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Business Cycles Synchronicity and Income Levels: Has Globalisation Brought us Closer Than Ever?

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1. INTRODUCTION

THE research on business cycle linkages that abounds in the literature shows a tendency to model countries of relatively the same degree of economic development jointly. The works of Gerlach (1988), Backus and Kehoe (1992), Backus et al. (1995), Norrbin and Schlagenhauf (1996), Artis and Zhang (1997), Artis et al. (1997, 2004), Gregory et al. (1997), Bergman et al. (1998), Gregory and Head (1999), Mills and Holmes (1999), Clark and Shin (2000), Lumsdaine and Prasad (2003), Stock and Watson (2003, 2005), Chauvet and Yu (2006), and Crucini et al. (2011) are examples of such practice. All these studies used OECD countries in their search for an international business cycle.

There have also been some attempts to jointly model countries of different economic backgrounds (Crucini, 1997, 1999; Aguiar and Gopinath, 2007; among others). For example, Mendoza (1995) and Kose (2002) document the similarity in business cycle features of developed and developing countries, Jean Louis (2004) and Jean Louis and Simons (2005, 2007) investigate the business cycle linkages between North American countries, but could not conclude that Mexico shares a common cycle with the United States and Canada combined. Mejía-Reyes (1999) models the United States along with the major Latin American economies and arrives at a similar conclusion. The business cycles of the United States and most of these countries are idiosyncratic, on a pairwise comparison basis. Focusing on Asia, Girardin (2002) found little evidence of symmetry between Japan and other South-East Asian countries' business cycle in a comparison of univariate results. Kose et al. (2003b) is the most comprehensive of the studies cited in the literature thus far. They use a Bayesian dynamic latent factor model to estimate common components in macroeconomic aggregates such as output, consumption and investment for a sample of 60 countries covering seven regions of the world. They find that a common world factor is an important source of volatility for aggregates in most countries, whereas region-specific shocks only play a minor role. In their view, this constitutes evidence on the existence of a world business cycle.

Although current studies on international business cycle linkages implicitly give indication that there is a link between business cycle synchronisation and levels of economic development, this research question has not been formally addressed in the literature. There are at least three reasons for exploring this issue. First, there is the idea that an all Americas' monetary union could be a stronger economic bloc to compete with the European Union and other rising economic powers such as India and China. Second, there is the debate of 'one world, one money?' without abolishing national currencies, which revisits the idea of a global money

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proposed by Keynes in 1944 (Mundell, 1995, 2001; Friedman, 2001; Starr, 2004). Third, there has been a proliferation of trade agreements among countries around the globe. On all accounts, our research contributes to the overall debate.

Be it because of competition at the world level that gives rise to the creation of economic blocs or because of globalisation of markets that might necessitate a world currency to facilitate international transactions, a study on business cycle linkages that account for the level of economic development within and across blocs is enriching for the ongoing debate. Moreover, business cycle synchronisation is a prerequisite, in line with Mundell (1961), for countries that contemplate higher forms of economic integration beyond customs union. Countries forming those blocs must be subjected to similar shocks, hence common cycle, in order for a 'one-size-fits-all' monetary policy to be effective for each member of the group. The absence of a common cycle in these unions may lead to severe complications from monetary policies for the member nations.

Although there have been some research (Alesina and Barro, 2002; Alesina et al., 2003) in the literature that explores the benefits of currency unions for countries of different sizes and degree of specialisation in the production of goods and services, it still remains a subject of contention whether industrialised and less-developed nations could find a mutually beneficial agreement. Disparities between the two groups of countries in the Americas and other continents are very well pronounced. In this paper, we use the non-parametric measure of cycle synchronicity proposed by Mink et al. (2007) to develop a two-step approach to investigate the linkage between business cycles and income levels. First, we examine the business cycles of each category of countries to determine whether (i) each group of countries follows its own dynamics and is therefore subjected to the same business cycle and (ii) whether these cycles are independent of each other across groups. Second, we use panel data analysis in search for an explanation of the synchronicity of the cycles observed. We extracted data on real income *per capita* for the 217 countries included in the National Accounts Main Aggregates of the United Nations Statistical Database and classified these countries by categories of income as per the World Development Indicators. The preliminary results indicate that high-income *per capita* countries (HICs) tend to be guided by stronger similarity in business cycles than countries in the middle-income *per capita* (MICs) and low-income *per capita* (LICs) groups. The synchronicity ratios (SRs) are on average 51, 50, 54, 73 and 100 per cent for the LICs, low middle-income countries, upper middle-income countries, HICs-OECD and HICs-non-OECD countries, respectively. We also determined that across groups, the wavelength was common in most of the countries suggesting the existence of a common world cycle. Section 2 presents the methodology. Section 3 deals with the data and results, and Section 4 concludes the paper.

2. METHODOLOGY

The starting point towards uncovering business cycle synchronicity or lack thereof across countries based on their levels of income *per capita* is the determination of the measure of the business cycle itself. To this end, we use the Hodrick and Prescott's (1997) non-parametric filter to decompose real output *per capita* into a trend and a cycle, where the trend is the potential output and the cycle is the deviation of actual output from its potential level. Output gap is calculated as the ratio of cycle over trend for each country. Once output gap is determined, a number of techniques are available in the literature to investigate the extent of co-movement of the cycles. These include Markov-switching vector autoregression decompo-

sition as in Artis et al. (2004), Krolzig (1997a, 1997b, 2005) and Krolzig and Sensier (2000); cointegration analysis as in Engle and Granger (1987), Stock and Watson (1988) and Johansen (1988, 1991); and test for common features as in Engle and Kozicki (1993); tests for common trends and common cycles as in Beveridge and Nelson (1981), Engle and Issler (1993) and Vahid and Engle (1993).[1] In addition to the conventional correlation, a few non-parametric tests have been developed recently to measure business cycle synchronisation. For example, Kalemli-Ozcan et al. (2011) use three different measures to investigate the linkage between financial integration and business cycle synchronisation ($SYNCH_{i,j,t}$) for 20 OECD countries on a bilateral basis. The first measure of synchronisation, which follows Giannone et al. (2009), is defined as the negative of the absolute value of the differential growth rate of real GDP *per capita* country pairs (i, j) over time:

$$\text{SYNCH1}_{i,j,t} \equiv -\left|(\ln Y_{i,t} - \ln Y_{i,t-1}) - (\ln Y_{j,t} - \ln Y_{j,t-1})\right|. \quad (1)$$

The second measure, $SYNCH2_{i,j,t,}$ which is based on Morgan et al. (2004), consists in estimating the real GDP *per capita* growth on country fixed effects and year fixed effects for each country to obtain a residual whose absolute value is used to construct the business cycle synchronisation proxy as the negative of the absolute value of the differential between two countries.

$$\ln Y_{i,t} - \ln Y_{i,t-1} = \gamma_i + \phi_t + v_{i,t} \ \forall i, j. \quad (2)$$

These residuals account for cross-country and across-year mean growth in real GDP *per capita* fluctuations:

$$\text{FLUCT}_{i,t} \equiv |v_{i,t}| \text{ and } \text{FLUCT}_{j,t} \equiv |v_{j,t}|. \quad (3)$$

Therefore,

$$\text{SYNCH2}_{i,j,t} \equiv -|v_{i,t} - v_{j,t}|. \quad (4)$$

Simply put, this index measures how similar growth rates are between each pair of countries in any given year when we account for the average growth rate in each country and the average growth in each year.

The third measure, $SYNCH3_{i,j,t}$, follows Imbs (2006) and Baxter and Kouparitsas (2005) in computing the five-year correlation of the cyclical component of output obtained from Baxter and King's (1999) band-pass filter.

Although the measures of synchronisation used by Kalemli-Ozcan et al. (2011) are state of the art, simpler, not subject to the shortcoming of various filtering methods and easy to grasp, the opportunity cost of using such methodology is too overwhelming in terms of time since we have 217 countries. With 20 industrial countries, Kalemli-Ozcan et al. were able to investigate business cycle synchronisation for 190 pairs of countries. Using similar methodology would require that we work with 23,436 pairs of countries (the total number of combinations of size two taken from a set of size 217). We chose the non-parametric methodology proposed by Mink et al. (2007) as the second best alternative available to answer our research question.

[1] The findings of Gregory et al. (1997) are based on Kalman filtering and dynamic factor analysis, Clark and Shin (2000) on VAR factor model, Gerlach (1988) on spectral methods, Stockman (1988) on the error correction method and Norrbin and Schlagenhauf (1996) on the dynamic factor model. Most of these techniques are not practical for our study since we have a large number of variables. For example, a VAR or VECM with 217 countries would be very cumbersome, if possible at all.

This measure is as flexible as Kalemli-Ozcan et al.'s in that it is easy to use and can be calculated at every point in time in a bivariate or multivariate setting within/across sectors or countries to indicate whether cycles are synchronised or not. However, it first requires filtering to obtain the output gap, and it is bounded between -1 and 1. We are not concerned about issues related to parameter heterogeneity raised by Kalemli-Ozcan et al. because our classification of the countries by income levels brings homogeneity to the groups.[2] The main issue, nonetheless, remains the choice of an appropriate reference cycle against which synchronisation can be assessed with individual cycles when dealing with multiple countries.[3] Should we use the cycle of a leading developed economy such as the United States or a weighted average of several advanced economies, or the cycle of a common factor? Facing this dilemma in their investigation of European business cycle synchronisation, Camacho et al. (2006) understandably used bilateral comparison of cycles, whereas Mink et al. (2007) used the median of all observed output gap. In this paper, we take a broader approach; we experiment with different criteria in choosing the reference cycle. We consider the country with the minimum average output gap over the sample period, the median average, the maximum average, the maximum median and the median average real GDP *per capita* growth rates, and the US as an *ad hoc* country, which is known to have great influence on the world economy, but was not chosen by the selection criteria.

