Business Cycles around the Globe*

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December 15, 2008

Very preliminary

Abstract

We document massive heterogeneity in basic cyclical patterns between (and within) groups of developed and emerging market economies. We use descriptive statistics in a uniquely large sample of quarterly frequency aggregate data, along with structurally estimating a small open economy model of the business cycle to show that business cycles are NOT alike. We demonstrate that one can go quite far, though definitely cannot travel the full distance, in accounting for heterogeneity in key sample moments, by allowing shock processes vary in a real business cycle economy, while restricting shock propagation to be identical across countries.

* We thank Tamás Briglevics, Kamram Mammadov, Ralica Starcheva and Sorina Vaju for expert research assistance. Helpful comments from Jeff Campbell and seminar participants at EUI, CEU research lunch at early stages of this project are gratefully acknowledged.
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1 INTRODUCTION

Are all business cycles alike?[1]. The perspective this paper takes in answering this classic question in macroeconomics is the one of bringing about more and better data, viewed through the lenses of an open economy, structural model of the business cycle. In order to characterize heterogeneity in the quantitative properties of economic fluctuations in a number of countries around the globe, we first provide a systematic, unconditional account of quarterly frequency facts of economic fluctuations in a large number of countries around the globe, the majority of them being emerging and developing ones. In doing so, we document key facts of volatility, cyclicality and persistence in cyclical components of basic macroeconomic aggregates. We then estimate country-specific innovations to the level and the growth rate in productivity, specified in an open-economy business cycle model. Our approach is to condense differentials in countries' cyclical fluctuations into differences in the underlying shock process, or other key structural parameters like investment adjustment costs. We also use our estimates to evaluate the fit of the baseline model along particular moment conditions.

We seek to improve on earlier efforts studying comparative features of macroeconomic fluctuations in several dimensions. First, we document business cycle facts in 62 countries around the globe, in terms of the choice of variables, time frame and country coverage, arguably the most extensive meaningful panel in this context.[2] The large country dimension allows us to split the sample into groups of 29 developed (industrial) versus 33 developing (emerging) economies. We then further refine country groupings by geography and historical origin. Second, to facilitate international comparisons, we focus our data analysis on the same, post-1990 time period in every country in the sample. This is explained by the fact that, relative to prior time periods this era (of the 'Great Moderation') features reduced time-series variability in world shocks, and improved quality and increased uniformity in international data collection standards.

While the vast majority of related research focuses on the business cycle in a handful number of developed economies[3], there is also a growing literature analyzing developing countries, though often carrying out the analysis in a narrow way. These papers either tend to be limited to comparisons in a

[1] Blanchard and Watson (1986) ask the exact same question, with the interest in examining the time-series variation in the intensity of US business cycle fluctuations over the twentieth century.

[2]

[3] See for example Agresti and Mojon (2001), Christodoulakis et al (1993), Fiorito and Kollintzas (1994), Kydland and Prescott (1990).

small group of countries, or to a single country[4]. Our work is most closely related to the research by Aguiar and Gopinath (2007), Garcia-Cicco, Pancrazi and Uribe (2006) and Neumeyer and Perri (2005), picking up the issue of the difference in business cycle fluctuations in emerging versus developed economies.

We document a number of stylized facts. First, output is more volatile in emerging market countries than in industrial ones. Second, output persistence is about 0.6, showing only small differences across country groups. Third, consumption is in general about as volatile as output in industrial economies, but significantly more volatile in emerging market ones. Fourth, relative investment volatilities are on the same order of magnitude in the different country groups. And finally, net exports appear to be more countercyclical in emerging markets than industrial economies; the result mainly being due to observations in countries of Latin America.

Our structural estimates show some interesting patterns in productivity dynamics. First, estimated innovations in productivity are more volatile in emerging market economies than in industrial ones, particularly in the permanent component. Second, the estimated persistence in both components of productivity innovations exhibits a relatively homogenous pattern. And third, the Beveridge-Nelson-decomposed random walk component in productivity innovations in emerging market economies slightly exceeds the one in industrial countries.

The rest of the paper proceeds as follows. Section 2 covers data and measurement. Section 3 summaries the small open economy real business cycle model. Section 4 discusses estimation. Section 5 presents the results. Section 6 concludes and indicates directions for further work.

2 DATA AND MEASUREMENT

We draw on various national and international, carefully cross-checked data sources. We set up a quarterly frequency dataset of key macroeconomic variables in 62 countries between 1990:1 (or later) and 2005:4. Even if a longer sample were available in particular instances, to ensure comparability in terms of time period, external shocks and data quality, we use data restricted to this time period. The resulting panel is almost balanced at the country level.

[4] For instance, examples for the former category include Alper (2003), Benczur and Ratfai (2008), for the latter one Bjornland (2000), Burgoeing and Soto (2000), Kydland and Zaragaza (1997).

The choice of countries is dictated by the availability of quarterly frequency National Income and Product Accounts data. We believe that the quality of the data we use is the best one can possibly have in this context. Based on income per capita, we first split countries into 2 large groups, industrial and emerging market. This classification roughly overlaps with OECD membership, and also coincides with patterns in financial depth and average inflation. As shown in Table 1, the two groups are then further divided into 7 subgroups, with countries in Central and Eastern Europe (CEE), the former Soviet Union (CIS), Latin America (LA), and other low- or middle income countries in the emerging market, and G7, traditional European Union (EU), and other high-income countries in the industrial group.

As dictated by our model, the aggregate variables we investigate are (constant price) GDP, private consumption, investment, net exports, and employment.[5] In most cases, with the exception of CIS countries, constant price data are obtained directly from the data sources. We transform the raw data prior to the empirical analysis in several stages. First, all variables are de-seasonalized and transformed into logs. One exception is net exports, where we employ the ratio of net exports to output in percentage terms. In separating the trend from the cyclical component in the data, our default filter is the H-P one, with parameter 1600, the standard choice for quarterly data.

We compute three key sample statistics. For capturing the volatility in cyclical measures, we calculate standard deviations in absolute and relative terms, for comovement, the contemporaneous correlation with output, and for persistence, the AR(1) coefficient in the series.

3 MODEL

The benchmark small open economy real business cycle model we employ is similar to the one developed in Aguiar and Gopinath (2007) and Garcia-Cicco, Pancrazi and Uribe (2006), now calibrated and estimated to each individual economy. Our working assumption is that national economies face different technological shock processes, but share the exact same propagation mechanism.

[5] Our complete dataset (not utilized here) includes observations on government consumption, real wage, productivity, money, CPI, inflation, interest rate, nominal exchange rate, real exchange rate and net capital flows as well.

Forward looking consumers maximize the present discounted value of utility over an infinite horizon, using the periodic Cobb-Douglas felicity function of $u_t = \left(C_t^{\gamma}(1-L_t)^{1-\gamma}\right)^{1-\sigma} \big/ (1-\sigma)$, where 0 < γ <1. The resource constraint reflects quadratic costs of capital adjustment in the form of

$$C_t + K_{t+1} = Y_t + (1-\delta)K_t - \frac{\varphi}{2}(\frac{K_{t+1}}{K_t} - e^{\mu_g})^2 K_t - B_t + q_t B_{t+1}.$$

International financial transactions are restricted to one-period, risk-free bonds. The level of debt due in period t is denoted by Bt and the time t price of debt due in period t+1 is denoted by qt. To close the model, as in Schmitt-Grohe and Uribe (2001), the price of debt is assumed to be sensitive to the level of debt, with

$$1/q_t = 1 + r_t = 1 + r^* + \psi(e^{B_{t+1}/\Gamma_t - b} - 1),$$

where r* is the world interest rate, b represents the level of debt in the steady state, and ψ > 0 determines the elasticity of the interest rate to changes in debt. Finally, the restriction the existence of the steady state puts on parameters is $\beta(1+r^*)^{1/\sigma} = \mu_g$.

Output is produced via a Cobb-Douglas production technology, $Y_t = e^{z_t} K_t^{1-\alpha}(\Gamma_t L_t)^{\alpha}$, with factors of production being labor, L_t, and capital, K_t. The transitory and permanent components in productivity are captured in the variables z_t and Γ_t, respectively. z_t follows an AR(1) process with $z_t = \rho_z z_{t-1} + \varepsilon_t^z$, where -1 < ρ_z < 1 and ε_t^z is an i.i.d. mean zero normal process with standard deviation of σ_z. Γ_t, captures the cumulative product of growth shocks, $\Gamma_t = \Gamma_{t-1} e^{g_t}$, with $g_t = (1-\rho_g)\mu_g + \rho_g g_{t-1} + \varepsilon_t^g$. Here again -1 < ρ_g < 1 and ε_t^g is an i.i.d. mean zero normal process with standard deviation of σ_g. Innovations in the productivity variables can be thought of as stemming from frictions in policy or regulations as well.

