of exogenous shocks are univariate for the time being.

$$\ln a_t^i = \rho_a^i \ln a_{t-1}^i + \epsilon_t^{a,i} \tag{22}$$

Parameter $|\rho_a^i| < 1$ measures the persistence of demand shocks a^i. Similarly, investment efficiency shocks are defined such:

$$\ln \epsilon_t^{x,i} = \rho_x^i \ln \epsilon_{t-1}^{x,i} + \upsilon_t^{a,i} \tag{23}$$

The persistence parameter is also constrained $|\rho_x^i| < 1$. Both $\epsilon_t^{a,i}$ and $\upsilon_t^{a,i}$ are zero-centered and normally distributed *iid*.

Table 10: Model structural parameters.

Parameters	Symbol	Value	Estimation
Preferences			
Discount factor	β	< 1	Calibration
Elasticity substitution	σ	> 1	Literature
Demand shocks	ρ_a	$\|\rho_a\| < 1$	GMM
World Weighting	ϕ_w	$\in (0,1)$	Trade flows
Regional Weighting	ϕ_r	$\in (0,1)$	*idem*
Country Weighting	ϕ_c	$\in (0,1)$	*idem*
Technology			
Share of Capital	α	$\in (0,1)$	GMM
Depreciation of Capital	δ	$\in (0,1)$	*idem*
Cost of Adjustment	ψ	$\in [1,200]$	*idem*
s.d. Technology shocks	σ_z		VAR
Investment shocks	ρ_x	$\|\rho_x\| < 1$	GMM

The structural parameters to the model are described in table 10. They are a mixture of calibration and estimation, and the latter has been kept to a minimum. Household discounting factor β is computed in the literature as the inverse ratio of long-run interest rates (1+R). CRRA elasticity of substitution parameter in equation (15) is chosen arbitrarily on the basis of values generally accepted by the literature.

The social planner's weightings ϕ_i are derived from IMF trade flows figures: the figures are derived from trade flows, intra-region, as well as the share of global trade in each region group, with the residual a proxy for the country-specific weighting. Other parameters, such as capital depreciation and its share in output are estimated *via* GMM, as well as costs of adjustment, and persistence of investment and demand shocks. Costs of adjustment estimates fall within the range of acceptable values in the literature, particularly in Rotemberg (1982). [43]

The values are then calibrated and estimated when applicable for all region groups, and displayed on table 11:

Table 11: Calibration values for the augmented Backus & *al* model

Parameters	Symbol	South Asia	Lat. Am.	MENA	OECD	SS Africa
Preferences						
Discount factor	β	.973	.931	.975	.979	.957
Elasticity substitution	σ	2	2	2	2	2
Demand shocks	ρ_a	.238	.156	-.105	.399	-.109
World Weighting	ϕ_w	22.34%	18.20%	15.34%	7.63%	25.88%
Regional Weighting	ϕ_r	9.55%	12.88%	5.76%	79.67%	15.70%
Country Weighting	ϕ_c	68.11%	68.92%	78.89%	12.70%	58.42%
Technology						
Share of Capital	α	.309	.315	.339	.333	.362
Depreciation of Capital	δ	.086	.125	.096	.084	.095
Cost of Adjustment	ψ	17.736	5.562	6.51	3.053	11.542
s.d. Technology shocks	σ_z	.015	.019	.023	.013	.028
Investment shocks	ρ_x	-.252	.047	-.007	.118	-.127

3.2 Main findings

Properties of the proposed model are summed up by the matching moments on the one hand, and the impulse response functions (IRF) it predicts for its variables. We start off with the OECD group and describe its results before moving on to the other region groups and offer a cross-group comparison.

The model predicts an output standard deviation of 2.72% which is slightly lower than the empirical data in table 2. Household consumption fluctuations are predicted to be at 2.25% *versus* 2.40% in the data. Relative volatility is close between the data and the model at 82%.

The model predicts a close estimate for correlation between output and consumption, which stands at .774, against .705 in the data. It drops however to .272 when only domestic output is taken into consideration. This is an illustration of the consumption-correlation puzzle, where household consumption patterns seem to be interlocked in OECD economies. The model also predicts the correct order of correlation with global and regional cycles, at .925 and .331 respectively. It is nonetheless unable to replicate close values to those exhibited by empirical data, namely .731 for correlation with the global cycle, and .576 for the regional one.