In its simplest form, the bivariate version of the synchronicity measure between the reference cycle ($g_{r,t}$) and the individual country cycle ($g_{i,t}$) as proposed by Mink et al. (2007) is represented as follows:

$$\phi_{i,r,t} = \frac{g_{i,t}g_{r,t}}{|g_{i,t}g_{r,t}|}. \tag{5}$$

This synchronicity measure takes the value of 1 when the reference cycle and the individual cycle have the same sign and -1 when they move in opposite directions. The percentage of time $\phi_{i,r,t}$ is 1 is a number that lies in the interval [0,1], and a cut-off point of 0.50 indicates that the cycles are neither synchronous nor asynchronous. We regroup all the countries with $\phi_{i,r,t} = 1$ more than 50 per cent of the time to form the pool of countries with synchronised cycles within each income *per capita* group. These groups are then amalgamated in the search for a world business cycle.

The multivariate version of the synchronicity measure as per Mink et al. (2007) is given by:

$$\phi_t = \frac{1}{N}\sum\nolimits_{i=1}^{N} \frac{g_{i,t}g_{r,t}}{|g_{i,t}g_{r,t}|}, \tag{6}$$

[2] It is worth highlighting that we do use the methodology of Kalemli-Ozcan et al. (2011) in another paper that we are currently writing where the country of references are chosen based on the degree of trade openness as opposed to output gap. This shortcut can be seen as a combination of Mink et al. (2007) and Kalemli-Ozcan et al. methodologies where the output gap is replaced with growth rate of output, but the reference cycle is still there. It would be interesting to see whether we arrive at results similar to those of this paper.

[3] As Basher (2010) points out, such dilemma does not necessarily exist in sectoral analysis since the choice of the reference cycle is at times pretty straightforward. The methodology of our paper is similar to Basher's, but the scope of our work is by far wider. Basher's investigation into the decoupling of the oil sector from the non-oil sector covers only three of the six Gulf Cooperation Council (GCC) countries (Kuwait, Qatar and Saudi Arabia), whereas our paper covers the 217 countries of the National Accounts Main Aggregates of the United Nations Statistical Databases.

where N is the number of countries in a given pool of income *per capita* group. This equation tells us at each point in time the average synchronicity of the individual countries' cycles with the reference cycle. Positive values of ϕ_t indicate the dominance of synchronous cycles over asynchronous cycles in relation to the reference country for a given year. We use both versions of Mink et al.'s (2007) synchronicity measure in our investigation of the linkage between business cycles and income levels.

It is worth noting that since the measures of synchronicity used are non-parametric in nature, although we have countries of different sizes, the relative size does not interfere in the calculation of the multivariate synchronicity measure. Our question is whether at each point in time, the cycles of the countries match on average. It is well known that averages may be subjected to outliers, but in this case, there are no outliers in that the values are either 1 (similar cycles) or -1 (dissimilar cycles). The weight of the countries could have played a role if the focus was on world output or world trade or the relative impact of countries' output on world output.

3. DATA AND DATA ANALYSIS

The yearly data for the period 1970–2008 used in this study are the real GDP *per capita*, consumption expenditures, exports and imports, all at constant prices in 1990 US Dollars extracted from National Accounts Main Aggregates of the United Nations Statistical Database online.[4] All the data were then reconverted to prices of 2008, the last year in our sample for which data are available. We use the real GDP *per capita* to investigate business cycles synchronicity, whereas exports and imports along with the real GDP were used to compute the degree of openness for each country.[5] Although financial openness is also important, it is extremely difficult to find complete data on financial flows for the 217

[4] While high frequency data are ideal for studies on business cycles, unfortunately this is not possible in our case since we have incorporated all 217 countries of the database in our analysis. For the great majority of these countries, only yearly data are available. Well-known databases such as Penn Tables, World Development Indicators and International Financial Statistics do not contain quarterly real GDP or real GDP *per capita* data for all countries of the world. The United Nations Statistical Database is the most comprehensive database on national accounts, but all data are yearly. Our use of yearly data to study business cycles is not a first in the literature (see Backus and Kehoe, 1992; Basu and Taylor, 1999; Fatás, 2002; Kose et al., 2003a; García-Cicco et al., 2010; and other papers cited therein).

[5] A number of studies in the literature have used real GDP *per capita* to shed light on business cycles. For example, Aguiar and Gopinath (2007) note their results did not change when they conducted their analysis with log GDP *per capita* instead. The work of García-Cicco et al. (2010) uses real GDP *per capita* over the period 1900–2005 for Mexico and Argentina. Kose et al. (2003a) investigate the effect of globalisation on the synchronisation of business cycles for 71 countries using data on real GDP *per capita* and real private consumption. There are many more studies that have focused on real GDP *per capita* towards understanding business cycles. The other reason for using real GDP *per capita* instead stems from the definition itself: real GDP *per capita* is the ratio of real GDP to population. By taking the natural log of both sides and differentiating with respect to time, it follows that growth rate of real GDP *per capita* is the difference between the growth rate of real GDP and the growth rate of population. In fewer words, there is a one-to-one positive relationship between the two variables. Hence, there is no great loss of information from focusing on real GDP *per capita*. We believe this to be the underlying reason for the large number of studies in the literature to also focus on this variable for understanding business cycles. Since our focus was to link business cycles with aspects of economic development where income distribution plays a key role, we believe real GDP *per capita* was a better candidate in the case at hand despite its well-known shortcomings.

countries included in our study. Chinn and Ito's (2008) index of financial openness (Kaopen_2007.xls) contains too much missing information in between the years for so many countries to make it usable for our ends. The monthly spot oil price data (West Texas Intermediate) were downloaded from the Dow Jones Industrial Average web site and were then expressed in yearly average prior to their conversion in real terms. Data on consumption *per capita* growth, trade openness and changes in oil prices were used to search for an explanation of the business cycle synchronicity.

The data on real GDP *per capita* were used to classify the countries as per the World Development Indicators (WDI) published by the World Bank. The World Bank classifies countries as high-income OECD (HIC_OECD), high-income non-OECD (HIC_other), upper middle income (UMC), low middle income (LMIC) and low income (LIC) as a proxy for the relative degree of economic development of countries. Accordingly, countries are grouped as LICs if their income *per capita* is $825 or less; LMCs, $826–3,255; UMCs, $3,256–10,065; and HICs, $10,066 or more. The World Bank views low-income and middle-income economies as developing economies.[6]

After classifying the data, we end up with an unbalanced panel of 57, 60, 38, 23 and 30 countries in the respective categories (see Table 1). We decomposed each series into a trend and a cycle using a penalty parameter of 6.25 for the Hodrick–Prescott filter as suggested by Ravn and Uhlig (2002) for annual data. The output gap was computed as the ratio of cycle over trend. A negative (positive) value indicates actual output is below (above) trend.[7] As a prelude to the empirical analysis, we computed the correlation coefficient for each pair of countries within each income category. The results are presented in Table 2, indicating that, with the exception of LMCs, there are more positive than negative correlations of the business cycles within each group. For example, we found positive correlations as a share of total correlation within LICs, LMCs, UMCs, HICs-OECD and HICs-other to be 60, 48, 57, 83 and 61

[6] The use of the term is convenient; it is not intended to imply that all economies in the group are experiencing similar development or that other economies have reached a preferred or final stage of development. Classification by income does not necessarily reflect development status.

[7] Output gap was used in this study based on the logic that as a country's actual output approaches its potential level, it tends to trade more with the rest of the world, whether it is trade that involves goods for goods, goods for assets or assets for assets. The gains from these trades, if shared by all, are welfare improving and vary with swings in markets. Hence, our contention that globalisation improves domestic welfare. This contention motivates the choice of output gap based on real GDP *per capita* to grasp business cycle synchronicity or lack thereof. If we focus on output growth, we do not have such a target to anchor this same argument. For, growth in output can stem from growth in domestic consumption, investment, government spending or a combination while current account may be stagnant. Moreover, growth in output may arise due to fluctuations in both the permanent and the transitory components. Our objective was not to focus on the fluctuations of the permanent component but the transitory component. Guidance from the literature of overwhelming support for the use of the HP filter was mostly after the publication of Ravn and Uhlig's (2002) adjustment of the Hodrick–Prescott filter for the frequency of observations. To date, this paper has received 770 citations. The HP filter remains one of the more used filters for extracting business cycles. We agree with an anonymous referee that focusing on annual growth rates instead does avoid filtering discrepancy and, if used concurrently, can strengthen the robustness of the results. This is an issue, however, that we must leave for a companion paper as per Footnote 2. The main reason why this was not possible was because it would render the paper bulky and hard to follow due to too much information. For example, focusing on annual growth rates requires that we produce another set of 15 tables. We have conducted ample robustness tests at different stages of the paper to make sure that the results are solid, except for the caveat duly documented in Footnote 2. We do recognise that the referee has a valid point, but we cannot do much about it now.