To make the model stationary, all variables as of time *t* are normalized by Γ_{t-1}. The solution to the constrained optimization problem is then obtained by the log-linearization of the first order conditions and the resource constraint around the deterministic steady state. Given a solution to the normalized equations, we recover the path of the non-normalized equilibrium by multiplying through by Γ_{t-1}. The theoretical moments are obtained from the coefficients of the log-linearized solution.

The equilibrium in the model reflects consumption smoothing behavior, exhibiting 'excess sensitivity' of consumption (Deaton 1991) due to the presence of shocks to trend productivity growth. The key prediction of the model is that consumption gets more volatile and net exports more countercyclical as the persistent component becomes more important.

The model with 13 parameters calibrated and estimated to individual economies. 7 of the parameters are common in the country-specific model economies and take on values picked in Aguiar and Gopinath (2007), while we estimate the rest of the parameters separately. The estimated county-specific parameters include the variance and persistence in the two productivity processes, the mean growth rate of the permanent component of productivity, and capital adjustment cost parameter. The common parameters are the time preference rate (β= 0.98), the consumption exponent in the utility function (γ=0.36), the steady state normalized debt (10%), the debt coefficient on the interest rate premium (ψ=0.001), the labor exponent in the production function (α=0.68), the risk aversion parameter (σ=2), and the depreciation rate (δ=0.05).

4 STRUCTURAL ESTIMATION

Similarly to Aguiar and Gopinath (2007), we estimate model parameters country by country, by matching nine (second) moment conditions. These include the standard deviation of output, the relative volatility of consumption, investment, net exports, the correlation of consumption, investment, net exports per GDP and employment with output, and finally, the first-order autocorrelation in output. Given that we have more moments than free model parameters, this is essentially a minimum distance estimator, which tries to minimize the (squared) distance between data and model moments. As a first step, we use equal weights, but we consider squared *relative* deviations between model and data variances, and squared *absolute* deviations between model and data correlations.

Based on our parameter estimates, one can then apply the Beveridge-Nelson decomposition of the Solow residual (overall TFP growth) into a stationary and a random walk (with drift) process, and then calculate the relative importance of trend shocks in the overall variance of the Solow residual *sr*:

$$\frac{\alpha^2\sigma_g^2}{\left(1-\rho_g\right)^2\sigma_{\Delta sr}^2}.$$

Currently, we cannot report formal overidentification tests and standard errors for our parameter estimates. We are in the process of calculating these statistics by an extensive bootstrap procedure.

5 RESULTS

5.1 Stylized Facts

Figures 1-5 show the distribution of cyclical data moments. The first two columns display the sample moments in the industrial versus the emerging market group, respectively. The next seven columns collect the same information, grouped together country group by group as shown in Table 1. The dark diamond indicates the unweighted average of the sample statistic in the particular country grouping.

Before discussing our findings variable by variable, let us make a general observation. There is quite substantial heterogeneity both across and within country groups, and that large industrial countries (G7) are often not representative for all industrial countries.

Figure 1 first documents the volatility of the cyclical component of output. The data clearly show that output is about twice as volatile in emerging market countries as in industrial ones. Output volatility is most muted in the G7 economies, while it is far the highest in CIS countries. The most volatile country is Venezuela, while the least volatile one is France. Volatility in industrial economies is in general more homogenous than in emerging market ones.

Figure 2 provides information on the persistence of output fluctuations. A comparison of the two major country groups reveals no significant heterogeneity in the persistence statistics. The mean value for the AR(1) coefficient is 0.62. The least persistent country group is the CIS one. The largest AR(1) coefficients are observed in Canada and the US, the countries often used to calibrate structural business cycle models.

Figure 3 demonstrates the fact first identified in Aguiar and Gopinath (2007) that private consumption on average is significantly more volatile than output in emerging market economies, and about as volatile as output in more developed countries. The excess volatility of consumption is particularly pronounced in CEE and CIS economies. On the other end of the spectrum, Canada exhibits one of the least volatile private consumption, relative to output.

Relative investment volatilities, as shown in Figure 4, show only modest differences between the two large country groups, with the ratio of the investment and output standard deviation figures fluctuating between 3 and 5 with only a handful number of exceptions.

As shown in Figure 5, net exports are clearly more countercyclical in the emerging market group than in the industrial one. In the latter group, the large number of statistics in the proximity of zero point to an acyclical pattern in net exports. While the emerging market group is dominantly countercyclical, this is mainly due to data in Latin America, the difference mainly originating from the reduced procyclicality of exports. In this sense, Latin America is not representative for a general industrial versus emerging comparison.

5.2 Model Fit

Next we discuss how closely our model can fit the nine data moments. Figure 6 shows that output volatility is matched very well, the percentage difference between actual and model moments never exceeds 15 basis points. With such a close fit, the model strongly replicates the fact that output volatility is smaller in industrial countries than in emerging ones.

Output persistence is less well tracked (see Figure 7), as the absolute difference between data and model moments are often as large as 0.1-0.2. On average, industrial countries' persistence is matched quite closely, while it is somewhat overpredicted (the difference is negative) for emerging market economies.

The relative volatility of consumption fits well, though clearly much less than output volatility itself (Figure 8). The average deviation for industrial economies is close to zero, while it is positive for developing countries, pointing to a slight underprediction of relative consumption volatility.

As Figure 9 demonstrates, the model has an extremely hard time in fitting investment volatility, for both country groups. On average, industrial economies exhibit 35% more volatile investment in the data than in the model, while this number is around 30% in emerging markets.

Finally, the cyclicality of net exports is overpredicted (Figure 10). Merging this information with Figure 5, we get that in industrial countries, the model leads to weakly procyclical net exports as opposed to acyclical behavior in the data; while in emerging markets, the model does predict countercyclical net exports, but much less strongly than the data suggests.

In general, one can conclude that the model manages to capture the key features of the data quite well. One notable exception is the volatility of investment. One caveat, however, is in order here: one needs to produce formal test of overall model fit and parameter significance, which would then enable a more careful evaluation of the model's performance. It would also allow checking which countries are less favorable to the model, and a tabulation of the significance of country-specific parameter estimates.

5.3 Productivity Dynamics

We now characterize the estimated temporary (z) and permanent (g) component of productivity dynamics. First, Figure 11 displays the standard deviation of the temporary (lower graph) and permanent (upper graph) component of productivity. The results indicate that volatility in productivity is in general higher in emerging market economies, particularly so in the case of permanent shocks. It is interesting to note that the extra volatility in the permanent component in the emerging group is primarily due to data in CIS economies; in the other country groups the difference is still present, but much less pronounced. Standard deviation statistics in the industrial group are much more homogenous, dominantly remaining below one percent, while in the emerging group spanning relatively evenly the interval up to five to six percent.

Figure 12 displays related information on the persistence in the two components of productivity, with the lower graph again referring to the transitory, while the upper one to the permanent component. The figures show that persistence on average is about the same in emerging and industrial economies in the permanent component of productivity, while in the transitory component the figures tend to be somewhat smaller in the emerging market group, mainly due to the CIS group again.

Lastly, Figure 13 displays the statistics for the Beveridge-Nelson decomposition of the random walk component in productivity. The results show that the random walk component is only slightly higher in emerging market countries, mainly driven by observation in CEE economies. Looking back to the much more pronounced heterogeneity in the relative volatility of consumption and the cyclicality of net exports, this indicates that the model's propagation mechanism succeeds in magnifying differences in the productivity process into much larger differences in business cycle moments.

6 CONCLUSIONS AND DIRECTIONS

Much of existing business cycle theory is motivated and evaluated by data observed in a handful number of highly developed economies, primarily in the United States. Drawing on a large sample of quarterly frequency observations, this paper empirically documents the existence of extensive significant cross-country differences in cyclical properties of key macroeconomic variables, both within and across country groups.

We document massive heterogeneity in basic cyclical patterns between (and within) groups of developed and emerging market economies. In order to gain a better and broader understanding of the importance of alternative sources and propagating mechanisms of macroeconomic fluctuations in different countries around the globe, the focus is first on characterizing unconditional facts, such as volatility, comovement and persistence in deviation cycles, and relating these facts to canonical models of the business cycle. Then we structurally estimate a small open economy model of the business cycle to obtain country-specific parameters in temporary and permanent productivity innovations. Overall, we demonstrate that one can go quite far, though definitely cannot travel the full distance, in accounting for heterogeneity in key sample moments, by allowing shock processes vary in a real business cycle economy, while restricting shock propagation to be identical across countries.

