Trends and Cycles in Small Open Economies: Making The Case For A General Equilibrium Approach

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Abstract

Economic research into the causes of business cycles in small open economies is almost always undertaken a partial equilibrium approach. This approach is characterized by two key assumptions. The first is that the world interest rate is unaffected by economic developments in the small open economy, an exogeneity assumption. The second assumption is that this exogenous interest rate combined with domestic productivity is sufficient to describe equilibrium choices. We demonstrate the failure of the second assumption by contrasting general and partial equilibrium approaches to the study of a cross-section of small open economies. In doing so, we provide a method for modeling small open economies in general equilibrium that is no more technically demanding than the small open economy approach.

1 Introduction

The veracity of business cycles differs dramatically across the nations of the world economy. Within our 68 country sample, the standard deviation of output growth ranges from an astounding 26.4% in Iraq to a mere 1.88% in the Netherlands; the median country is the Domincan Republic (3.83%). The annual data used here is from the PWT tables and span the period 1971 to 2005. Since our approach focuses on real as opposed to financial causes of business cycles, we omit the Great Recession from our analysis. Figure 1 presents a comprehensive view. Countries are organized into three groups in the figure and in subsequent analysis: 42 developing countries, 18 developed countries and the G-7 plus Australia (hereafter the G-8). While the original intent of the division of countries into groups was not based on relative output variability it turns out to roughly distinguish the three groups.

The goal of this paper is to build on the work of Baxter and Crucini (1995) and Aguiar and Gopinath (2007). Baxter and Crucini (1995) were the first to emphasize the importance of persistence in distinguishing complete and incomplete markets versions of an otherwise standard one-secotr, two-country, stochastic growth model. Aguiar and Gopinath (2007) were the first researchers to emphasize a larger role for permanent productivity shocks in developing countries compared to developed countries.

Using a method-of-moments approach Aguiar and Gopinath find permanent shocks to productivity account for 96% of productivity growth in Mexico compared to only 37% in Canada. In their international cross-section, permanent shocks account for 84% of productivity growth variation for developing countries compared to 61% for developed countries. Notice that comparing the cross-country averages to the two case studies, Mexico is more representative of emerging markets than Canada is of developed economies in the sense that Canada has a stochastic trend component 24% lower than the average of developed economies.

Our analysis begins with an attempt to replicate the basic finding of AG using a small open economy model very similar in structure to theirs in our broader sample of countries. And we do, at least qualitatively, finding that permanent productivity shocks dominate the variance of output growth of developing countries while playing a relatively small role in the case of developed countries. On average, permanent shocks account for almost three times as much of the output growth variability in developing countries compared to developed countries, 60% versus 22%. Thus our results give the same basic message as theirs when the small open economy framework is utilized. The quantitative differences, however, are significant and arise for a number of reasons. First, we report decompositions of output variance while AG report decompositions of productivity variation, which are likely to be comparable due to the weak internal propagation mechanisms of the basic neoclassical the model, but certainly not exact. The samples also differ in significant ways: i) we have a larger set of countries, 68, compared to 26 in AG; ii) our time span is longer; and iii) our time periods are consistent across countries whereas the AG samples differ by as much as a decade across countries in many cases.

General equilibrium analysis, however, overturns the AG results. In the move from partial equilibrium analysis to general equilibrium analysis,the fraction of output variance explained by the permanent component of productivity rises from 22% to 60% for developed countries and drops from 60% to 52% for developing countries. The main reason for the change is that structural estimation using the general equilibrium model adds the correlation of macroeconomic aggregates between the G-8 and each country to the set of moments used in the estimation, which is infeasible when using the small open economy approach. The higher comovement of business cycles across the G-8 and developed economies relative to the G-8 and developing countries is what alters the composition of permanent and transitory shocks. The model and estimation attribute this to larger spillovers of the stochastic trend of productivity from the G-8 to developed economies relative to developing economies.

The remainder of the paper is organized as follows...

2 The one-sector stochastic growth model

Our use of the basic one-sector, two-country stochastic growth model is motivated by two objectives. The first is to stay as close as possible to the model specification utilized by AG. The second is to ensure that the general equilibrium and partial equilibrium versions of the model are structurally compatible. Three sources of novelty are introduced into these otherwise standard models. First, careful attention is given to international productivity spillovers from the large industrial block to each individual nation for both the permanent and transitory components of these shocks. Second, the cross-section of countries is comprehensive. Third, general equilibrium and partial equlibrium models are explicitly compared. The general equilibrium model is the one-sector, two country, DSGE model developed by Baxter and Crucini (1995). The partial equilibrum version of this model omits the world goods market clearing condition and adds a stochastic process to capture the evolution of the world interest rate.[1] This section begins by quickly reviewing common features of these two versions of the one-sector model and concludes with a discussion of the differences.