TABLE 1
Classification of Countries Based on Income Levels

Low Income	*Low–Middle–Income*	*Upper–Middle–Income*	*HIC_OECD*	*HIC_OTHER*
Afghanistan	Albania	ARG-Argentina	AUS-Australia	Andorra
BGD_Bangladesh	DZA-Algeria	Barbados	AUT-Austria	Anguila
BEN_Benin	Angola	Belize	BEL-Belgium	Antigua_Barbuda
Bhutan	BOL-Bolivia	BWA-Botswana	CAN-Canada	Aruba
BFA_Burkina Faso	Brazil	CHL-Chile	DNK-Denmark	BHS-Bahamas, The
BDI_Burundi	Bulgaria	Cook_Island	FIN-Finland	Bahrain
Cambodia	Cape_Verde	CRI-Costa Rica	FRA-France	Bermuda
CMR-Cameroon	CHN-China	GAB-Gabon	GRC-Greece	Virgin_Islan_Br
CAF-Central African Republic	COL-Colombia	HUN-Hungary	ISL-Iceland	Brunei
TCD-Chad	COG-Congo, Rep.	MYS-Malaysia	Ireland	Cayman_I
Comoros	Cuba	MEX-Mexico	ITA-Italy	Cyprus
ZAR-Congo, Dem. Rep.	DOM-Dominican Republic	OMN-Oman	JPN-Japan	HKG-Hong Kong, China
CIV-Cote d'Ivoire	ECU-Ecuador	PAN-Panama	LUX-Luxembourg	ISR-Israel
North_Korea	EGY-Egypt, Arab Rep.	SAU-Saudi Arabia	NLD-Netherlands	MLT-Malta
GHA-Ghana	SLV-El Salvador	SYC-Seychelles	NZL-New Zealand	SGP-Singapore
HTI-Haiti	FJI-Fiji	ZAF-South Africa	NOR-Norway	French Polynesia
IND-India	GTM-Guatemala	TTO-Trinidad and Tobago	PRT-Portugal	Greenland
IDN-Indonesia	GUY-Guyana	URY-Uruguay	ESP-Spain	Ireland
KEN-Kenya	HND-Honduras	Dominica	SWE-Sweden	Kuwait
LSO-Lesotho	JAM-Jamaica	Equatorial Guinea	CHE-Switzerland	Liechtenstein
LBR-Liberia	MAR-Morocco	Grenada	GBR-United Kingdom	Macao, China
MDG-Madagascar	PNG-Papua New Guinea	Libya	USA-United States	Monaco
MWI-Malawi	PRY-Paraguay	Mauritius	Germany	New_Caledonia
MRT-Mauritania	PER-Peru	Montserrat		Puerto_Rico
MMR-Myanmar	PHL-Philippines	Palau		Qatar
NPL-Nepal	LKA-Sri Lanka	Poland		South_Korea
NIC-Nicaragua	SYR-Syrian Arab Republic	St_Kitts		San_Marino
NER-Niger	THA-Thailand	St_Lucia		Turks_Caicos
NGA-Nigeria	TUN-Tunisia	St_Vincent		UAE
PAK-Pakistan	Djibouti	Slovakia		Slovenia
RWA-Rwanda	Iran	Turkey		
SEN-Senegal	Jordan	Turkmenistan		
SLE-Sierra Leone	Kiribati	Croatia		
TGO-Togo	Lebanon	Czech_Rep		
ZMB-Zambia	Maldives	Estonia		
ZWE-Zimbabwe	Marshalls_I	Latvia		
Gambia	Micronesia	Lithuania		
Guinea	Namibia	Russia		
Guinea_Bissau	Nauru			
Iraq	Palestine			
Lao_Rep	Romania			
Mali	Samoa			

TABLE 1 *Continued*

Low Income	*Low–Middle–Income*	*Upper–Middle–Income*	*HIC_OECD*	*HIC_OTHER*
Mongolia	Sao_Tome			
Mozambique	Sudan			
Solomon_I	Swaziland			
Somalia	Tonga			
Surinam	Tuvalu			
Uganda	Vanuatu			
Tanzania	Venezuela			
Vietnam	Ukraine			
Eritrea	Macedonia			
Uzbekistan	Serbia			
Tanzania_ Zanzibar	Montenegro			
Tajikistan	Kosovo			
Timor	Bosnia_H			
Moldova	Georgia			
Kyrgystan	Kazakhstan			
	Armenia			
	Azerbaijan			
	Belarus			
Total				
57	60	38	23	30

Notes:
(i) Countries are grouped as LICs if their income *per capita* is $825 or less; LMCs, $826–3,255; UMCs, $3,256–10,065; and HICs, $10,066 or more. This classification is based on the World Development Indicators of the World Bank.

TABLE 2
Synchronicity of Cycles based on Correlation Measure

	LICs	*LMCs*	*UMCs*	*HICs-OECD*	*HICs-NON-OECD*
Total correlation pairs	999	812	622	252	434
Positive correlation counts	601	387	367	210	266
Negative correlation counts	398	425	255	42	168
Share of positive correlation counts	0.6	0.48	0.57	0.83	0.61
Positive correlation ranges	[0.06, 0.88]	[0.06, 0.95]	[0.07, 0.87]	[0.25, 0.84]	[0.004, 0.77]
Country pair with maximum correlation	Moldova–Malawi	Armenia–Georgia	Latvia–Estonia	Belgium–Italy	Cyprus–Monaco

per cent, respectively. The minimax and the maximax of the positive correlations vary widely in range [0.06, 0.88], [0.06, 0.95], [0.07, 0.87], [0.25, 0.84] and [0.004, 0.77], respectively, for each income group. In his classical business cycles in Latin America, Mejía-Reyes (1999) considers a Pearson's corrected contingency coefficient (CC_{corr}) <40 per cent as a clear sign of 'low' association, between 40 and 60 per cent as 'mild' and >60 per cent as an indication

TABLE 3
Countries Used as Reference Cycles As per the Selection Criteria

CRITERIA	*LIC*	*LMC*	*UMC*	*HIC_OTHER*	*HIC_OECD*
Min Gap	Pakistan	Sri Lanka	South Africa/Czech Rep	Andorra	Australia
Median	Fictitious	Fictitious	Fictitious	Fictitious	Fictitious
Max Average	Bhutan	China	Equatorial Guinea	Virgin Island	Ireland
Median_Average	Equatorial Guinea	Paraguay	Poland	Liechtenstein	United Kingdom
Max_Median	Vietnam	China	Equatorial Guinea	Virgin Island	Ireland
Ad_Hoc					United States

Notes:
(i) Min Gap or Minimum Gap is the country with the lowest average output gap. (ii) The Median is the observation in the middle at each point in time, which gives us a column series we term 'Fictitious'. (iii) The Max Average or Maximum Average is the country with the highest average growth rate over the full sample period. (iv) Median Average is obtained by computing the average growth rate for each country to select the country in the middle as reference. (v) The Max Median is obtained by computing the median growth rate for each country and selecting the country with the maximum value as reference. Once the references are selected, we apply the measures of synchronicity to the output gap data. (vi) In estimating the median of the average GDP *per capita* growth, we rounded off the value to the next integer when the number of countries (N) in a group is even, [(N/2) + 1 = X]; the Xth country is taken as reference. (vii) The data sample for Czech Republic spans the period 1992–2007, as is the case for many UMCs that became independent states after the dismantlement of the Soviet system.

of strong association of the cycles. Along the same line, we attest that countries with similar levels of income are on average characterised by more positive than negative association of their cycles, and the tendency towards synchronicity of the group irrespective of the correlation magnitudes of the individual pairs range from mild to strong. The HICs-OECD is the group with the largest share of positive correlation. Thus far, the data seem to suggest that within groups, there is more tendency towards synchronisation of the cycles than not, but nothing can be said across groups at this point.

a. Empirical Results

(i) Business Cycles Synchronicity within Groups

Do countries of similar income levels on average follow similar business cycles? We answer this question by examining the synchronicity measure proposed by Mink et al. (2007) depicted in equations (5) and (6). We used different criteria to choose the reference cycle. We select a country of reference for each group on the basis of the minimum real-income *per capita* gap (Min_Gap). Our contention here is that the closer a country's output is to its potential level, the more it tends to trade with the rest of the world, as a result a number of countries tend to see an increase in their own levels of output for that same reason. We also computed the average and the median growth rate for each country to select within each income category the country with the maximum of the averages (Max_Average), the median of the averages (Median_Average) and the maximum of the medians as reference cycles. The median of all observed output gaps was also considered following Mink et al.'s strategy. Since this time series could not be associated with any country in particular, we refer to it as a fictitious country (Fictitious). As can be seen from Table 3, despite the comprehensive nature of our selection criteria for the reference cycle, none of the criteria selected the US as

TABLE 4
Synchronicity of Cycles within Groups based on Various Reference Cycles

Criteria	*LIC*			*LMC*		
	Country	*Bivariate*	*Multivariate*	*Country*	*Bivariate*	*Multivariate*
Min_Gap	Pakistan	0.30	0.30	Sri Lanka	0.50	0.53
Median	Fictitious	0.76	0.95	Fictitious	0.73	1.00
Max_Average	Bhutan	0.44	0.50	China	0.40	0.53
Median_Average	Equatorial Guinea	0.51	0.50	Paraguay	0.50	0.53
Max_Median	Vietnam	0.52	0.60	China	0.40	0.53
Global Average		0.51	0.57		0.51	0.62
				UMC		
Min_Gap				South Africa	0.65	0.68
Median				Fictitious	0.90	0.92
Max_Average				Equatorial Guinea	0.30	0.37
Median_Average				Poland	0.54	0.50
Max_Median				Equatorial Guinea	0.30	0.37
Global Average					0.54	0.57
	HIC-OECD			HICs-NON-OECD		
Min_Gap	Australia	0.64	0.53	Andorra	0.62	0.53
Median	Fictitious	1.00	1.00	Fictitious	0.83	0.92
Max_Average	Ireland	0.62	0.50	Virgin Island	0.65	0.63
Median_Average	United Kingdom	0.86	0.68	Liechtenstein	0.41	0.44
Max_Median	Ireland	0.62	0.50	Virgin Island	0.65	0.63
Ad_Hoc	United States	0.91	0.71			
Global Average		0.78	0.65		0.63	0.63

Note:
(i) The country with the highest median growth rate was chosen as the reference cycle. The Median is the observation at the middle at every point in time. This time series represents a fictitious country.

reference. Hence, we analyse the linkage between US cycles and cycles of other OECD countries on an *ad hoc* basis. As could be expected, Table 4 shows that the US is, behind the fictitious country, the country with tighter comovement of cycles with the remaining countries of the group than any other countries selected through the battery of computations used.

We proceeded in four steps to arrive at the SR for each group of countries in the pairing of the reference cycle and each individual cycle.[8] First, we counted the number of synchronised cycles (+1) and divergent cycles (−1) and obtained a total equal to the number of cycles over the years for each pair of countries. Second, we computed the share of +1s of the total. Third, we produced a count of the shares of +1s >0.50. Fourth, we calculated the SR as the count of shares of +1s >0.50 over the total (+1s and −1s).