The research can be extended and refined in several directions. We first seek to obtain evidence for cross-country heterogeneity in shock propagation, as evidenced by patterns in openness in goods and capital markets, country size, economic and financial development. For instance, one can think of extending the benchmark RBC model with a role for financial frictions, so that more permanent TFP shocks in emerging market economies are replaced with similar TFP shocks translating into different consumption responses due to the ability to borrow and smooth consumption.

Second, as demonstrated in Garcia-Cicco, Pancrazi and Uribe (2006), the current model yields a random walk dynamics in net exports. Experimentation with the slope coefficient in the bond price equation reveals that the calibrated figure for the slope coefficient (and potentially the steady state NFA level) is not an innocuous assumption for emerging economies. While this modeling shortcoming can be immediately cured by assuming a higher elasticity of risk premium to the net foreign asset position, a more elegant approach would be add a small, tractable, yet meaningful model of credit constraints and risk-premium.

More straightforward refinements include an update of the dataset with data running until at least 2007:4. To check upon the consistency of the idea of permanent shocks with the particular filtering H-P procedure adopted here, we also plan to estimate the first-difference moments, including persistence in net exports.

A broader extension of the model would include a role for the real interest rate in propagating productivity shocks, in the spirit of Neumeyer and Perri (2005). Another possible avenue for further research is adding government spending shocks to the model as a source of fluctuations.

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TABLE 1
Country groups

G7	EU	DE	CE	LA	EM2	CIS
Canada	Austria	Australia	Bulgaria	Argentina	Malaysia	Belarus
France	Belgium	Cyprus	Croatia	Bolivia	Philippines	Georgia
Germany	Denmark	Hong Kong	Czech Republic	Brazil	South Africa	Kazakhstan
Italy	Finland	Iceland	Estonia	Chile	Thailand	Kyrgyzstan
Japan	Greece	Israel	Hungary	Colombia	Turkey	Moldova
UK	Ireland	Malta	Latvia	Ecuador		Russia
USA	Luxembourg	New Zealand	Lithuania	Mexico		Ukraine
	Netherlands	Norway	Poland	Peru		
	Portugal	South Korea	Romania	Uruguay		
	Spain	Switzerland	Slovakia	Venezuela		
	Sweden	Taiwan	Slovenia			

Sources: CBs and SOs, IFS, OECD, DataStream, ILO, BIS, EuroStat, WIIW, ECB DW, ‘direct contacts’