2.1 Preferences and technology

Individuals in each country have Cobb-Douglas preferences over consumption and leisure

$$U(C_{jt}, L_{jt}) = \beta^t \frac{1}{1-\sigma}[C_{jt}^{\theta} L_{jt}^{1-\theta}]^{1-\sigma}, \tag{1}$$

where parameter $\theta \in (0,1)$, and the inter-temporal elasticity of substitution is $1/\sigma$.

The final good is produced using capital and labor. The production function is Cobb-Douglas and each country experiences stochastic fluctuations in the level of factor productivity, A_{jt},

$$Y_{jt} = A_{jt} K_{jt}^{1-\alpha} {N_{jt}}^{\alpha} \ . \tag{2}$$

The stochastic processes for productivity will involve both permanent and transitory components each potentially with a component common across nations and unique to the nation. The processes are described in more detail and estimated in the next section.

The capital stock in each country, depreciates at the rate δ and is costly to adjust:

$$K_{jt+1} = (1-\delta)K_{jt} + \phi(I_{jt}/K_{jt})K_{jt}, \tag{3}$$

where $\phi(\cdot)$ is the adjustment cost function. As in Baxter and Crucini (1995), adjustment costs have the following properties: i) at the steady-state, $\phi(I/K) = I/K$ and $\phi'(I/K) =$

[1] AG incorporate a domestic interest rate response to home debt relative to productivity, but this plays a minor quantitative role in their exercise.

1 so that in the deterministic solution to the model the steady state with and without adjustment costs are the same and ii) $\phi' > 0$, $\phi'' < 0$.

2.2 Closing the model

Following Baxter and Crucini (1995), the two country general equilibrium model is closed by imposing one intertemporal budget constraint and world goods market clearing. The intertemporal budget constraint is:

$$B_{jt} + Y_{jt} - C_{jt} - I_{jt} - B_{jt+1}P_t^B = 0 \tag{4}$$

where B_{jt+1} denotes the quantity of bonds purchased in period t by country j. P_t^B is the price of a bond purchased in period t and maturing in period $t+1$. The bond is not state-contingent, it pays one physical unit of output in all states of the world. Implicitly this defines, r_t, the real rate of return for the bond (i.e., $P_t^B \equiv (1+r_t)^{-1} < 1$). The price of this bond is endogenous in the two-country equilibrium model, determined by the market-clearing condition in the world bond market.

The world goods market clearing condition is:

$$\sum_{j=0}^{1} \pi_j (Y_{jt} - C_{jt} - I_{jt}) = 0, \tag{5}$$

where π_j denotes the fraction of world GDP produced by country j. These weights are necessary to define market clearing because the quantities in the constraint are in domestic per capita terms.

The small open economy is closed with an inter-temporal budget constraint identical to (4). However, the discount rate follows an exogenous stochastic process describe below. In addition, the following boundary condition is imposed:

$$\lim_{t\to\infty} \beta^t p_{jt} B_{jt+1} = 0,$$

where p_{jt} is the multiplier on the inter-temporal budget constraint of small open economy j.

Parameterization of tastes and technology are set to values commonly used in the literature. The value of β is set to be 0.954, so that the annual real interest rate is 6.5%. The parameter of relative risk aversion σ is 2 and labor's share α in the production function is 0.58. In the Cobb-Douglas preference function, $\theta = 0.233$. The depreciation rate of capital, δ, is assigned a value of 0.10. The elasticity of the investment-capital ratio with respect to Tobin's Q is $\eta = -(\phi'/\phi'') \div (i/k) = 15$.

2.3 Exogenous shocks

Moving from theory to quantitative implications involves decisions about the stochastic properties of exogenous variables that drive business cycles. General equilibrium models require the specification of stochastic processes for both home and foreign productivity. The world interest rate is endogenous, determined by market clearing in the bond market. Partial equilibrium models require specification of stochastic properties for home country productivity and the domestic interest rate. Our specification and estimation method for each of these stochastic processes is discussed in turn below.

2.3.1 Total factor productivity

Begining with the G-8 as an aggregate economic entity, indexed by 0, the logarithm of productivity is the sum of a non-stationary and a stationary component, $\ln A_{0t} = \ln A^P_{0t} + \ln A^T_{0t}$. The non-stationary component follows a pure random walk,

$$\ln A^P_{0t} = \ln A^P_{0t-1} + \ln \varepsilon^P_{0t} \ , \tag{6}$$

and the stationary component follows an AR(1) process:

$$\ln A^T_{0t} = \rho_0 \ln A^T_{0t-1} + \ln \varepsilon^T_{0t} \ . \tag{7}$$

The innovations are drawn from independent normal distributions with different standard deviations: $\varepsilon_{0t}^{T} \sim N(0, \sigma_0^T)$, $\varepsilon_{0t}^{P} \sim N(0, \sigma_0^P)$.