For the multivariate formula, we computed the horizontal average of the +1s and −1s stemming from the matching of the reference cycle with the individual cycle at every point in time. This calculation produced a column series of 39 observations between −1 and +1. Positive values indicate tendency towards synchronisation, whereas negative values indicate just

[8] It is important to note that our pairing differs from that of Kalemli-Ozcan et al. (2011) and others. The reference cycle is the same for all individual countries, whereas in Kalemli-Ozcan et al., there is no reference cycle since both countries forming the pair can vary within the pool.

the opposite. The multivariate SR is computed as the count of the positive averages over the total of all averages (positive and negative).

We summarise in Table 4 the SR for each income group for both the bivariate and the multivariate framework.[9] The results are quite similar. We find that the fictitious country represented by the median of all observed output gaps as the reference cycle is strongly synchronised with the individual countries of each group irrespective of the income levels taken into consideration. On average, LICs (0.51, 0.57), LMCs (0.51, 0.62) and UMCs (0.54, 0.57) are characterised each by mild association of the cycles, whereas HICs-OECD (0.78, 0.65) and HICs-other (0.63, 0.63) exhibit each stronger association of the cycles with some variations within pools depending on the criterion used for the reference cycle. The averages for HIC-OECD do not change much when the US is excluded from the calculation (0.75, 0.65). These results indeed suggest that countries of similar income levels do share similar business cycles.

(ii) Business Cycles Synchronicity across Groups

To determine whether the synchronisation of cycles that we observe within groups for countries of relatively similar degree of economic development also extends across groups, we pooled all the countries with ratio of synchronised cycle with the reference country >0.50 irrespective of the income group they belong to. We ended up with 99 countries for the minimum gaps, 169 for the medians, 96 for the maximum averages and the maximum medians (MAMMs) with Bhutan, 101 for the MAMMs with Vietnam and 112 for the median averages. For each of these pools of synchronised cycles, we calculated the bivariate and the multivariate SRs using the country dictated by the minimum gap criterion as the reference cycle. We also used the US as an *ad hoc* global reference for each pool, and whenever the minimum gap criterion produced a country that we believed was not likely to make sense as a reference, we experimented with the countries that served as references in the original bivariate analysis by selecting the one with the minimum average output gap (e.g. the minimum of the minima criterion). For example, the pool of median averages selected France as the reference, but the previous reference cycles with United Kingdom, Liechtenstein, Poland, Paraguay and Equatorial Guinea pointed to Equatorial Guinea as the reference when the minimum output gap is identified for these six possible candidates. In cases like this one, we chose UK as another *ad hoc* country, since it is the largest economy of choices available. Similar treatments were given to other pools. Table 5 supplies details about the selection process of the reference cycle for each large pool of countries, which is representative of the dynamics governing the world economy. We chose the reference cycles for 5 possible groupings of the world.[10] Australia, France and the US were selected for the Minimum Gap pool; Ireland and the US for the MAMM with Vietnam pool; Ireland, Monaco and the US for the MAMM with Bhutan pool; UK, France and the US for the Median Average pool; and France and the US for the Median pool.

Table 6 presents the results pertaining to the synchronisation of the business cycle at the world level for various representations of the world. For the bivariate and multivariate formula, respectively, we find the SR to lie between 0.60 and 0.65 for the Minimum Gap pool on average, 0.61 and 0.59 for the MAMM with Bhutan pool, 0.61 and 0.62 for the MAMM

[9] Detailed tables and computations are available upon request. Figures in parentheses are for the bivariate and multivariate SRs, respectively.

[10] The grouping of countries based on the Median reference cycle is not incorporated in Table 5 because this reference is considered as a fictitious country. The country selected by the minimum average gap criterion and the US as an *ad hoc* are used as references for the Median pool.

TABLE 5
Reference Cycles Across Pools of Countries with Synchronised cycles

Criteria and Selection	*Minimum Gap*			*Maximum Average & Maximum Median Growth Rate With Bhutan*		
	References	Output Gap		References	Output Gap	
	Australia	0.002		Ireland	0.004	
	Andorra	0.007		Virgin island	0.030	
	South Africa	0.005		Equatorial Guinea	0.081	
	Sri Lanka	0.002		China	0.006	
	Pakistan	0.002		Bhutan	0.016	
Minimin		0.002			0.004	
Selection		Pakistan	X		Ireland	√
AD HOC Minimum Reference		Australia	√		N/A	..
Global Reference		France	√		Ireland	√
AD HOC Reference		USA	√		USA	√
	Median Average Gap			Maximum Average and Maximum Median Growth Rate With Vietnam		
	UK	0.004		Ireland	0.004	
	Liechtenstein	0.025		Virgin Island	0.030	
	Poland	0.021		Equatorial Guinea	0.081	
	Paraguay	0.007		China	0.006	
	Equatorial Guinea	0.003		Vietnam	0.008	
Minimin		0.003			0.004	
Selection		Equatorial Guinea	x		Ireland	√
AD HOC Minimum Reference		United Kingdom	√		N/A	..
Global Reference		France	√		Monaco	√
AD HOC Reference		USA	√		USA	√

Notes:
(i) We have five possible groupings of the countries with cycles associated with one or more countries for the world. (ii) The grouping based on the Median is left out in this table because no country in that pool can be portrayed as a reference because the Median is considered as a fictitious country. (iii) The Minimum Gap pool, for example, contains all countries that were selected by the minimum average gap criterion with SR above 0.50 irrespective of the income group. (iv) Minimin is the minimum of all minimum average output gap for the reference countries within each pool. Once this minimum is found, the country associated is considered under selection, and a decision is made as to whether it is plausible to use this country as one of the references for the pool. If the country is a less-developed country, it defies common sense to use it as a reference cycle when there is a large country in the group. A check mark is used if the answer is yes and a cross is used otherwise. If we have to reject the country selected by the Minimin as a potential reference cycle, we take the large country in the group of 5 previous references in the bivariate set up within that specific pool as the AD HOC Minimum Reference. (v) The Global Reference cycle is the country with the minimum average output gap in the big pool. (vi) USA is of course used an *ad hoc* reference since it is the largest economy of the world.

with Vietnam pool, 0.62 and 0.72 for the Median Average pool and 0.65 and 0.70 for the Median pool. Adhering to the criteria of determination, low (SR < 0.40), mild ($0.40 \leq$ SR ≤ 0.60) and strong (SR > 0.60) association of the cycles, there is 'strong' evidence that a common world business cycle exists despite income *per capita* differences across countries. This finding is quite interesting, but posits quite an intriguing question: Which of the countries is the driver of the world business cycle? Well, we know for sure that it is not any of the less-developed or developing countries. Since we had chosen the US as an *ad hoc*

TABLE 6
Synchronicity Across Income Groups based on Various Reference Cycles

Reference Cycles		*Minimum Gap*			*Maximum Average and Maximum Median with Bhutan*	
Criteria	*Country*	*Bivariate*	*Multivariate*	*Country*	*Bivariate*	*Multivariate*
Minimin/AD HOC Minimum	Australia	0.46	0.53	Ireland	0.60	0.53
Global Reference	France	0.72	0.76	Ireland	0.60	0.53
AD HOC Reference	USA	0.61	0.66	USA	0.62	0.71
Average Synchronicity Ratio		0.60	0.65		0.61	0.59
		Maximum Average and Maximum Median with Vietnam			Median Average	
Minimin/AD HOC Minimum	Ireland	0.60	0.50	United Kingdom	0.61	0.71
Global Reference	Monaco	0.61	0.71	France	0.62	0.76
AD HOC Reference	USA	0.62	0.66	USA	0.62	0.7
Average Synchronicity Ratio		0.61	0.62		0.62	0.72
		Median				
Minimin/AD HOC Minimum	N/A	N/A	N/A			
Global Reference	France	0.73	0.74			
AD HOC Reference	USA	0.57	0.66			
Average Synchronicity Ratio		0.65	0.70			

Notes:
(i) Minimin is the minimum of all minimum average output gap for the reference countries within each pool. (ii) The AD HOC Minimum Reference is the large country which is used as reference when the minimum average gap criterion selects a less-developed country. (iii) USA is chosen as a *ad hoc* reference due to its well-known influence on the world economy.

reference cycle, it bears asking how this selection influenced the results. As can be seen from Table 6, the average SR across the five pools when the US is left out lies between 0.62 and 0.65, which is still a strong association of the cycles as per the benchmark. Therefore, our choice did not taint the results. It is difficult to compare the countries that were selected as references to determine which one emerges as the principal driver of the world business cycle, because the countries are not the same across pools. It is worth noting, however, that in each pool where both France and the US were present, the SR with France was on average greater than that of the US, thereby suggesting a greater role of France at the world stage, which is contrary to what one would expect when compared to the US, the largest economy of the world.