FIGURE 1
Output volatility

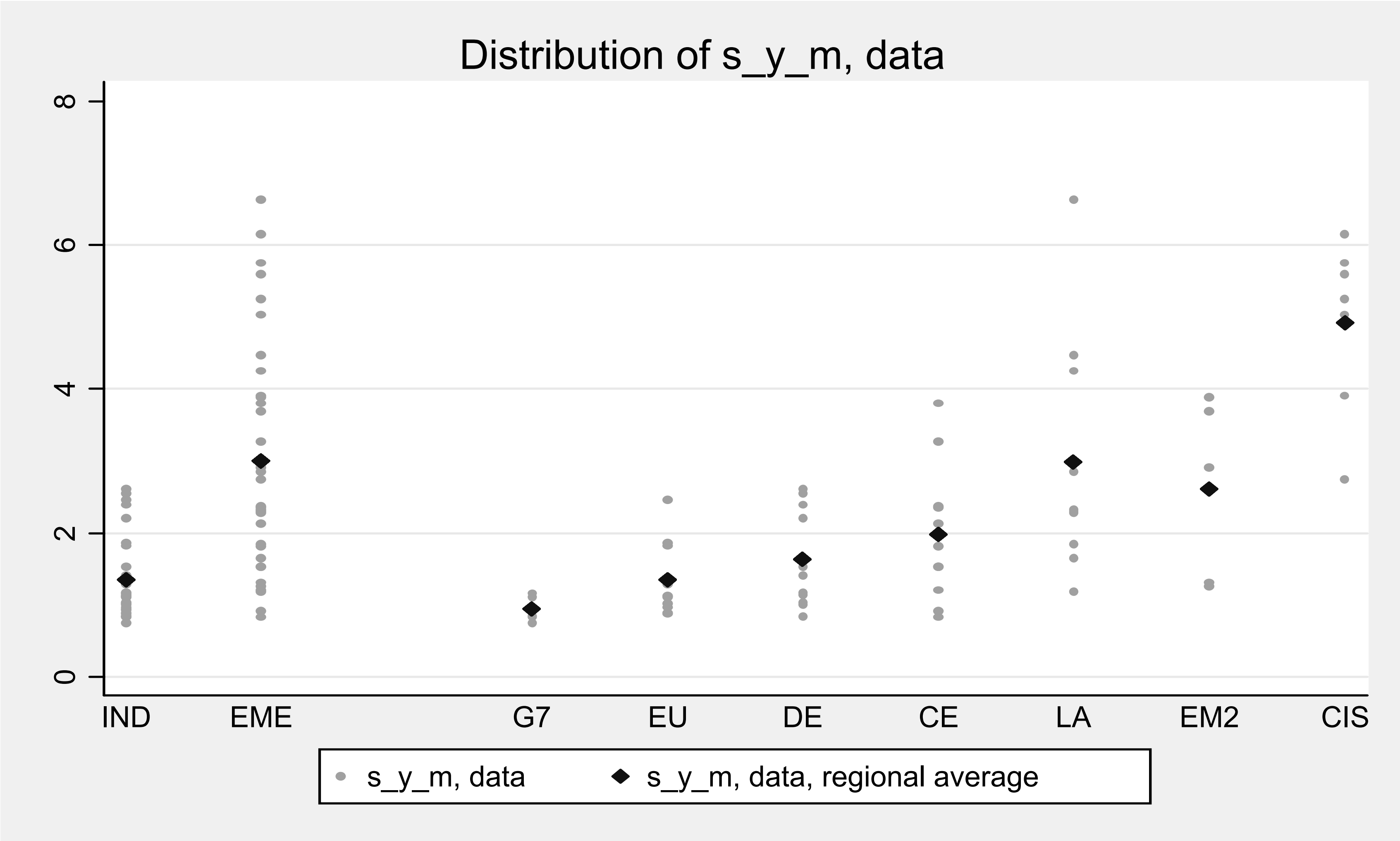


FIGURE 2
Output persistence

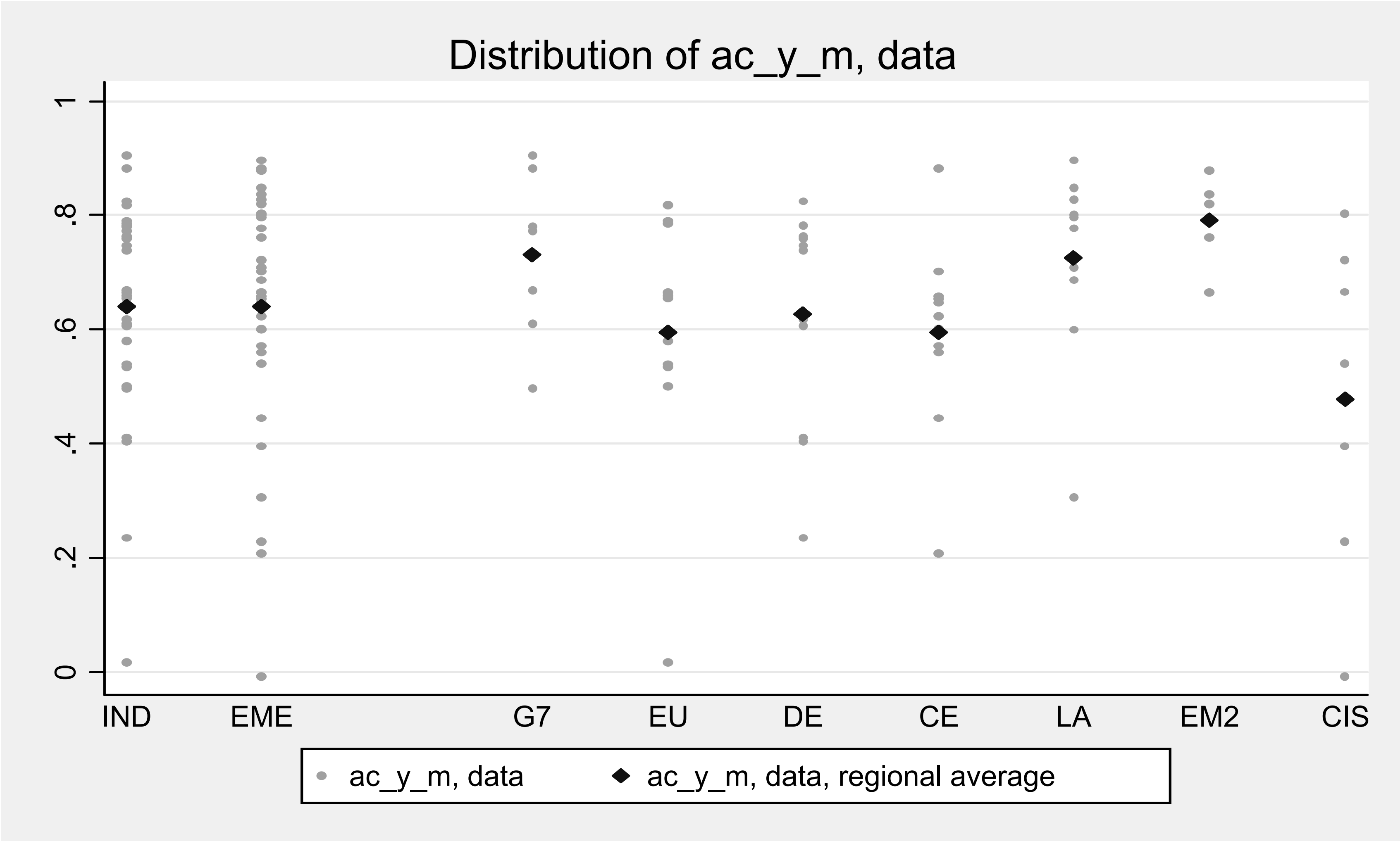


FIGURE 3
Consumption volatility

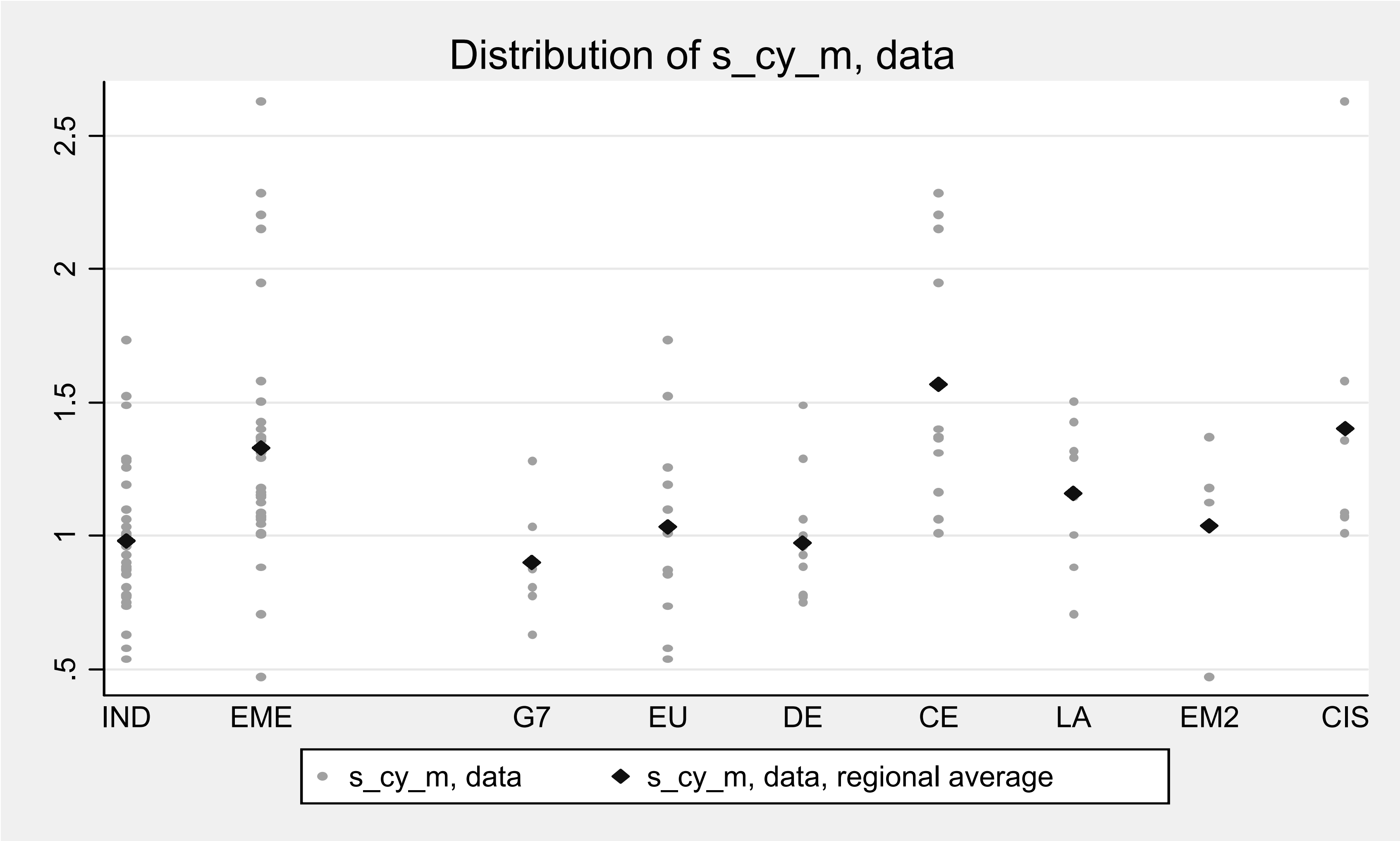