As the G-8 is by far the largest region and we assume that productivity spills over from G-8 to the G-60 and not the reverse, simulations of the closed economy version of the benchmark model are used to estimate the parameters of the productivity components of the G-8 (effectively by setting $\pi = 1$ in the general equilibrium model described earlier). Inputs into the estimation are G-8 aggregates, constructed as country-size-weighted averages of the national output growth, consumption growth and the logarithm of the consumption-output ratio. Productivity parameters are chosen to match the observed sample variances of these three key macroeconomic variables.

Table 1 – Estimates of G-8 Productivity Processes

	Data	Model
Standard deviation of:		
GDP growth	1.80	1.94
Consumption growth	1.28	1.15
Consumption-GDP ratio	1.44	1.32
G-8 productivity parameters		
Std. dev. of permanent innovation	1.1	
Persistence	0.85	
Std. dev. of transitory innovation	1.2	

Notes: The upper panel reports the moments of G-8 data in the first column that are matched with the model simulations reported in the second column. The closed economy version of the model is simulated 2,700 times with the range of parameters as follows: $\widehat{\rho}_0 \in [0.40, 0.95]$, $\widehat{\sigma}_0^T \in [0.006, 0.02]$ and $\widehat{\sigma}_0^p \in [0.006, 0.02]$. The parameters that best fit the model to the data are reported in the lower panel.

The outcome of the moment-matching exercise is reported in Table 1. The average difference (across countries) between the moments from the data and from the model simulation, reported in the upper panel of the table, is less than 10% in all cases. The estimated persistence of the stationary component of productivity is 0.85, which, when converted to a quarterly estimate matches closely the existing closed economy real business cycle literature that focuses exclusively on persistent, but transitory shocks and business cycle frequencies of output fluctuations. It is interesting that the innovations to the two components have near identical standard deviations, 1.2 and 1.1. When combined with the estimated persistence of the stationary component, the implication is that the unconditional variance of the transitory shock adds about 18% *more* to the variance of productivity growth than the permanent shock. This accords with Crucini and Shintani (2014) who estimate a bivariate error-correction model of output and consumption growth for each of the G-7 nations and Australia and find comparable contributions of stochastic trend and cycle shocks.

The specification of total factor productivity of the small open economies (nations outside of the G-8 block) are specified in two different ways. The existing literature using the partial equilibrium approach has recognized that small open economies are subject to both permanent and transitory shocks. Thus, productivity is, again, the sum of these two stochastic components,

$$\ln A_{jt} = \ln A_{jt}^P + \ln A_{jt}^T \ .$$

The permanent component of TFP in country j is,

$$\ln A_{jt}^P = \ln A_{jt-1}^P + \ln \varepsilon_{jt}^P \ , \tag{8}$$

and a stationary AR(1) component is:

$$\ln A_{jt}^T = \rho_j \ln A_{jt-1}^T + \ln \varepsilon_{jt}^T \ . \tag{9}$$

As was the case of innovations to the components of TFP of the G-8, ε_{jt}^P, ε_{jt}^T, are *i.i.d.* draws from normal distributions both with mean zero, but different standard deviations.

For expositional convenience, the distributions are expressed as: $\varepsilon_{jt}^T \sim N(0, v_j^T \sigma_0^T)$, $\varepsilon_{jt}^P \sim N(0, v_j^P \sigma_0^P)$. Thus, v_j^P and v_j^T, are the standard deviations of the innovations to the permanent and temporary components of productivity in country j *relative* to their counterparts in the G-8, estimated earlier. For purposes of parsimony and tractability, the persistence of the transitory component of TFP in all countries is set equal to its G-8 counterpart: $\rho_j = \widehat{\rho}_0 = 0.85\ \forall j$.[2]

The second specification of total factor productivity is the correctly specified one in the sense that it is estimated by simulating the two country general equilibrium model. Specifically, with the G-8 productivity processes estimated fromthe closed economy general equilibrium model, the stochastic process for TFP in the small open economy in the two-country general equilibrium model is specified as: $\ln A_{jt} = \ln A_{jt}^P + \widehat{\omega}_j^P \ln A_{0t}^P + \ln A_{jt}^T + \widehat{\omega}_j^T \ln A_{0t}^T$ .The parameters ω_j^P and ω_j^T are factor loadings capturing non-stationary and stationary productivity spillovers from the G-8 to country j. Thus, the correct structural model is taken to be the two-country general equilibrium model with a block-recursive bivariate model for TFP of country j and the G-8 ($j = 0$):

$$\begin{bmatrix} \ln A_{jt} \\ \ln A_{0t} \end{bmatrix} = \begin{bmatrix} 1 & 1 & \omega_j^P & \omega_j^T \\ 0 & 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} \ln A_{jt}^P \\ \ln A_{jt}^T \\ \ln A_{0t}^P \\ \ln A_{0t}^T \end{bmatrix}.$$