We brought further robustness to the finding of the common world business cycle by focusing solely on the countries originally determined as references in Table 3. We therefore searched for the reference among the references. The minimum average gap criterion of the 17 countries had selected Vietnam as the global reference cycle, but this choice was not used since Vietnam is a LIC. As a result, we use the US, UK and China (for its growing importance), which were part of this pool as *ad hoc* references. Since France was never selected by the many criteria used in the original pairing of the countries, it was this time incorporated as an extra *ad hoc* country for comparison with the US, upon the finding that France might be

TABLE 7
Synchronicity of the Reference Cycles

Reference Cycles	*USA*	*UK*	*CHINA*	*FRANCE*
Bhutan	0.50	0.47	0.45	0.45
Guinea	0.50	0.37	0.39	0.45
Pakistan	0.53	0.45	0.47	0.47
Vietnam	0.45	0.42	0.55	0.55
China	0.63	0.61	1.00	0.63
Paraguay	0.45	0.53	0.55	0.50
Sri Lanka	0.58	0.55	0.58	0.63
Equatorial Guinea	0.55	0.53	0.66	0.45
Poland	0.47	0.55	0.68	0.63
South Africa	0.58	0.50	0.53	0.63
Andorra	0.61	0.58	0.50	0.61
Liechtenstein	0.63	0.45	0.37	0.47
Virgin Island	0.42	0.61	0.42	0.53
Australia	0.53	0.55	0.68	0.58
Ireland	0.66	0.42	0.45	0.45
United Kingdom	0.66	1.00	0.61	0.76
United States	1.00	0.66	0.63	0.63
Bivariate Synchronisation Ratio	0.63	0.56	0.53	0.59
Multivariate Synchronisation Ratio	0.61	0.47	0.53	0.63
Synchronised Cycles Count	10	9	9	10

Note:
(i) Only countries with synchronicity measure >0.50 were counted towards the average bivariate/multivariate synchronisation ratio.

the driver of the world business cycle. As per Table 7, We find the bivariate and multivariate SRs to be, respectively, 0.63 and 0.61 for the US, 0.56 and 0.47 for the UK, 0.53 and 0.53 for China and 0.59 and 0.63 for France with the rest of the 16 reference countries. With 10 of these countries, the US and France equally share a common cycle more than 50 per cent of the time, whereas it is nine for both UK and China. These results suggest that France is equally important as the US in leading the world business cycle.

(iii) Did The 1990s Onward Make a Difference to Business Cycle Synchronicity Within and Across Income Groups?

The 1990s have always been regarded as a turning point in international trade and finance. The Uruguay Round completed in 1994 was the last leg of trade negotiations and administrative reforms under the General Agreement on Tariffs and Trade, or GATT, that cuts tariff rates around the world, a whopping 40 per cent from developed countries. It was anticipated that such cuts would produce substantial increase in world trade, but only a small increase was observed since average tariff rate had only fallen from 6.3 to 3.9 per cent (Krugman et al., 2012; Schott, 1994). The creation of the World Trade Organisation (WTO) in 1995 to replace the GATT aimed at fostering further trade among nations in goods and in services by implementing dispute settlement procedures to resolve trade disputes in a timely manner. According to the Organisation of Economic Cooperation and Development (OECD), the world economy was expected to gain more than $200 billion annually once the Uruguay Round agreement was fully implemented, an estimate, of course, that is not devoid of controversy.

Added to the creation of the WTO, progresses in communications and transportation systems that started since the late 1970s have facilitated capital market integration as more countries embraced deregulation to foster investment at home and to compete with others in attracting more capital. Not only did capital flow to many developing countries, but also technology transfers took place as multinational corporations established subsidiaries in host countries. The resulting effect was higher level of consumption and income. The 1990s onward was considered as the rebirth of globalisation, which was interrupted by the First World War and other subsequent events until the end of the second oil shock of 1979. It is often reckoned that the world has become more integrated than before as a result of the globalisation process. The dissenting view, however, is that this level of integration has made countries more vulnerable to financial crises, and the poorest countries are the most affected since they are least likely to be attractive to foreign investors due to existing political strife and lack of proper infrastructure at home. The anti-globalisation movement also contends that redistribution of income from the rich to the poor is not at all possible in a globalised world since governments in less-developed countries do not have the means necessary to make the rich pay taxes since they can relocate their capital to other low-tax countries at little or no cost.

Regardless of the merits of the ongoing debate as to whether the costs of globalisation exceed its benefits, one issue is certain: the world has become more vulnerable to shocks than before. The recent housing crisis that originated in the United States in 2007 that triggered financial crisis in many countries and a worldwide recession is a consequence of the tight linkages of modern economies. It also appeared that even countries with sound macroeconomic fundamentals could not escape since investors had to retire their capital from these countries to mitigate losses they had suffered in large international financial markets. Our contention in this paper is that if it is true that globalisation is welfare improving, growth in countries with, say, high-income *per capita* will spill over countries with low-income *per capita* through international trade and foreign direct investment (FDI) effects. We shall therefore observe a more synchronised response of income *per capita* to shocks across countries for the 1990s onwards than for the two previous decades, which would dictate that globalisation has indeed benefited countries. To assess this claim, we split the full sample into two subsamples covering the period 1970–89 and 1990–2008 and investigate the business cycle synchronicity across and within income groups according to the five selection criteria of the reference cycle presented in Table 8. The maximum average and the maximum median growth rate criteria select the same countries as reference cycles, although these countries differ across subperiods.

We present in Table 9 the synchronicity of cycles within income groups based on the various reference cycles for each subsample. The results are presented side by side to allow for comparison. We find that, on average, there is a mild association of the cycles for LICs, LMCs and HICs-NON-OECD on the basis of the bivariate synchronicity measure regardless of the sample period under consideration. UMCs lie at the border of mild and strong associations, whereas HICs-OECD are characterised by a strong association of the cycles for both subsamples. The multivariate measure of synchronicity in most cases shows greater association than the bivariate measure. The results do not differ too much when the synchronicity measure based on the median output gap, which is the largest in each income category, is discarded from the computation of the global average. The most important result portrayed in Table 9 is that the synchronicity measure for the period 1970–89 is superior to that of 1990–2008 (the globalisation wave) for all income groups but HICs-OECD. This is quite sur-

TABLE 8
Countries Used as Reference Cycles As per the Selection Criteria for the Samples 1970–89 and 1990–2008

Sample 1970–89	*LIC*	*LMC*	*UMC*	*HIC-OECD*	*HICs-NON-OECD*
Minimum Gap	Congo	Nauru	Chile	Luxembourg	Qatar
Median	Fictitious	Fictitious	Fictitious	Fictitious	Fictitious
Max Average	Indonesia	China	Botswana	Iceland	Aruba
Median Average	Nepal	Morocco	South Africa	France	French Polynesia
Max Median	Indonesia	China	Botswana	Iceland	Aruba
Ad Hoc				USA	
Sample 1990–2008					
Minimum Gap	Haiti	Jamaica	Gabon	Sweden	Andorra
Median	Fictitious	Fictitious	Fictitious	Fictitious	Fictitious
Max Average	Myanmar	China	Equatorial Guinea	Ireland	Virgin Island
Median Average	Malawi	Iran	Equatorial Guinea	Sweden	Antigua–Barbados
Max Median	Myanmar	China	Equatorial Guinea	Ireland	Virgin Island
Ad Hoc				USA	

Note:
(i) Min Gap or Minimum Gap is the country with the lowest average output gap. (ii) The Median is the observation in the middle at each point in time, which gives us a column series we term 'fictitious'. (iii) The Max Average or Maximum Average is the country with the highest average growth rate over the full sample period. (iv) Median Average is obtained by computing the average growth rate for each country to select the country in the Middle as reference. (v) The Max Median is obtained by computing the median growth rate for each country and selecting the country with the maximum value as reference. (vi) Once the references are selected, we apply the measures of synchronicity to the output gap data.

prising since one would expect tighter linkage of the cycles within income groups due to trade liberalisation, FDI and globalisation overall.

What can possibly explain the lesser synchronicity of the cycles from the 1990s onward? One feature of the business cycle linkages uncovered in Table 9 is that only cycles of countries with similar income levels are being matched. It is quite possible that these countries do not trade much with each other since they are all trying to reach the larger markets of Europe and North America, for example. The 1970–89 period, which precedes the Uruguay Round, could perhaps represent a period of more trade for countries of similar income since the concessions on tariff and non-tariff barriers from the developed world were not yet made. Less-developed and developing countries had no other choices than to foment trade within their own groupings. Well, this argument would be a hard sell because when we peruse Tables 10 and 11 where countries with synchronous cycles are grouped as a possible picture of the world economy irrespective of their level of income, the outcome is pretty much similar.

Table 10 shows the selection of the reference cycles when we pool countries with synchronous cycles based on the minimum output gap, the maximum average, maximum median and median average growth rate criteria. We used the Minimin criterion to choose the global reference cycle in each large pool. However, two countries kept reappearing as world reference cycles: Luxembourg for the period 1970–89 and Sweden for the period 1990–2008. Since these countries were too small to be drivers of the world business cycle, a global reference other than these two countries was then selected according to the same criterion. If in that round we did not find a high-income country, we applied the Minimin criterion to OECD countries, except Luxembourg or Sweden. In addition, we selected France and the USA as

TABLE 9
Synchronicity of Cycles within Groups based on Various Reference Cycles for the Samples 1970–89 and 1990–2008

				LICs		
Criteria	*Country*	*1970–89*		*Country*	*1990–2008*	
		Bivariate	*Multivariate*		*Bivariate*	*Multivariate*
Min_Gap	Congo	0.48	0.40	Haiti	0.42	0.50
Median	Fictitious	0.55	1.00	Fictitious	0.64	0.90
Max_Average	Indonesia	0.31	0.40	Myanmar	0.33	0.33
Median_Average	Nepal	0.54	0.65	Malawi	0.36	0.40
Max_Median	Indonesia	0.31	0.40	Myanmar	0.33	0.33
Global Average		0.44	0.57		0.42	0.49
Global Average - Fictitious		0.41	0.46		0.36	0.39
				LMC		
Min_Gap	Nauru	0.58	0.60	Jamaica	0.35	0.20
Median	Fictitious	0.70	1.00	Fictitious	0.83	0.90
Max_Average	China	0.46	0.50	China	0.55	0.50
Median_Average	Morocco	0.27	0.30	Iran	0.60	0.45
Max_Median	China	0.46	0.50	China	0.55	0.50
Global Average		0.49	0.58		0.58	0.51
Global Average - Fictitious		0.44	0.48		0.51	0.41
				UMC		
Min_Gap	Chile	0.45	0.65	Gabon	0.43	0.50
Median	Fictitious	0.87	0.90	Fictitious	0.92	0.94
Max_Average	Botswana	0.52	0.60	Equatorial Guinea	0.43	0.56
Median_Average	South Africa	0.66	0.75	Equatorial Guinea	0.43	0.56
Max_Median	Botswana	0.52	0.60	Equatorial Guinea	0.43	0.56
Global Average		0.60	0.70		0.53	0.62
Global Average - Fictitious		0.54	0.65		0.43	0.55
				HIC-OECD		
Min_Gap	Luxembourg	0.75	0.80	Sweden	0.86	0.72
Median	Fictitious	0.84	1.00	Fictitious	0.91	1.00
Max_Average	Iceland	0.50	0.40	Ireland	0.60	0.61
Median_Average	France	0.74	0.70	Sweden	0.86	0.72
Max_Median	Iceland	0.50	0.40	Ireland	0.60	0.61
Ad_Hoc	USA	0.65	0.75	USA	0.73	0.67
Global Average		0.65	0.65		0.74	0.72
Global Average - Fictitious		0.63	0.61		0.73	0.67
				HICs-NON-OECD		
Min_Gap	Qatar	0.46	0.55	Andorra	0.34	0.40
Median	Fictitious	0.76	1.00	Fictitious	0.75	0.94
Max_Average	Aruba	0.54	0.60	Virgin Island	0.55	0.67
Median_Average	French Polynesia	0.60	0.30	Antigua–Barbados	0.33	0.44
Max_Median	Aruba	0.54	0.60	Virgin Island	0.55	0.67
Global Average		0.58	0.61		0.50	0.62
Global Average - Fictitious		0.54	0.51		0.44	0.55