While the data suggests a weakly negative correlation between output and trade balance, the model predicts a positive correlation of .072. The correlation of demand shocks with trade balance at -.002 is closer to the data, which point the way to future adjustments in the model. It makes up however with a persistent auto-correlation: though it starts at a lower first order in comparison with the data (.331 against .492) it is just as persistent in higher orders of autocorrelation. The model in this respect outperforms the trend shock hypothesis, whose predict is that of a flat ACF.

Figure **??** above plots output, consumption and trade balance IRFs to a 1% increase in the three exogenous shocks specified in the model: productivity, demand and investment efficiency. Output reaction to exogenous shocks follows standard results. Increase in productivity is a mainstay of RBC core results, whereas demand and investment shocks are reaction to the increase in both components: output increases with a demand shock because household expenditure increases, just as investment increases when a its efficiency shock occurs.

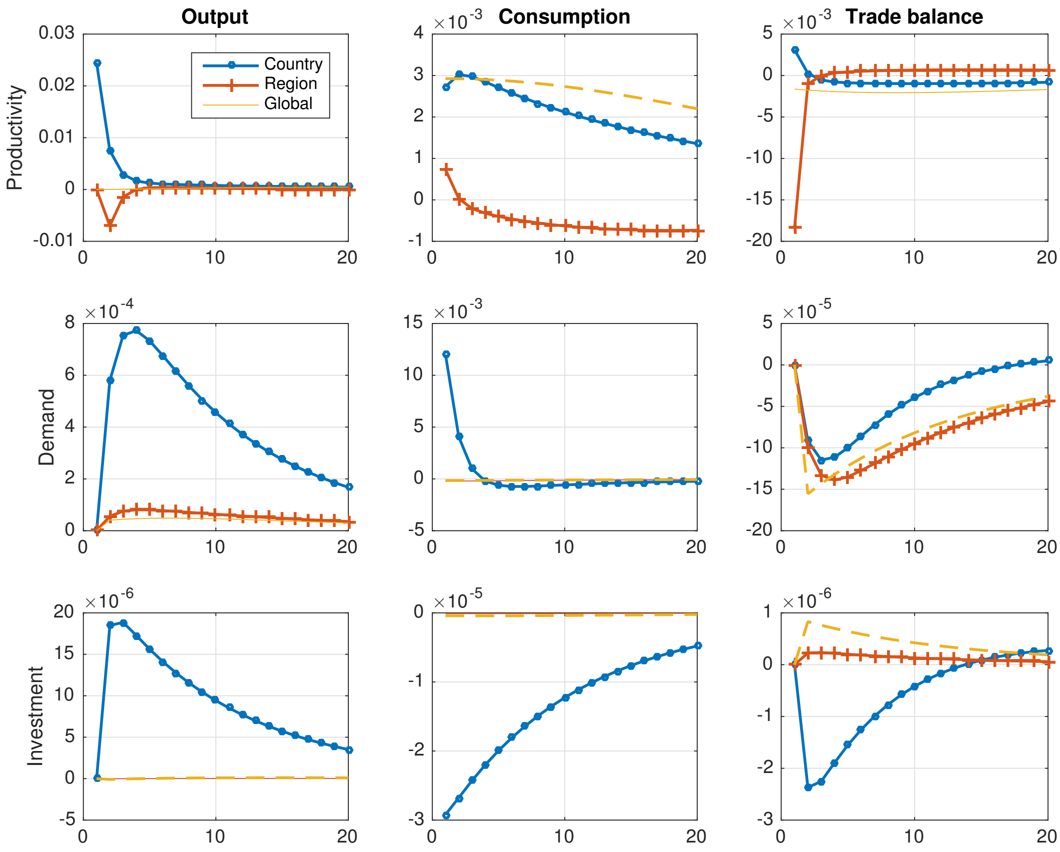

Figure 8: Macroeconomic aggregates' IRF to exogenous shocks in OECD.

Trade balance invariably declines after these three shocks, due to the additional generated demand (either for consumption goods or investment) and pushes the home economy to supplement its shortfall from abroad.

Table 12 compares empirical variance decomposition computed in the previous section against the model's prediction. As we can see, it replicates quite well the respective contributions of imported and domestic shocks into output fluctuations for all emerging economies. Sub-Sahara Africa and Latin America's peculiar large contribution of domestic factors at respectively 21% and 22.2% are replicate in the model to similar proportions, respectively 27.9% and 16.06%. Similarly, the model managed to capture South Asia's sensitivity to regional shocks, with a predicted value of 68.4% against the empirical contribution of 53.6%; the over-estimated value in this case may be due to the model's incorporation of large spill-over effects from regional exogenous shocks.