As a matter of accounting, the true productivity process of the small open economy is the sum of four terms, the first two are permanent and temporary components coming from domestic innovations and the second two are permanent and temporary productivity spillovers from the G-8.

Naturally, the response of an economy to a permanent or temporary productivity shock

[2] While this choice of persistence for the stationary component is based on maintaining some aspects of tractability and symmetry across countries, it turns out this is equivalent to a quarterly persistence of 0.96 and thus consistent with the findings of Aguiar and Gopinath (2007). They estimated persistence of their transitory component of productivity at the quarterly frequency of 0.97 for Canada and 0.95 for Mexico, respectively. Moreover, they find this value is close to what the persistence of transitory component of productivity equals for a number of other developed countries.

will depend on whether the shock is of home or foreign origin. This is what distinguishes general equilibrium analysis from partial equilibrium analysis of international business cycles. As we shall see, the spillovers are necessary to match the international correlation of business cycles, which are absent from the set of moments available using the partial equilibrium approach.

To estimate the nation-specific factor loadings on G-8 productivity components, ω_j^P and ω_j^T, and the *relative* standard deviations of nation-specific productivity innovations, v_j^T and v_j^P, the general equilibrium open economy model is used. Specifically, each one of the 60 small open economies is taken in turn and combined with the G-8 and moments are matched with the simulated the two country general equilibrium model. The G-8 takes the role of the large open economy and nation j takes the role of the small open economy in the model. The relative size of the small country is set to the fraction of world GDP that country produces, on average, over the sample period of observation. The model is simulated for a range of values for the relative innovation variance of the permanent and transitory shock to the small country, while keeping the G-8 processes as previously estimated, to match: i) the variance of GDP growth of country j; ii) the variance of consumption growth of country j; iii) the correlation of GDP growth between the G-8 and country j. and iv) the correlation of consumption growth between the G-8 and country j.

Table 2 – Estimates of G-60 Productivity Processes

	Developing		Developed	
	Data	Model	Data	Model
Std. Dev. of consumption	7.77	7.74	2.45	4.43
Std. Dev. of GDP	5.98	7.16	3.01	4.32
Corr. with G-8 GDP	0.16	0.17	0.49	0.48
Corr. with G-8 consumption	0.038	0.042	0.37	0.38
Innovation standard deviations				
relative to G-8 counterparts				
$v_j^P \in [0.1, 15]$	4.21			1.18
$v_j^T \in [0.1, 15]$	2.14			1.19
Factor loadings on G-8 spillovers				
$\omega_j^P \in [-15, 15]$	0.7			2.5
$\omega_j^T \in [-15, 15]$	0.6			0.3

Begining with the moments of the actual data, reported in the upper panel of Table 2, note that the standard deviation of consumption growth is higher than that of output growth for developing countries while the reverse is true for developed countries. This is a key facet of the AG result that trend shocks need to be much more important in developing countries compared to developed countries, based on permanent income reasoning. This tendency is evident in the much higher standard deviation of the innovations to the permanent component of productivity, on average, in developing countries (4.21) compared to developed countries (1.18).

Turning to the novel part of our analysis, the spillovers of permanent and transitory productivity from the G-8 to other individual nations, we see first of all positive spillovers in all cases. Factor loadings range from a low of 0.3 for the temporary component of G-8 productivity for developed countries to a high of 2.5 for the permanent component of G-8 productivity for developed countries. This larger spillover of the permanent component of productivity to the developed nations is what helps the model to match international correlation patterns. Note that developed nations have lower consumption correlations with the G-8 block, averaging 0.37, compared to 0.49 for output correlations. The correlation of consumption growth of the typical developing country with the G-8 block is close to zero, while the corresponding output growth correlations average 0.16. This general pattern, where international output correlations exceed international consumption correlations is what led Backus, Kehoe and Kydland (1992) to coin the phrase '*international comovement puzzle*.' With complete financial markets, the consumption correlation should be near unity, bounding the output correlation from above.