TABLE 10
Reference Cycles Across Pools of Countries with Synchronised cycles – Subsamples 1970–89 and 1990–2008

Criteria and Selection	*Minimum Gap*					
	1970–89			*1990–2008*		
	References	*Output Gap*		*References*	*Output Gap*	
	Congo	0.0002		Haiti	0.0003	
	Nauru	0.0150		Jamaica	0.0004	
	Chile	0.0030		Gabon	0.0064	
	Luxembourg	0.0001		Sweden	0.0000	
	Qatar	0.0002		Andorra	0.0010	
Minimum		0.0001			0.0000	
Selection		Luxembourg	√		Sweden	√
AD HOC Minimum Reference		N/A	..		N/A	..
Global Reference		Luxembourg*	√		Sweden*	√
Global Reference but *		Congo	X		Haiti	X
Global Reference OECD but *		New Zealand	√		France	√
AD HOC Reference		France and USA	√		USA	√
	Maximum Average and Maximum Median Growth Rate					
	Indonesia	0.0150		Myanmar	0.0240	
	China	0.0500		China	0.0700	
	Botswana	0.0150		Equatorial Guinea	0.2100	
	Iceland	0.0200		Ireland	0.0440	
	Aruba	0.0340		Virgin Island	0.0340	
Minimum		0.0150			0.0240	
Selection		Indonesia	X		Myanmar	X
AD HOC Minimum Reference		China	√		China	√
Global Reference		Luxembourg*	√		Sweden*	√
Global Reference but *		Congo	X		Ireland	√
Global Reference OECD but *		New Zealand	√		N/A	..
AD HOC Reference		France and USA	√		France and USA	√
	Median Average Growth Rate					
	Nepal	0.0020		Malawi	0.0042	
	Morocco	0.0160		Iran	0.0630	
	South Africa	0.0070		Equatorial Guinea	0.2100	
	France	0.0050		Sweden	0.0000	
	French Polynesia	0.0130		Antigua–Barbados	0.0200	
Minimum		0.0020			0.0000	
Selection		Nepal	X		Sweden	√
AD HOC Minimum Reference		France	√		N/A	..

TABLE 10 *Continued*

Criteria and Selection	*Minimum Gap*					
	1970–89			*1990–2008*		
	References	*Output Gap*		*References*	*Output Gap*	
Global Reference		Luxembourg*	√		Sweden*	√
Global Reference but *		Qatar	√		Haiti	X
Global Reference OECD but *		New Zealand	√		France	√
AD HOC Reference		USA	√		USA	√

Notes:
(i) We have 5 possible groupings of the countries with cycles associated with one or more countries for the world. (ii) The grouping based on the Median is left out in this table because no country in that pool can be portrayed as a reference because the Median is considered as a fictitious country. (iii) The Minimum Gap pool, for example, contains all countries that were selected by the minimum average gap criterion with SR above 0.50 irrespective of the income group. (iv) Minimin is the minimum of all minimum average output gap for the reference countries within each pool. Once this minimum is found, the country associated is considered under selection, and a decision is made as to whether it is plausible to use this country as one of the references for the pool. If the country is a less-developed or a very small open-economy country, it defies common sense to use it as a reference cycle when there is a large country in the group. (v) A check mark is used if the answer is yes and a cross is used otherwise. If we have to reject the country selected by the Minimin as a potential reference cycle, we take the large country in the group of 5 previous references in the bivariate set up within that specific pool as the AD HOC Minimum Reference. (vi) The Global Reference cycle is the country with the minimum average output gap in the big pool. Since Luxembourg and Sweden kept reappearing as Global Reference, an effort was made to rid the results of such bias by computing the minimum average gap for the pool while setting aside these two countries. Common sense was used to either accept the alternative found or look into the pool for an OECD country, hence the terms Global Reference but * and Global Reference OECD but *. (vii) USA is of course used an *ad hoc* reference since it is the largest economy of the world. We have also brought France as another *ad hoc* whenever none of the criteria pointed to France. This accords with our earlier finding that France might play an even greater role than the USA in driving the world business cycle.

ad hoc reference cycles. This information is fed into Table 11, which unequivocally shows that there was more synchronicity of the cycles in the 1970s and 1980s combined than in the 1990s and 2000s combined, despite the globalisation wave of the latter period. Further analysis of the data using the reference cycles of each income group to investigate synchronicity with major international players such as the United States, United Kingdom, China and France reveals on average that the association of the cycles range from mild to strong for period 1970–89 and from low to borderline strong for the period 1990–2008, as per Table 12. These results do not support the view that globalisation has led countries to move along the same wavelength. Table 12 is also quite intuitive; for example, it shows that countries with cycles linked to Qatar (a reference cycle for HICs-NON-OECD) will likely react similarly to economic disturbances affecting the US, UK, China and France, whereas countries with cycles linked to Democratic Republic of Congo or Haiti will not share such similarity.

We believe Todaro and Smith's (2003) introduction to globalisation contains a more plausible explanation of the weaker synchronicity of the cycles supported by the data for most income groups or make-up of the world with the exception of the OECD countries. Todaro and Smith observe that while FDI was flowing in promising developing areas such as Asia and part of Latin America, foreign aid has been declining substantially over the years for the majority of less-developed and developing countries, including those living in abject poverty. In their view, although it is true that developed countries have become more open due to globalisation, widespread protectionist policies are still being practised by the most advanced

TABLE 11
Synchronicity Across Income Groups based on Various Reference Cycles – Subsamples 1970–89 and 1990–2008

Minimum Gap

Reference Cycles	*1970–89*			*1990–2008*		
Criteria	*Country*	*Bivariate*	*Multivariate*	*Country*	*Bivariate*	*Multivariate*
Minimin/AD HOC Minimum	Luxembourg*	0.77	0.95	Sweden*	0.52	0.55
Global Reference	Luxembourg*	0.77	0.95	Sweden*	0.52	0.55
Global Reference but *	Congo = N/A			Haiti = N/A		
Global Reference OECD but *	New Zealand	0.64	0.80	France	0.60	0.75
AD HOC Reference 1	France	0.71	0.80	France	0.60	0.75
AD HOC Reference 2	USA	0.55	0.75	USA	0.40	0.50
Average Synchronicity Ratio		0.67	0.83		0.51	0.60
Comparable Average		0.67	0.83		0.53	0.64
Maximum Average and Maximum Median Growth Rate						
Minimin/AD HOC Minimum	Luxembourg*	0.71	0.7	Sweden*	0.53	0.5
Global Reference	Luxembourg*	0.71	0.7	Sweden*	0.53	0.5
Global Reference but *	Congo = N/A			Ireland	0.56	0.5
Global Reference OECD but *	New Zealand	0.57	0.55	Ireland	0.56	0.5
AD HOC Reference 1	France	0.72	0.75	France	0.7	0.8
AD HOC Reference 2	USA	0.62	0.75	USA	0.52	0.55
Average Synchronicity Ratio		0.655	0.6875		0.5775	0.5875
Comparable Average		0.655	0.6875		0.5775	0.5875
Median Average Growth Rate						
Minimin/AD HOC Minimum	France	0.78	0.9	Sweden	0.56	0.6
Global Reference	Luxembourg*	0.66	0.75	Sweden*	0.56	0.6
Global Reference but *	Qatar	0.6	0.6	Haiti = N/A		
Global Reference OECD but *	New Zealand	0.64	0.7	France	0.62	0.7
AD HOC Reference 1	France	0.78	0.9	France	0.62	0.7
AD HOC Reference 2	USA	0.53	0.6	USA	0.51	0.65
		0.642	0.71		0.563333	0.65

TABLE 11 *Continued*

Minimum Gap						
Reference Cycles	*1970–89*			*1990–2008*		
Criteria	*Country*	*Bivariate*	*Multivariate*	*Country*	*Bivariate*	*Multivariate*
Average Synchronicity Ratio						
Comparable Average Median		0.6825	0.775		0.5775	0.6625
Minimin/AD HOC Minimum	N/A	N/A	N/A	N/A	N/A	N/A
Global Reference	Luxembourg*	0.71	0.7	Sweden*	0.48	0.6
Global Reference but *	Qatar	0.68	0.8	Haiti = N/A		
Global Reference OECD but *	New Zealand	0.64	0.7	Norway	0.68	0.65
AD HOC Reference 1	France	0.74	0.8	France	0.62	0.8
AD HOC Reference 2	USA	0.6	0.85	USA	0.36	0.55
Average Synchronicity Ratio		0.674	0.77		0.535	0.65
Comparable Average		0.66	0.783333333		0.553333	0.666666667

Notes:
(i) The Comparable Average is average of the Minimin/AD HOC Minimum, the Global Reference OECD but* and the AD HOC References.
(ii) The Global Reference cycle is the country with the minimum average output gap in the big pool. Since Luxembourg and Sweden kept reappearing as Global Reference, an effort was made to rid the results of such bias by computing the minimum average gap for the pool while setting aside these two countries. Common sense was used to either accept the alternative found or look into the pool for an OECD country, hence the terms Global Reference but * and Global Reference OECD but *. (iii) USA is of course used an *ad hoc* reference since it is the largest economy of the world. We have also brought France as another *ad hoc* whenever none of the criteria pointed to France. This accords with our earlier finding that France might play an even greater role than the USA in driving the world business cycle.