While the model does well in accounting for ranked contribution to output fluctuations in OECD, it does a poor job in replicating the regional component in that country group. It over estimates by a large margin global factors, while it neglects the empirically large effect of regional factors. In that sense, the model assigns a larger weight to global shocks than the data suggests, as far as wealthy economies are concerned.

Table 12: Output variance decomposition: global and local exogenous shocks.

Region	Country	Region	World
OECD (Model)	12.25%	26.08%	61.67%
Data	7.45%	42.80%	49.75%
MENA	8.13%	42.73%	49.14%
	11.70%	39.45%	48.74%
Latin America	16.06%	33.40%	50.54%
	22.22%	32.22%	45.52%
South Asia	4.15%	68.41%	27.44%
	8.70%	53.60%	37.30%
Sub-Sahara Africa	21.01%	35.50%	43.49%
	27.90%	34.60%	37.30%

Table 13: Simulated vs Empirical moments: stylised facts comparison.

Moment		OECD	MENA	Lat.Am	S.Asia	S.Africa
Data	σ_y	2.85%	6.50%	2.53%	4.00%	5.30%
Model		2.72%	4.61%	3.10%	2.58%	6.08%
	σ_c	2.40%	5.10%	3.20%	4.80%	7.90%
		2.25%	4.44%	3.90%	3.80%	6.91%
	$\rho_{y,c}$	.705	.426	.711	.649	.581
		.774	.669	.683	.790	.592
	$\rho_{y,tb}$	-.006	-.051	-.011	-.054	-.018
		.072	-.032	-.037	-.051	-.090
	$\rho_{y,z}$	.222	.241	.216	.271	.217
		.375	.288	.194	.524	.430
	$\rho_{y,w}$	.731	.394	.242	.402	.429
		.925	.613	.489	.498	.249
	$\rho_{y,r}$	.576	.378	.194	.301	.286
		.331	.291	.544	.330	.189
TB ACF						
	ρ_1	.492	.552	.436	.386	.350
	ρ_2	.359	.401	.281	.284	.293
	ρ_3	.279	.281	.226	.177	.233
	ρ_1	.331	.801	.803	.428	.614
	ρ_2	.281	.682	.74	.417	.459
	ρ_3	.262	.578	.690	.399	.344

Yet the close match observed for most if not all emerging economies is an encouraging sign as to the model's ability to replicate stylised facts discussed in the first section. In fact, it is a testimony to the model's robustness that it has managed to account for empirical variance decomposition among a heterogeneous set of economies.

Similar observations can be made as to the comparison of empirical moments against those generated by the model. We look at output and consumption standard variations, as well as output correlation with an array of macroeconomic variables. Table 13 compares the main stylised facts as discussed in the previous two sections against the model's predictions. As seen before for the OECD group, the model performs fairly well in account for output and consumption fluctuations and their correlation. It overestimates other components, such as output and productivity correlation, as well as trade-balance ACF. On the other hand, it has missed out on the correlation between output and trade balance, a key stylised fact.

Apart from Latin America, the model predicts modestly larger fluctuations in consumption and output. This discrepancy however is offset by similar levels of their standard deviation ratio. For those economies whose household consumption fluctuates more than output, it means there are other ways to account for this feature without resorting to the trend shock hypothesis advocated in Aguiar & Gopinath.

As for Latin America, even if it over-predicts fluctuations in its main macroeconomic aggregates, their relative standard deviation remains essentially the same: consumption is 23.5% more volatile than output in the data, against 22.9% predicted by the model.

Consumption and output correlations are broadly positive and significant. The model predicts a slightly higher correlation for all regions save for Latin America, whose correlation it predicts to be at .683 against the empirical .711. All predicted correlations fall however when only domestic output is taken into account, another feature of the consumption correlation puzzle. The discrepancy in predictive correlation may provide answers to this puzzle: as economies open up to trade and exchange goods, their consumption patterns synchronise, regardless of the nature of their trading partners. Though it does not appear explicitly in the model, it would be fair to assume that consumptions correlate across regions because all consumers value diversity.

Output and productivity correlation is also another feature the model over-explains for most region groups. Assuming empirical TFP estimates to be accurate, the model relies rather heavily on productivity shocks to create fluctuations, hence the larger correlation. For Latin America and Sub-Sahara Africa however, the discrepancy is large enough to suggest that demand and investment efficiency shocks need to be investigated further. This result is another contradiction to the Aguiar & Gopinath's assumption that all shocks can be consolidated into trend productivity.