As the model used here is an incomplete markets model, it has the potential to better match international comovement with the right mix of shocks.Through the lens of the model, these facts point to more idiosyncratic movements in wealth in the developing countries as a group compared to the developed countries who tend to share a common stochastic trend with the G-8. As we shall see, this a key facet of the data overturns the AG result regarding the importance of permanent versus temporary shocks across nations. The permament shocks are comparable for developed economies in terms of contributions to output variance once one attempts to match international comovement.

2.3.2 Interest rate shocks

In SOE models, domestic productivity shocks play a central role, just as in the general equilibrium models. However, foreign productivity shocks are not explicitly modeled. This limits the ability of the model to contrast the macroeconomic response of the home country to shocks of home and foreign origin. To explore potential errors of prediction or interpretation that arise when the interest rate is modelled as an exogenous shock, we assume as Mendoza (1991) did, that the discount rate follows an AR(1) process:

$$\ln P_t^B = \gamma_j \ln P_t^B + \ln \varepsilon_{jt}^B, \tag{10}$$

where $0 < \gamma_j < 1$ denotes the persistence of the logarithm of the bond price, and ε_{jt}^{B} is an *iid* draw from a normal distribution with zero mean and standard deviation σ_j^{PB}.[3]

To parametrize the real interest rate we match the same second moments as before (namely, the variance of output and consumption growth), but use the partial equilibrium model of a small open economy as the simulation model. Table 3 shows the estimation results for the median and two points in the cross-sectional distribution of the 60 small countries. Under the first model with transmission of TFP shock from G-8, we observe three patterns in the table. First, the persistence of the bond price process is similar in both developing and developed countries. The median autocorrelation coefficient is 0.25 for developing countries and 0.23 for developed countries. Second, the median standard deviation of the innovation term is the same for developing and developed countries as well. This is reassuring since it would be odd for the estimated processes to differ given our approach presumes a single world real interest rate and full integration of international bond markets at that common rate. It is worth noting that the developing country group is more asymmetric than the developed country group as evident in the much higher persistence and innovation of the implied real interest rate in the tail of the cross-country distribution.

Table 3 – Bond Price Shock Parameters

	Developing		Developed	
Spillovers	Yes	No	Yes	No
Persistence ($\widehat{\gamma}_j$)	0.25 (0.23, 0.60)	0.10 (0.00, 0.55)	0.23 (0.20, 0.24)	0.55 (0.15, 0.79)
Innovation variance ($\widehat{\sigma}_j^{PB}$)	0.001 (0.001, 0.008)	0.004 (0.002, 0.006)	0.001 (0.001, 0.003)	0.004 (0.003, 0.005)

The calibration results of bond price process significantly changes when the small open economy model is assumed to be driven by only domestic productivity shocks. First, the

[3] Recent extensions of this basic approach allow for a differential to arise between the domestic interest rate and the world interest rate and for that differential to be a function of domestic productivity, as Uribe and Yue (2006). The latter formulation is intended to allow for the possibility that changes in domestic productivity change the probability of default and this feeds back into banks willingness to lend. However, this formulation still abstracts from the differential response of a country to a home and global productivity change.

median value of standard deviation for the the innovation term increases from 0.1 percent to 0.4 percent for both developed and developing countries. The reason is straightforward: as foreign TFP shocks are absent under in the second model some of the variance of output and consumption growth is compensated by a larger role for the interest rate process. This result shows that underestimation of the magnitude of TFP shocks, especially the spillovers from abroad, may lead one to overestimate the role of the interest rate shock. Second, we find that the interest rate shock in developing countries are less persistent than in developed countries. The median value of $\widehat{\gamma}_j$ is 0.10 for developing countries, and 0.55 for developed ones. Recall that in our GE model, we find advanced economies are greatly affected by the permanent TFP shocks from G-8. Therefore, the lack of such shock in a standard SOE model will raise the persistence of the interest rate shock that serves as a proxy of the shocks from foreign countries.

3 Variance Decomposition

With the calibration of the DGSE and SOE models complete, we are in a position to compute variance decompositions of output growth into the underlying exogenous sources of variation.

Table 4 reports the results using the small open economy model without spillovers as this corresponds most closely to the analysis of AG. Begining with the pooled results for all countries the permanent and transitory shocks account for almost the same fraction of output growth fluctuations, 48.6% and 44%, respectively with the world interest rate accounting for the remainder. These averages obscure considerable heterogeneity in the cross-section. Dividing the sample into developing and developed countries the asymmetry point out by AG shows up quite vividly. In fact, the roles of the permanent and transitory shocks are almost transposed across the two groups with the permanent shock accounting for about 59.9% of the variance in developing countries while the transitory shock account for about the same fraction (63.9%) in the case of developed economies. The interest rate plays a relative minor role in both cases, but is more important for the developed economies than the developing economies.