FIGURE 4
Investment volatility

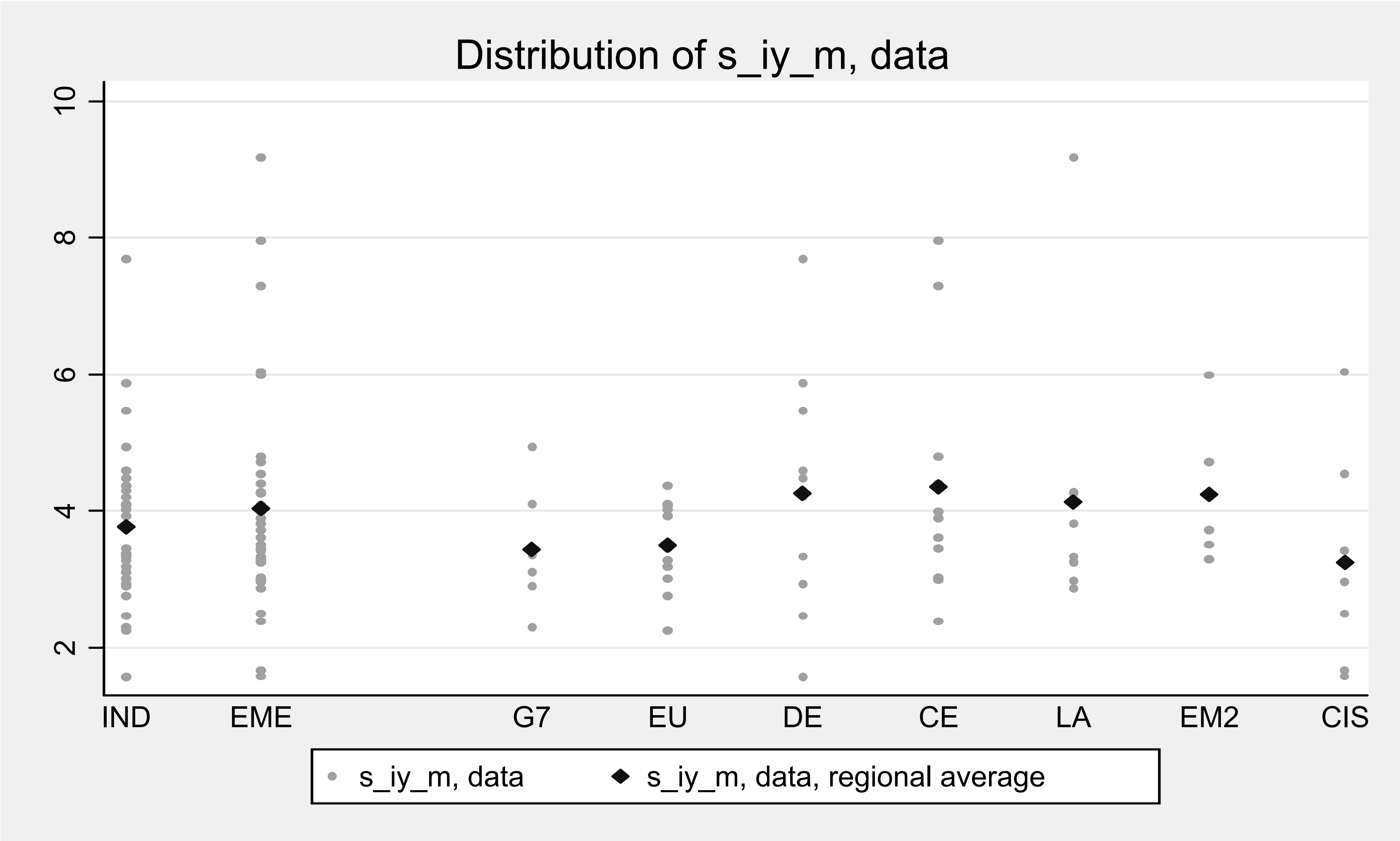


FIGURE 5
Net exports cyclicality

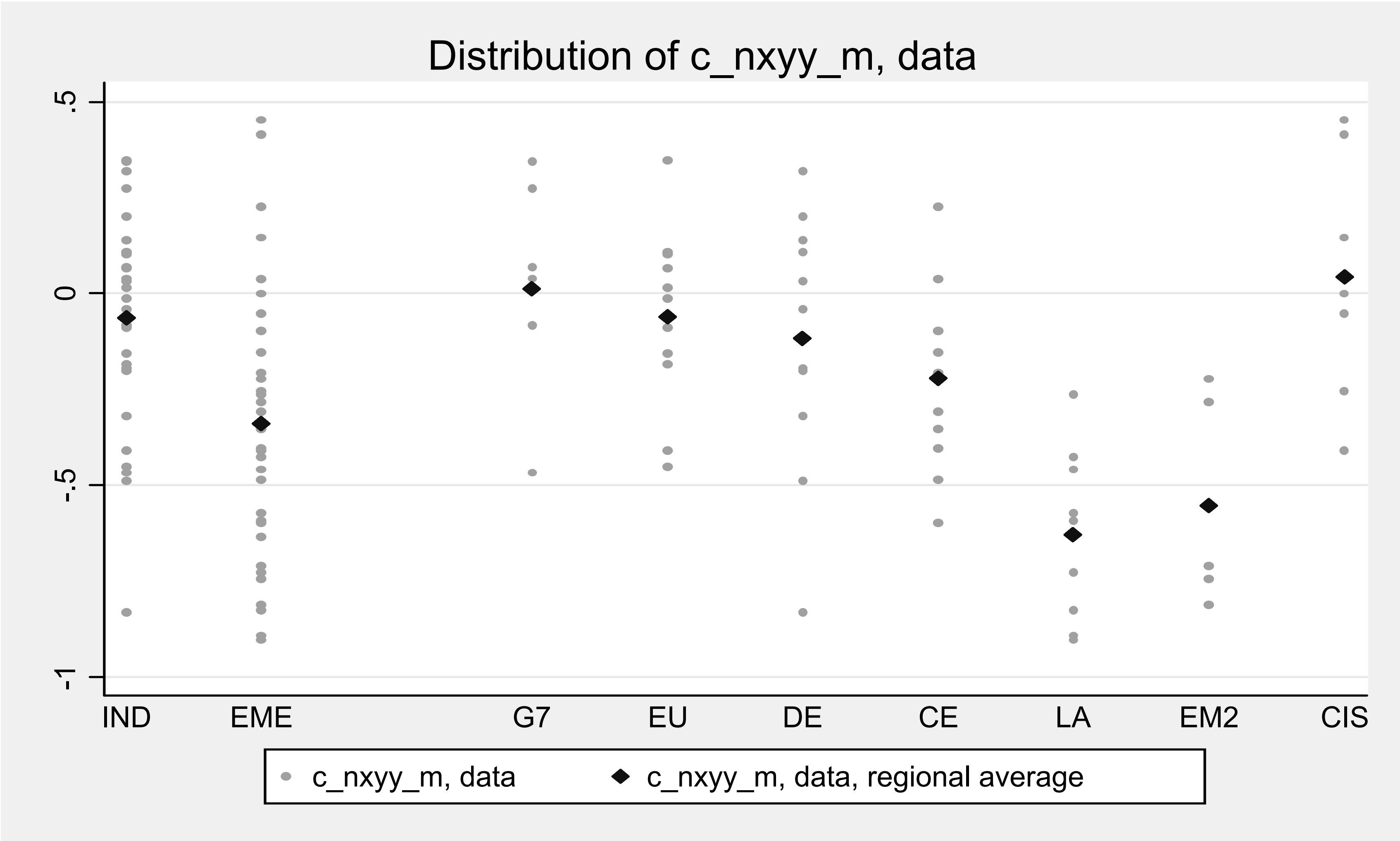
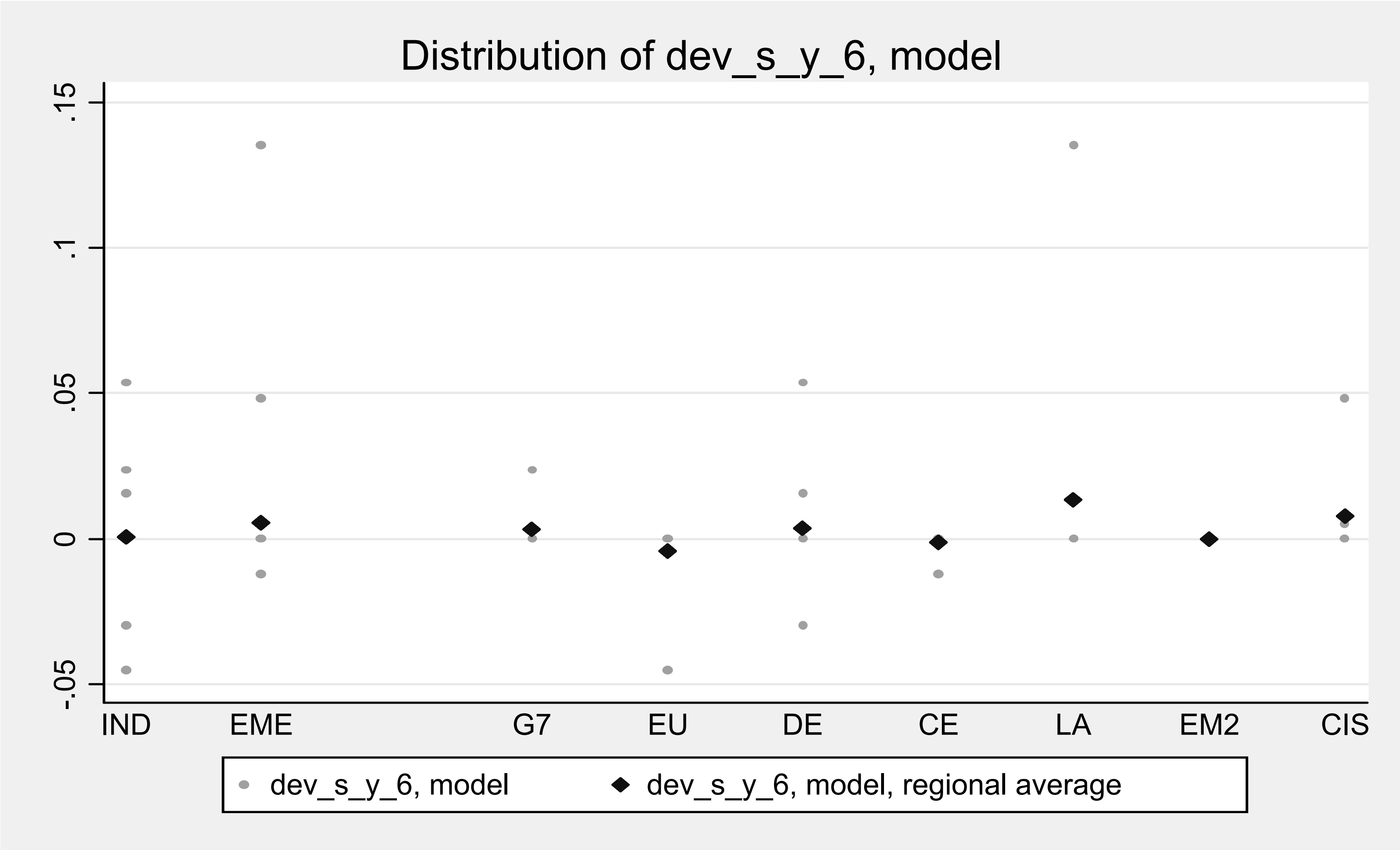