This over-explanation can also be found in trade balance ACF. This is not a significant problem however, since it improves on the trend shock hypothesis' inability to replicate its empirical persistence. Our model actually finds trade balance to be *more* persistent than the data suggests, although in the case of OECD, it starts at a lower level of first-order autocorrelation. All emerging economies on the other hand predict strong and persistent ACF values observed otherwise.

Synchronisation to global and regional cycles, as well as output and trade balance correlation do not perform quite as well. While the former's negative correlation has been adequately captured by the model, it systematically over-predicts low values; further trade frictions are therefore needed to bring down correlation to empirical levels. In particular, the sunk cost component can be improved to adjust the model without significant loss of relevance.

The model finally over-predicts synchronisation with the global cycle save for Sub-Sahara Africa, where predictions point to the lower order of correlation of .249 against the empirical .429.

It does not stray much from regional synchronisation for that country group, whose empirical correlation of .286 is slightly under-predicted at .189. Latin America, because of its significantly low synchronisation with global and regional cycles does not come out well in the model, with stronger and more significant values.

4 Conclusions

This paper sought to investigate the reasons why fluctuations are larger in emerging economies than developed economies. It finds that is also the case that fluctuations differ from one region to the other. The central assumption that guided this paper's argument is that imported and domestic shocks affect EMEs differently from their wealthier counterparts, and among themselves.

We started with an exhaustive presentation of stylised facts common and specific to country groups. We found out that the literature's reliance on one region group to describe EMEs provided a distorted view of the latter, and sought instead to provide a region-based compendium of stylised facts. The paper also offered some preliminary evidence as to the effects of imported shocks

Give the fact that the global and regional cycles are not observable variables *per se*, we offer an estimate of global and regional factors by means of a two-step non-parametric estimation. Its reliance on a minimal set of assumptions and constraints made sure the end result was not conditioned by prior data structure. It also proved to offer statistically robust estimates for both factors. The resulting data is then compared against the proposed model.

The theoretical framework borrows from the Backus & *al* model for international business cycles. It introduces global and regional entities as abstract trading partners of the home economy. We also introduce distortions on goods and capital markets, in the form of demand and investment efficiency shocks. In particular, capital flows are disturbed when a given economy does not converge with the rest of the world in its aggregate investment schedule. We find the model replicates adequately output variance decomposition and matches the empirical contributions of imported and domestic shocks in output volatility.

The model would gain from a more elaborate description of trade restrictions, in order to improve on its predictive powers regarding output and trade balance correlation. Overall the model's predictions stand: differences in fluctuations are due to a variety of factors. First, the different spill-overs effect from technology shocks account for a large part in differences within EMEs. Second, estimated and calibrated parameter values for each region provide different outcomes within the same theoretical framework. Third, a diverse set of exogenous shocks is better suited to account for the heterogeneous properties of business cycles in EMEs.

The policy implications of these results are significant for emerging economies. Contrary to Lucas' (1987) estimates for smoothing cycles, welfare costs to aggregate fluctuations can be quite large per Loayza, Rancière, Serén & Ventura (2007)[25] for developing economies. Pallage & Robe (2003)[36] argue welfare costs of aggregate fluctuations to be at least 10 times larger that those in the United States. Athanasoulis & Van Wincoop (1999) [4] point to large and significant welfare gains from dealing with consumption smoothing, and even larger gains from global risk-sharing.

Government intervention could therefore be desirable to smooth fluctuations, since such a policy can yield significant gains to households. However, an ill-conceived policy may result in exacerbating fluctuations and deteriorating agents' welfare. Such an outcome may be precipitated by an inadequate estimation of domestic and imported shocks. This paper offers a variance decomposition specific to each region group, which means cycle smoothing policies have to be region-specific. For instance, a policy designed to alleviate the adverse effects of investment cost of adjustment has to be careful to take into account the economy's convergence in investment dynamics.

To sum up, this model offers evidence the Backus & *al* research program is best suited to study fluctuations in emerging economies. That is so for two main reasons: first, it concludes a more diversified universe of exogenous shocks need to be defined to account for fluctuations. It rans contrary to the literature's stand that exogenous shocks in a small open economy can be consolidated into trend productivity. Garcia-Cicco & *al* [14] offer a variety of the extended RBC model to make that point. They conclude the trend shock hypothesis does not do an adequate job. Second, the Backus & *al* provides an adequate base to elaborate on international business cycles models able to account for many international macroeconomics puzzle.

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