Ironically, the thrust of AGs findings are more consistent with our broader sample than the AG sample. The reader should keep in mind that our sample periods are symmetric across countries and typically longer than AG, so differences are to be expected. Emphasis should be placed, then, on the broadest sample in the upper panel in terms of the main conclusions arising from the partial equilibrirum model. Another general lesson is that it may be more informative to report the country-by-country results because the averages themselves obscure considerably heterogeneity across countries within the panel.

TABLE 4. OUTPUT VARIANCE DECOMPOSITIONS, SMALL OPEN ECONOMY MODEL

	Variance Decomposition				Number	Std. dev.
Source of shock	Home	Home	World	Total	of	of
Type of shock	Permanent	Transitory	Interest rate		Countries	Output
All Countries	48.6	44.0	7.5	100	60	5.2
Developing	59.9	35.4	4.7	100	42	6.0
Developed	22.2	63.9	13.8	100	18	3.2
AG Sample	34.6	54.0	11.4	100	20	3.3
Developing	49.9	47.2	2.8	100	9	4.2
Developed	22.1	59.5	18.4	100	11	2.5

Notes:Productivity spillovers are abstracted from in this specification because they would not be identified using the small open economy model.

Turning to the result when the simulation model is correctly specified as a two country general equilibrium model with productivity spillover, the asymmetry in the contribution of permanent and transitory shocks across the country groups is now the reverse of what AG found. That is, the permanent shocks now play a relatively important role in the case of the developed countries, 60% versus 51.6% for developing countries. Notably this tendency is preserved in the narrower sample used by AG. The right-most panel shows that the partial equilibrium model may be calibrated and simulated to mimic these properties of the data. Unfortunately this might be described as false comfort for partial equilibrium modelers because the correctly specified productivity process can only be recovered from the general equilibrium simulations. Recall why this must be so: it is necessary to add international comovement of macroeconomic aggregates to recover the correct international productivity spillovers and those are simply not available in the partial equilibrium model setting.

In summary, these results points to both the desirability, in fact, the necessity of using the general equilibrium framework. The general equilibrium approach provides a more complete description of the international business cycle by endogenizing the world interest rate while also requiring the researcher to match international comovement of business cycles. The lower panel of the table breaks the permanent and transitory proportions into the home and G8 spillover contributions. The differences between general equilibrium and partial equilibrium modeling is now evident. In particular, the small open economy model does not reproduce the correct decomposition of the permament and temporary components into home and foreign (spillovers). For example, in the case of developed countries, the correct decomposition of the permament shocks is 45.5% spillover from the G-8 while the small open economy assigns only 13.2%. This is another implication of the general idea that the small open economy will respond in the same fashion to shocks of domestic or foreign origin provided they have the same stochastic properties (persistence) whereas this is untrue in a general equilibrium context.

TABLE 5. OUTPUT VARIANCE DECOMPOSITIONS, MODELCOMPARISONS

Model	DSGE		SOE		
Source of shock	Home + G8	Home + G8	Home + G8	Home + G8	Interest
Type of shock	Permanent	Transitory	Permanent	Transitory	rate
All Countries	54.1	45.9	45.7	43.3	11.0
Developing	51.6	48.4	43.1	45.5	11.4
Developed	60.0	40.0	51.8	38.0	10.2
Aguiar and Gopinath	57.3	42.7	50.3	40.1	9.5
Developing	49.9	50.1	39.5	45.6	14.9
Developed	60.0	40.0	51.8	38.0	10.2

Source of shock	Home	G8	Home	G8	Home	G8	Home	G8	Interest
Type of shock	P	P	T	T	P	P	T	T	rate
All Countries	31.7	22.4	34.1	11.8	18.0	27.6	10.2	33.1	11.0
Developing	39.0	12.5	36.1	12.3	9.2	33.9	10.6	35.0	11.4
Developed	14.4	45.5	29.3	10.7	38.6	13.2	9.2	28.8	10.2
AG Sample	24.7	32.6	31.6	11.1	29.1	21.2	9.7	30.5	9.5
Developing	38.9	11.0	41.0	9.1	7.8	31.7	7.9	37.6	14.9
Developed	13.1	50.2	23.9	12.8	46.6	12.6	11.1	24.6	5.1

Figure 2 provides a more complete view of the differences between the general equilibrium and partial equilibrium models. The figure depicts the fraction of output variance attributable to the permanent shocks in both cases. Note that the interest rate is a shock in the small open economy case and thus the contribution of productivity shocks (generally) will be bounded from above by the general equilibrium model which endogenizes the interest rate and thus provides no independent role for this shock in the variance accounting. Finally, it is important to note that both permanent and transitory shocks give rise to transitory movements in the equilibrium interest rate, though with different dynamics. Thus, it is inherently challenging to identify the role of permanent and transitory shocks in shaping the evolution of the equilibrium interest rate without the use of the general equilibrium model.