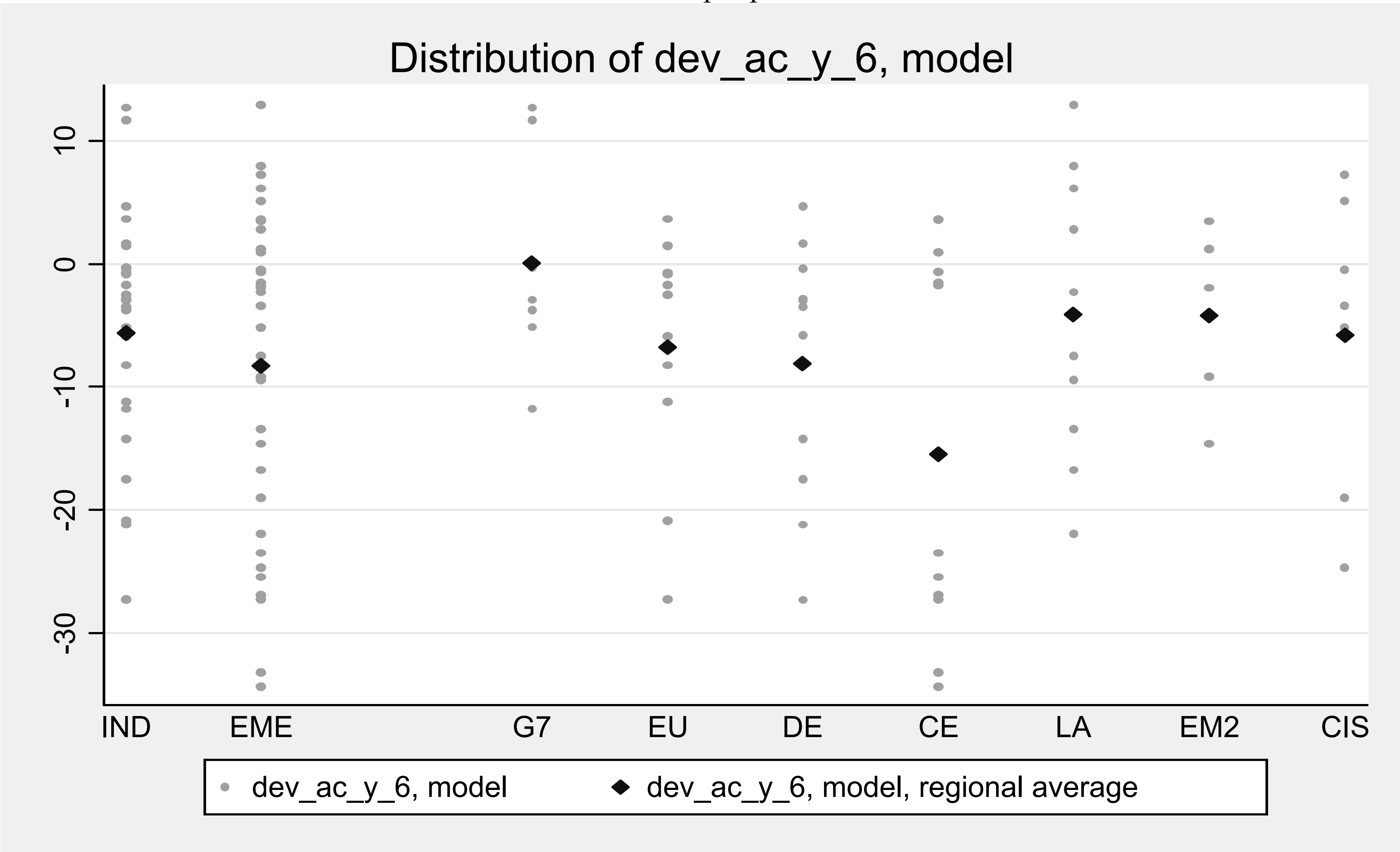
Figure 6
Model fit - Output volatility



(Percentage difference between data and model moment)