OECD countries in agriculture and textiles where the less-developed countries could enjoy a competitive advantage. It bears acknowledging that for Todaro and Smith (2003), openness to globalisation itself does not inevitably forestall growth, at least among more developed countries. In their view, globalisation has been a key to rapid growth in countries such as South Korea, China and India, among others. But globalisation does carry the seed for inequality to accentuate across and within countries as some people and countries may not receive their fair share of economic windfall. Well-known examples are the growing disparities between coastal and inland China, between countries in Africa and countries in Asia or Latin America, Dominican Republic and Haiti, among others. Another factor that we think is relevant in understanding the cross-period synchronicity is immigration policies erected by developed countries that started in mid-1980s but further intensified in the 1990s onward. Impediments to labour mobility across countries (not between developed countries) have been intensified in contrast with the 1970s and the early 1980s. During these times, it was relatively easier for workers from less-developed countries to seek economic refuge in abundant countries so that

TABLE 12
Synchronicity of the Reference Cycles – Subsample Analysis

	1970–89					*1990–2008*			
	USA	*UK*	*CHINA*	*France*		*USA*	*UK*	*CHINA*	*France*
CONGO DEM. REP.	0.33	0.22	0.33	0.44	HAITI	0.28	0.44	0.50	0.44
INDONESIA	0.44	0.44	0.44	0.56	MALAWI	0.44	0.39	0.67	0.39
NEPAL	0.67	0.44	0.44	0.67	MYANMAR	0.67	0.61	0.44	0.72
CHINA	0.78	0.67	1.00	0.67	CHINA	0.56	0.61	1.00	0.61
MOROCCO	0.39	0.50	0.39	0.61	IRAN	0.50	0.33	0.50	0.33
NAURU	0.56	0.44	0.56	0.44	JAMAICA	0.56	0.28	0.44	0.39
BOTSWANA	0.72	0.61	0.61	0.61	EQUATORIAL GUINEA	0.56	0.50	0.67	0.50
CHILE	0.39	0.28	0.39	0.50	GABON	0.33	0.61	0.44	0.50
SOUTH AFRICA	0.61	0.50	0.50	0.72	FRANCE	0.61	0.89	0.61	1.00
FRANCE	0.67	0.67	0.67	1.00	IRELAND	0.72	0.44	0.39	0.56
ICELAND	0.44	0.33	0.44	0.56	SWEDEN	0.72	0.56	0.39	0.67
LUXEMBOURG	0.67	0.67	0.67	0.89	UNITED STATES	1.00	0.50	0.56	0.61
USA	1.00	0.78	0.78	0.67	ANDORRA	0.67	0.50	0.44	0.61
ARUBA	0.56	0.44	0.56	0.56	ANTIGUA BARBUDA	0.61	0.56	0.39	0.56
FRENCH POLYNESIA	0.39	0.61	0.28	0.61	VIRGIN ISLAND (Britain)	0.44	0.72	0.33	0.61
QATAR	0.83	0.72	0.61	0.72	UNITED KINGDOM	0.50	1.00	0.61	0.89
UNITED KINGDOM	0.78	1.00	0.67	0.67					
Bivariate Synchronisation Ratio	0.63	0.44	0.50	0.81		0.60	0.47	0.33	0.60
Multivariate Synchronisation Ratio	0.70	0.60	0.50	0.75		0.55	0.55	0.45	0.65
Synchronised Cycles Count	11.00	8.00	9.00	14.00		10.00	8.00	6.00	10.00

Notes:
(i) Each country of reference is linked to a group of countries of certain level of real income *per capita*. (ii) By transitive association, synchronicity of business cycles between country of reference j and either USA, UK, China or France applies to the whole group of countries linked to country j. (iii) The bivariate synchronisation ratio is the number of synchronised cycles >0.50 divided by the sum of synchronised and divergent cycles over time. (iv) The multivariate synchronisation ratio is the horizontal average of the matching of the reference cycle with the individual cycle at every point in time that is positive divided by the total of all averages (both positive and negative). This table, for example, shows that countries with cycles linked to Qatar will likely react similarly to economic disturbances affecting USA, UK, China and France, whereas countries with cycles linked to Democratic Republic of Congo or Haiti will not share such similarity.

they could provide for their relatives back home and even bring them along after certain time. All these factors, in our view, may be contributors to the underlying relative weak association of the cycles for the period 1990–2008.[11]

Further perusal of Tables 9, 11 and 12 also provides further convincing evidence that France is indeed an important driver of the world business cycle. The synchronicity measure with France as an *ad hoc* global reference is greater than that with the United States, whether we use the bivariate or the multivariate formula or whether we use full sample or subsamples. This finding is quite puzzling since France is not even the second largest economy of the world after the United States. Is there an explanation for such surprising results? Well, it is quite possible that as the largest economy, the US cycle may move concurrently with cycles of other OECD countries that enjoy similar income levels and perhaps similar habit formation, whereas France as a former colonist might enjoy concurrent cycles with most less-developed and developing countries, and for being a European country, proximity to other European Countries and Africa might place France in position to trade with the rest of the world at a lower cost than the US. One way to capture this spatial explanation of the tighter business cycle linkage is by introducing leads and lags into the analysis.[12] We formally test whether it makes a difference in the results if we assume that disturbances affecting the rest of the world take some time before they can have some effects on the US or whether the pulse of the US economy is an indication of trouble or opportunities to come for the rest of the world. We calculate both measures of synchronicity for the full and subsample periods and present the results in Table 13. Unequivocally, the results show that US synchronicity measures are far superior to those of France when lagged cycles are matched with the contemporaneous cycles of the rest of the world. These findings are by and large in accordance with the chronology of modern economic crises, safe for those originated in the US including the most recent financial crisis.

b. Is There an Explanation for the Synchronicity of Business Cycles across Income Groups?

Thus far, we have shown that despite differences in income levels which would normally dictate asynchronous business cycle, there is a common world business cycle, and economies of the US and France play a pivotal role as drivers. This finding raises a fundamental question as to what underlies the commonality in the world business cycle. We took two approaches to investigate the role that globalisation might have in increasing economic interdependence among countries. We use dynamic panel data model with synchronised output gap as the dependent variable and panel logit regression with the synchronicity measure as the left-hand-side variable to gauge the influence that growth in consumption *per capita*, real oil prices and increased trade openness might exert on these two variables. The theory is clear on the choice of the explanatory variables. Consumption is the largest component of aggregate demand, and changes in tastes and preferences, real incomes, real interest rates, expectations about future

[11] It would be quite counterintuitive here to argue that the lesser synchronicity of the cycles for the 1990s onward is a good thing since it enables countries to buy insurance against bad times as supported by the risk sharing literature. The reason is simply that less-developed countries have little resources to allocate to capital markets.

[12] We thank an anonymous participant at the International Macro/Macroeconomie Internationale Session of the 44th Annual Conference of the Canadian Economics Association 28–30 May 2010 for making these valuable suggestions, which definitely brought more robustness to our findings.

TABLE 13
Business Cycles Synchronicity - the Dynamics

Pool	*1970–89*							
	USA				*France*			
	Lag		*Lead*		*Lag*		*Lead*	
	Bivariate	*Multivariate*	*Bivariate*	*Multivariate*	*Bivariate*	*Multivariate*	*Bivariate*	*Multivariate*
Minimum Gap	0.70	0.65	0.17	0.20	0.22	0.25	0.25	0.20
Median	0.63	0.55	0.43	0.35	0.34	0.30	0.35	0.40
Maximum_Average and Max_Median	0.60	0.40	0.25	0.15	0.18	0.25	0.34	0.30
Median_Average	0.54	0.45	0.36	0.20	0.25	0.20	0.44	0.45
	1990–2008							
Minimum Gap	0.55	0.50	0.32	0.30	0.35	0.30	0.33	0.35
Median	0.60	0.50	0.20	0.32	0.26	0.33	0.36	0.50
Maximum_Average and Max_Median	0.62	0.42	0.32	0.42	0.31	0.53	0.34	0.37
Median_Average	0.70	0.68	0.17	0.21	0.22	0.26	0.25	0.21
	1970–2008							
Minimum Gap	0.52	0.58	0.40	0.34	0.34	0.40	0.40	0.45
Median	0.55	0.50	0.34	0.34	0.32	0.34	0.31	0.40
Maximum_Average and Max_Median (Bhutan)	0.47	0.51	0.42	0.38	0.32	0.38	0.34	0.43
Maximum_Average &Max_Median (Vietnam)	0.55	0.60	0.40	0.35	0.37	0.46	0.35	0.38
Median_Average	0.65	0.62	0.36	0.30	0.43	0.38	0.40	0.46

incomes and future prices do impact real output.[13] It is also the case that the more open an economy is, the more vulnerable it is to international shocks. Gains from trade accrue to consumers in terms of lower prices for their consumption products and availability of wider range of differentiated products. Therefore, there is interaction between these two variables in explaining synchronicity. Oil remains one of the most important sources of energy in the production of output. Shocks to real oil prices do have severe repercussions on real income regardless of whether a country is a net exporter or a net importer. Our contention is that ups and downs in the level of economic activities across countries of different income levels can be synchronised if they revolve around these global variables (See Baxter and Stockman, 1989; Baxter, 1991, 1995). However, there is contention in the literature whether standard multicountry business cycle models can capture the relationship between trade and business cycle comovement (see Kouparitsas, 1997a, 1997b; and Kose and Yi, 2001a, 2006).