Figure 3 revisits the question of spillovers by contrasting the small open economy model under the correct specification with productivity spillovers from G-8 and the more common practices (as in AG) where the small open economy model is simulated with only domestic permament and transitory shocks. While the average proportion of variance attributed to permanent shocks is roughly correct when average across countries, the errors of variance accounting country-by-country are very substantial. Moreover, the biases are not completely random distributed, the role of permanent shocks tends to be underestimated when spillovers are ignored for developed economies, but overestimated when spillovers are ignored in the case of developing countries.

4 Concluding remarks

In this paper we have compared the performance of one-country SOE model with the two-country DSGE model. We conduct variance decompositions for the 60 small economies under the two-country general equilibrium framework and one-country small open economy framework. We find that the limitation of the SOE model is that it cannot capture the properties of permanent TFP shock from the foreign countries. This is particularly true, for the small developed countries, whose economic behavior is heavily influenced by permanent TFP shocks originating from the G-8, the SOE model tends to significantly underestimate the influences of the shocks originated from abroad.

5 References (to be added)

Figure 1. International business cycles

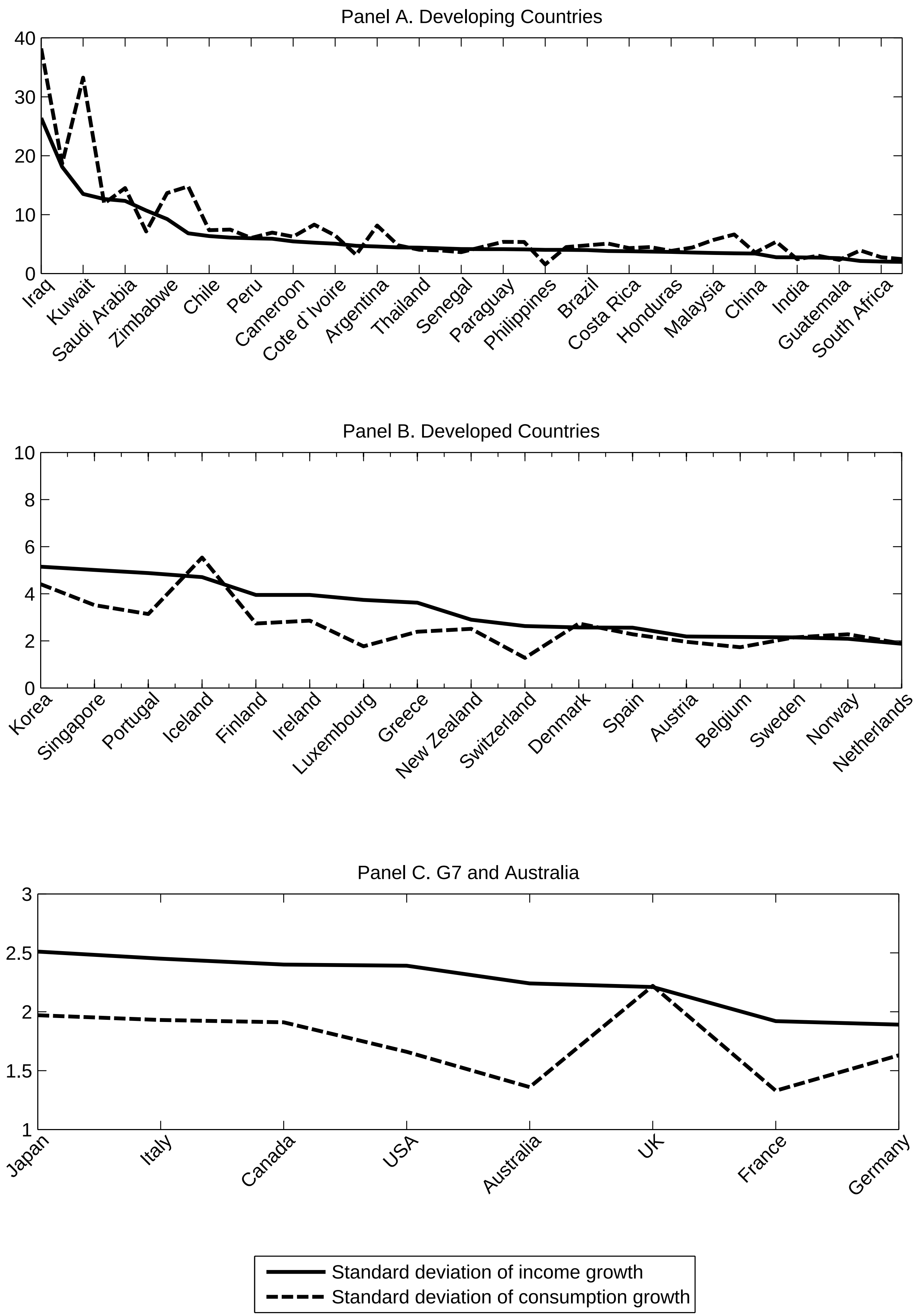

Figure 2. Proportion of output growth variance accounted for by permanent shocks: Comparison of DGSE model and SOE with productivity spillovers