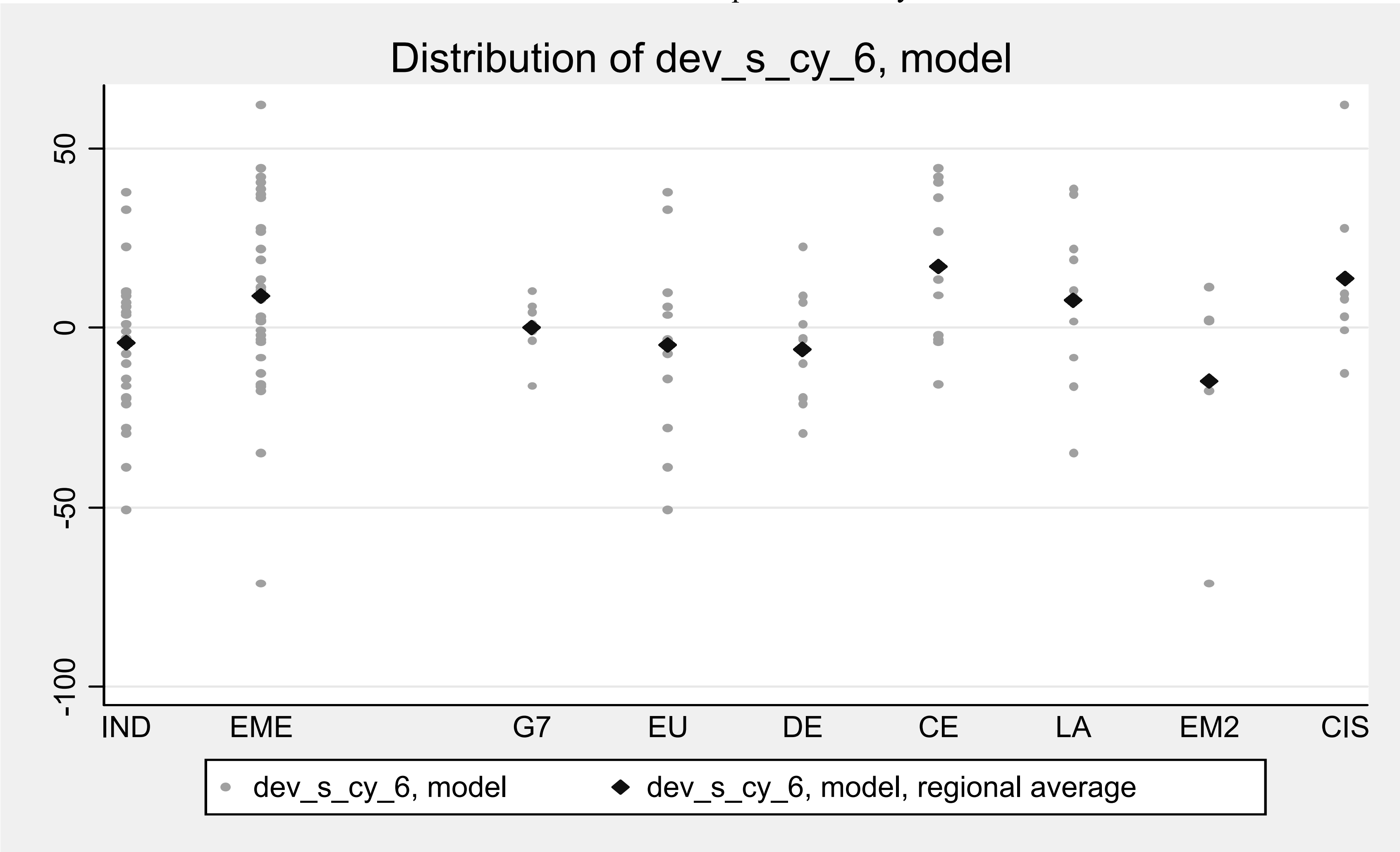
Figure 7

Model fit - Output persistence



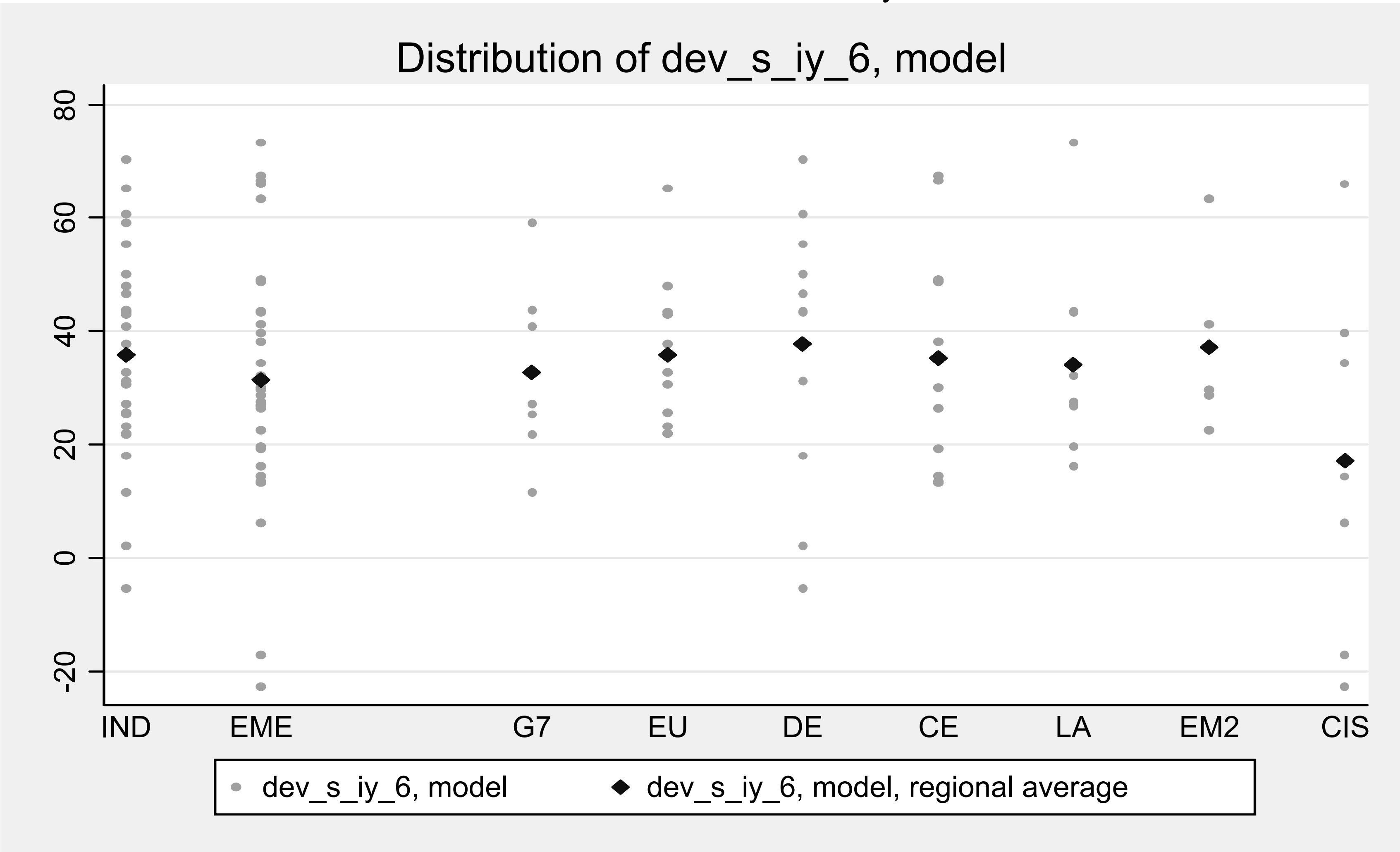
(Absolute difference between data and model moment)

Figure 8
Model fit - Consumption volatility



(Percentage difference between data and model moment)

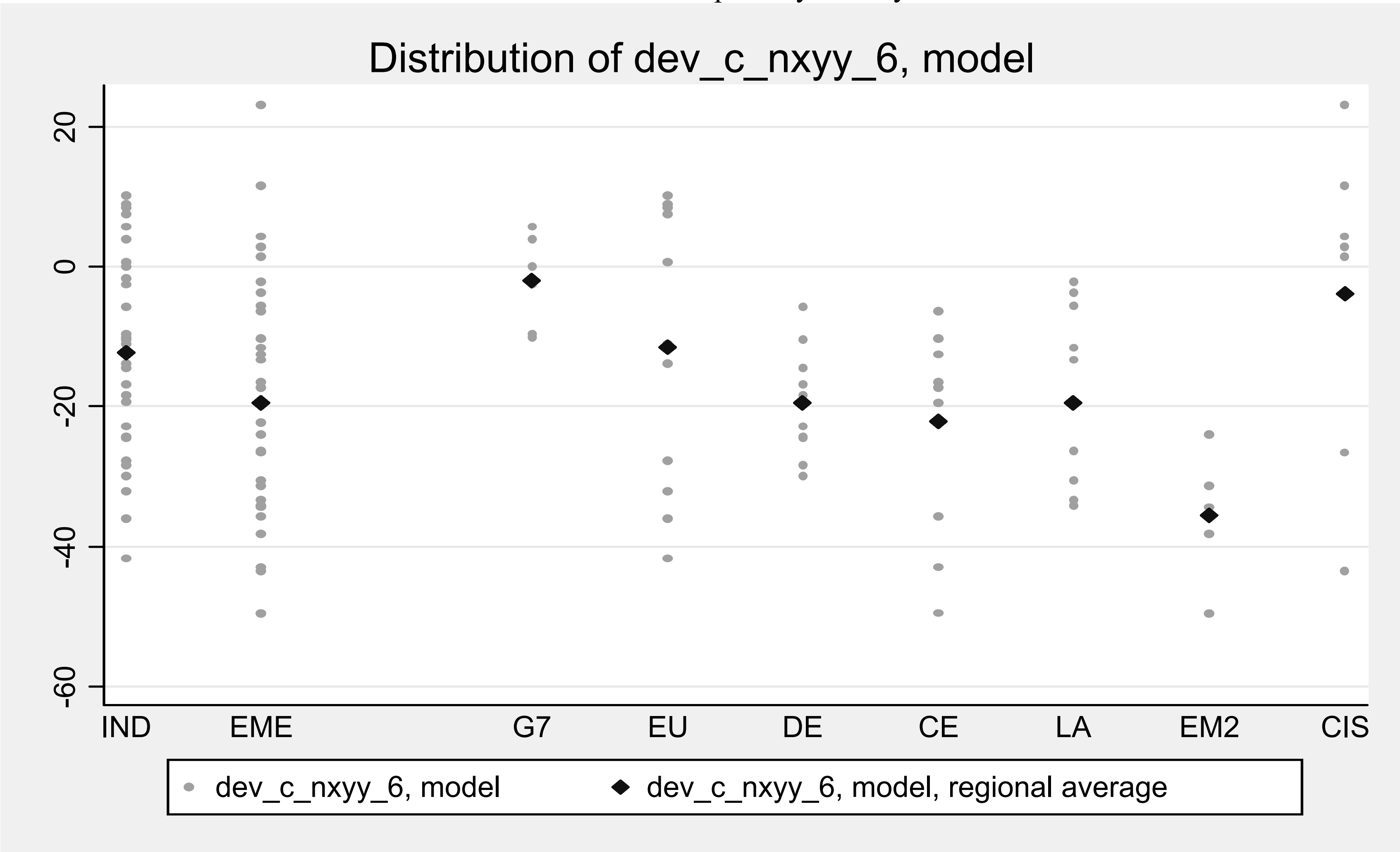
Figure 9
Model fit - Investment volatility



(Percentage difference between data and model moment)

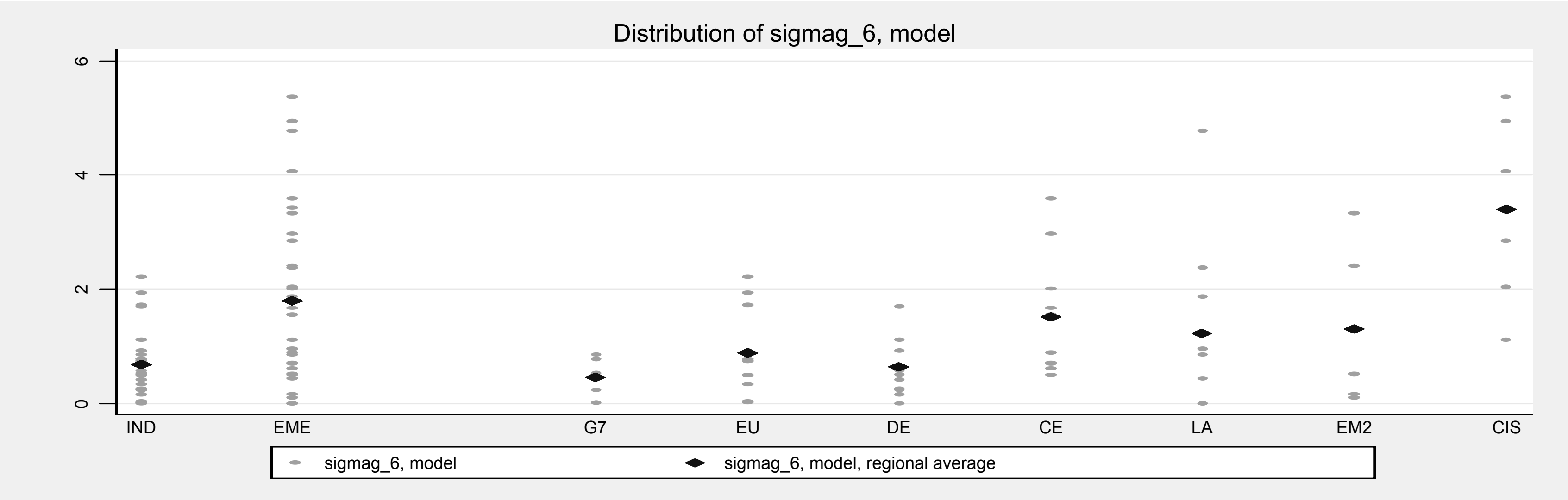
Figure 10

Model fit - Net exports cyclicality



(Absolute difference between data and model moment)