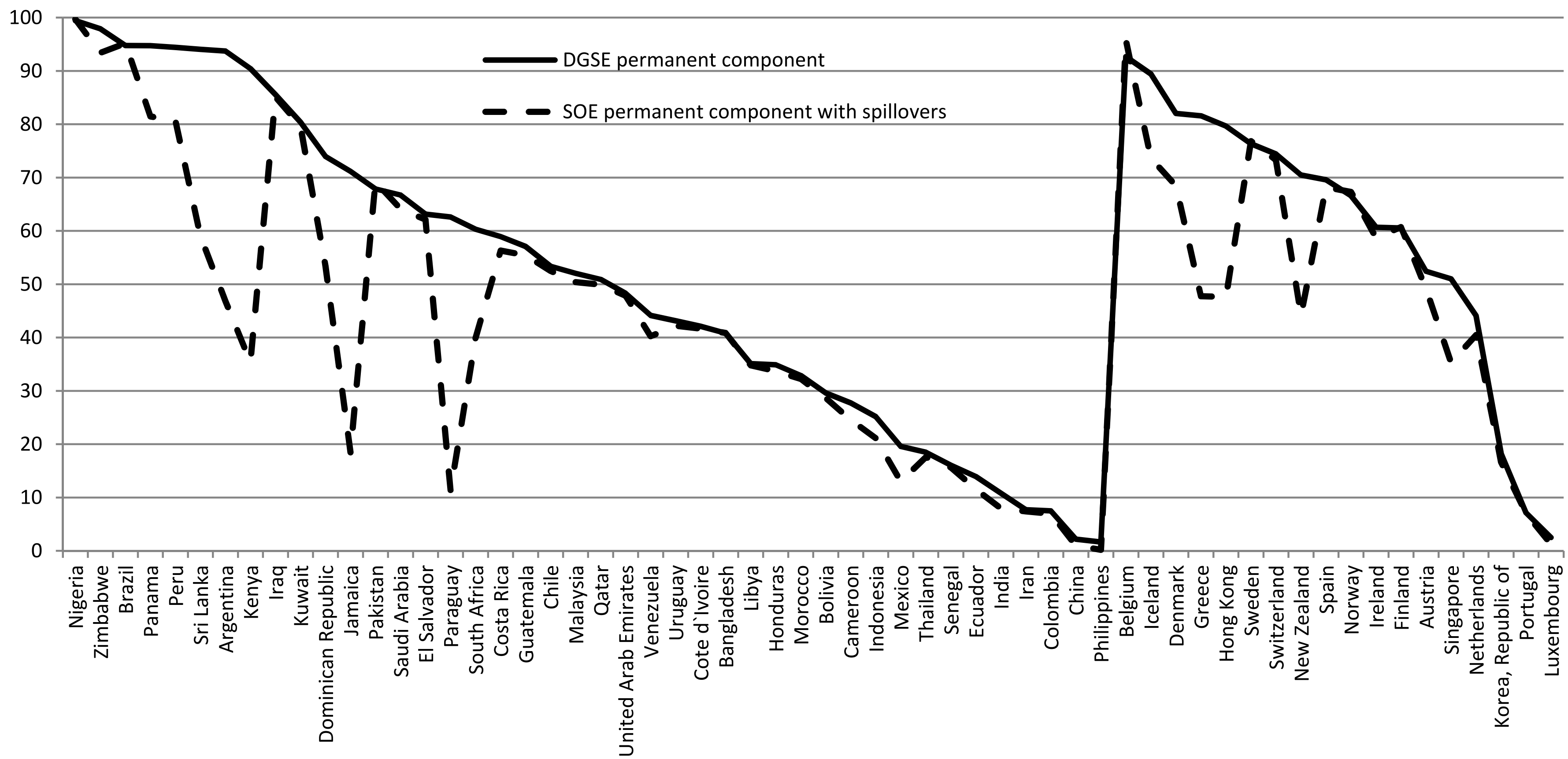

Figure 3. Proportion of output growth variance accounted forby permanent shocks: Comparison of SOE model with productivity spillovers to SOE model without spillovers