Figure 11
Productivity volatility



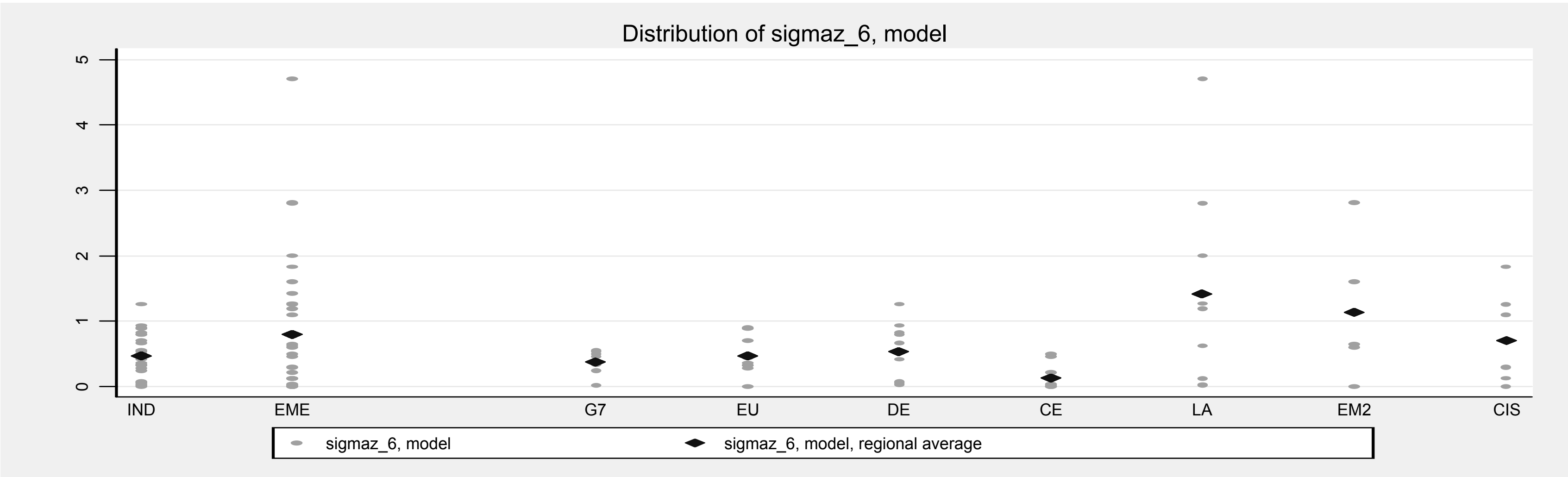
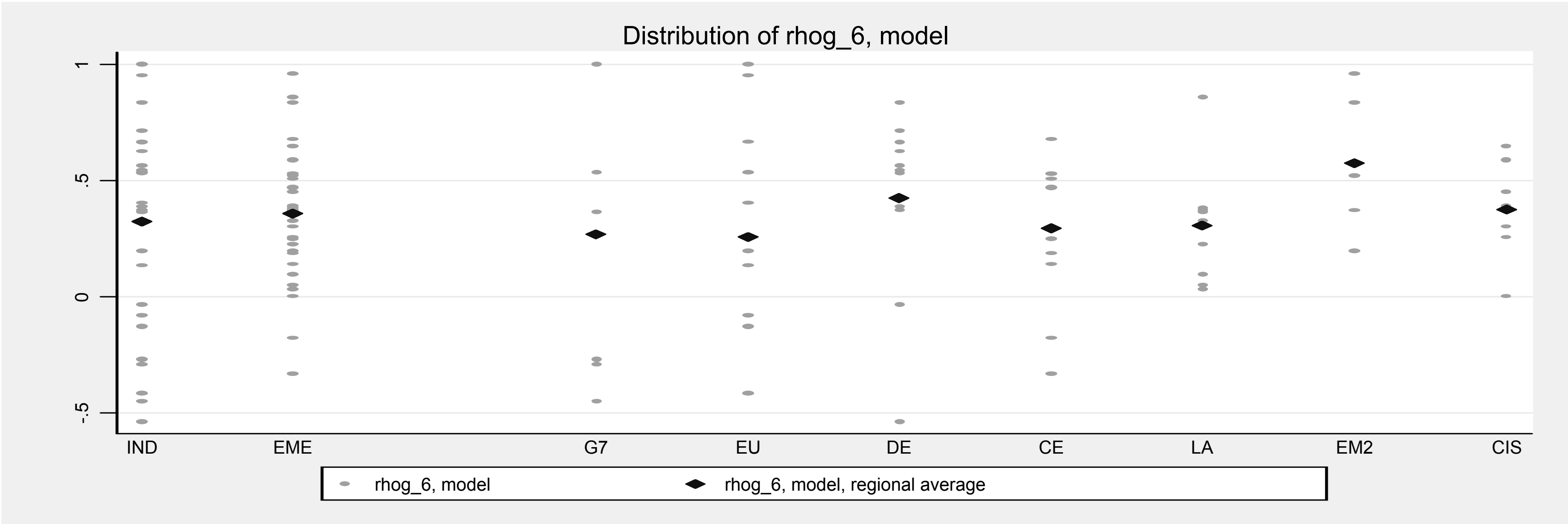


Figure 12
Productivity persistence



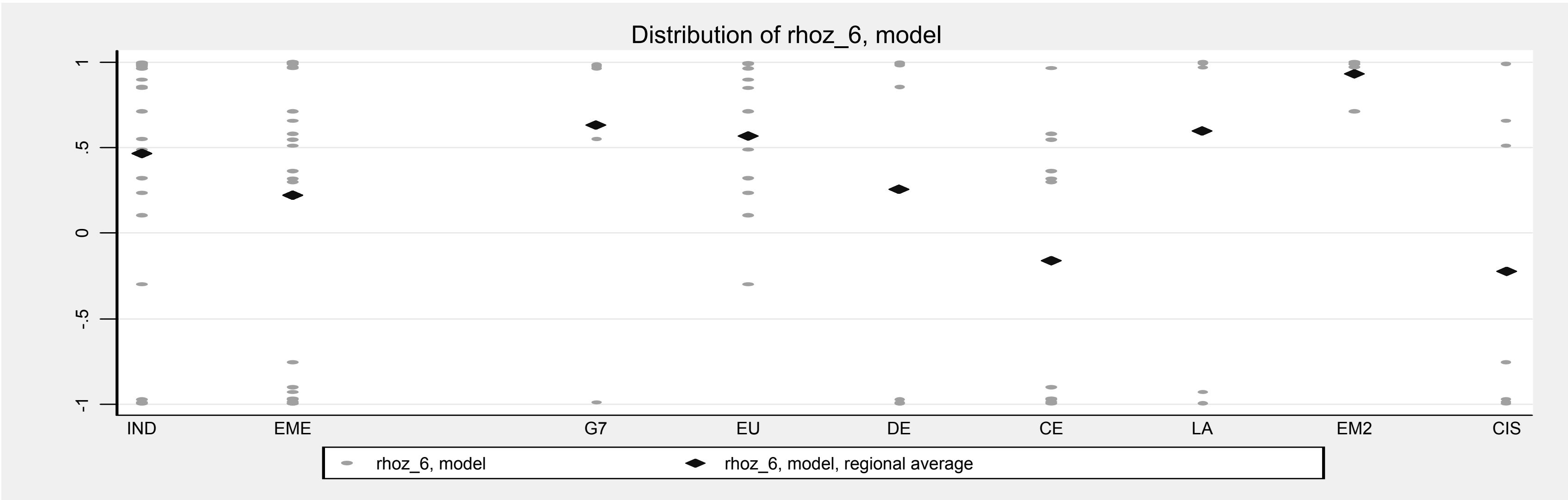


Figure 13
B&N random walk component