We attempt to model the explanation using three main panel regression models: panel Logit, panel linear estimation and dynamic panel estimation. For each model, we used both the full set of observations (1970–2007) and subsamples (1970–89 and 1990–2007).

For the linear and dynamic panel data models, we used the output gap of the countries with SR above 0.50 as per the criteria listed in Tables 3 and 4.

(i) Panel Logit Estimation

For the panel logit regression, we convert the synchronicity measures of equations (5) and (6) into a binary variable such as:

$$\phi_{i,r,t} = \begin{cases} 1 & \text{when individual and reference country output gaps have the same sign(+1s)} \\ 0 & \text{when output gaps have opppsite signs (-1s)} \end{cases}$$

$$\phi_{i,r,t} = \begin{cases} 1 & \text{when the average of +1 s and -1s are positive at each point in time} \\ 0 & \text{when the average is negative} \end{cases}$$

The logistic probability function is given by:

$$Pr(\phi_{i,r,t}) = (1|x_{i,r,t}, \beta, \alpha_i) = \Lambda(\alpha_i + x'_{i,r,t}\beta). \tag{7}$$

We rewrite this equation for estimation purpose as:

$$\phi_{i,r,t} = \ln\left(\frac{Pr_i}{1 - Pr_i}\right) = \alpha_i + \beta_1 OP_{i,t} + \beta_2 C_{i,t} + \beta_3 TR_{i,t} + v_{i,t}, \tag{8}$$

where $OP_{i,t}$ is real oil prices, $C_{i,t}$ is consumption, and $TR_{i,t}$ is the trade openness of country i at time t. All variables are expressed in percentage change using natural log differences for the first two variables. $TR_{i,t}$ is measured as the sum of exports and imports as a share of real GDP for each country. The growth in $TR_{i,t}$ captures the increase in trade openness as opposed to just the openness of a country over time. Hence, we ask to what extent further openness of

[13] The linkage between consumption (C) and output (Y) can be understood in the following terms: increase in domestic interest rate above foreign interest rate leads to a decrease in domestic current consumption as individuals shift a larger portion of their income to savings, thereby decreasing domestic output. In foreign countries, output will also fall as households increase their purchase of domestic bonds due to the higher interest rate. Hence, the synchronisation of the business cycle observed (Barro, 1997; Baxter and Crucini, 1993).

domestic economies to the world is likely conducive to synchronisation of business cycles across income groups.

For the lagged values model:

$$\pi_{ij}(t-1) = \ln\left(\frac{Pr_i}{1-Pr_i}\right) = \beta_1 OP_{t-1} + \beta_2 C_{t-1} + \beta_3 TR_{t-1} + u_t. \quad (9)$$

For both models, the Hausman's test is employed to determine whether a model that allows for the possibility of a correlation between unobserved country characteristics and the predictor variables (fixed effects) or one that assumes that the variation across countries is random and uncorrelated with the predictor variables (random effects) is more appropriate. Results of the tests showed that the differences across countries have no influence on the dependent variable; hence, fixed effects estimation was applied to all the regressions.

The results from the robust fixed effects estimation presented in Tables 14 and 15 indicate that only real oil prices are consistently significant, whether we include lagged variables or not as explanatory variables. The lagged values of real oil prices appear to have the most significant explanatory power in determining synchronicity of output gap across countries and methods. Also, in all models estimated, the sign was mostly positive suggesting that real oil prices play an important role in shaping the dynamics of output gaps.[14]

(ii) Linear Panel Estimation

The fixed effect static model is as follows

$$Y_{it} = X_{it}\beta + v_i + \varepsilon_{it}, \quad (10)$$

where: v_i ($i = 1.....n$) is the unknown intercept for each country (n country-specific intercepts), Y_{it} is the output gap of country i in year t, X_{it} is a vector of the independent variables (real oil prices, consumption and trade) for country i in year t, ε_{it} is the error term.

Thus,

$$Y_{it} = \beta_1 OP_t + \beta_2 C_t + \beta_3 TR_t + v_i + \varepsilon_{it}. \quad (11)$$

This model controls for all time-invariant differences between the countries. In other words, the estimated coefficients are not biased because of omitted time variant country characteristics.

Under this specification, lagged real oil prices appear to significantly explain the synchronicity in output gaps for both the contemporaneous and lagged estimations.[15]

(iii) Dynamic Panel Estimation

We estimate a model similar to the static panel data estimation but include the lagged dependent variable.

$$Y_{it} = Y_{it-1}\delta + X_{it}\beta + v_i + \varepsilon_{it}. \quad (12)$$

Since Y_{it-1} is correlated with the unobserved v_i, the dynamic model first differences both sides and uses instrumental variables and generalised method of moments estimators.

[14] Results for the subsample periods showed that lagged real oil prices play a consistent significant role in explaining synchronicity. These results are available on request.

[15] For brevity, the full results for both the full and subsample estimations are not presented here but are available on request.

TABLE 14
Panel Logit Estimation

Method	*Minimum Gap*			*Median Average*		
Reference country	*France*	*USA*	*Median*	*France*	*USA*	*UK*
OP_t	0.2469 (0.1755)	0.0406 (0.1770)	0.1392 (0.1588)	0.4158 (0.1529)*	0.4438 (0.1606)*	0.6757 (0.1626)*
C_t	0.5975 (0.4071)	−0.3407 (0.4112)	0.1519 (0.3309)	0.1054 (0.4794)	0.3910 (0.8367)	0.5250 (0.5023)
TR_t	−0.0535 (0.1068)	−0.2351 (0.1957)	−0.1424 (0.2232)	0.0552 (0.0987)	0.0894 (0.1506)	0.1861 (0.1461)
N	2584	2280	2812	2698	2090	2280
# of groups	68	60	74	71	55	60
Obs. per group	38	38	38	38	38	38
	Maximum Average and Maximum Median with Bhutan			Maximum Average and Maximum Median with Vietnam		
	Monaco	Ireland	USA	Monaco	Ireland	USA
OP_t	0.3002 (0.1750)**	0.5196 (0.2017)*	−0.3156 (0.1662)**	0.3132 (0.1319)*	0.5048 (0.1544)*	−0.2529 (0.1775)
C_t	−0.3222 (0.7317)	−1.2308 (0.5356)*	0.3838 (0.5248)	−0.0155 (0.4752)	−0.7170 (0.4122)**	0.2668 (0.2783)
TR_t	−0.0965 (0.0971)	0.1226 (0.1052)	−0.2089 (0.2328)	−0.1015 (0.0957)	0.0639 (0.1571)	−0.2326 (0.2393)
N	2318	1558	1862	2432	1748	1938
# of groups	61	41	49	64	46	51
Obs. per group	38	38	38	38	38	38

Notes:
(i) Standard errors in parentheses are based on 1,000 bootstrap replications.
(ii) *Statistical significance at 5% level and **significance at 10% level.

TABLE 15
Panel Logit Estimation (lagged variables)

Method	*Minimum Gap*			*Median Average*		
Reference country	*France*	*USA*	*Median*	*France*	*USA*	*UK*
OP_{t-1}	0.6910 (0.2353)*	−0.4505 (0.2058)*	0.4154 (0.1750)*	0.6880 (0.1499)*	0.8162 (0.1850)*	0.6065 (0.1883)*
C_{t-1}	0.0723 (0.4927)	−0.3255 (0.2770)	−0.0408 (0.4333)	0.9007 (0.6204)	0.7533 (0.4868)	0.2786 (0.2707)**
TR_{t-1}	−0.0204 (0.0787)	0.1651 (0.2216)	−0.4976 (0.4202)	−0.1054 (0.3935)	−0.0552 (0.3437)	−0.3108 (0.3702)
N	2516	2220	2738	2627	2035	2220
# of groups	68	60	74	71	55	60
Obs. per group	37	37	37	37	37	37
	Maximum Average and Maximum Median with Bhutan			Maximum Average and Maximum Median with Vietnam		
	Monaco	Ireland	USA	Monaco	Ireland	USA
OP_{t-1}	0.7053 (0.2055)*	0.7931 (0.2952)*	−0.7506 (0.1515)*	0.6901 (0.2264)*	0.6824 (0.2220)*	−0.7242 (0.2162)*
C_{t-1}	0.4489 (0.5832)	0.1382 (0.7371)	−0.2669 (0.4582)	0.3001 (0.4336)	0.1818 (0.5716)	0.0147 (0.2713)
TR_{t-1}	0.1335 (0.3972)	−0.6014 (0.5469)	0.0602 (0.3433)	0.1767 (0.2750)	−0.1149 (0.4843)	−0.1371 (0.5508)
N	2257	1517	1813	2368	1702	1887
# of groups	61	41	49	64	46	51
Obs. per group	37	37	37	37	37	37

Notes:
(i) Standard errors in parentheses are based on 1,000 bootstrap replications.
(ii) *denotes statistical significance at 5% level and **denotes significance at 10% level.

In this paper, we used the Arellano and Bover (1995)/Blundell and Bond (1998) estimator, which is an extension of the Arellano-Bond (1991) estimator. This estimator is more efficient and produces smaller biased estimates if the autoregressive process is large, in which case the lagged levels become weak instruments. The Arellano-Bover/Blundell-Bond (ABBB) estimator uses additional moment conditions based both on the first differences and levels in which the lagged differences of the dependent variable are uncorrelated with levels of the errors.

The automatic instruments created are based on the assumption of the absence of serial correlation so we performed postestimation tests for the presence of serial correlation in the model. Where the null is rejected, we used a flexible model where we select the instruments to allow for serial correlation and moving average serial correlation in the residuals. There were no significant differences between using the Arellano-Bover-Blundell-Bond model and the flexible model, so the results reported in this paper are those of the ABBB model.

These estimated models confirm the statistical significance of lagged real oil prices in determining synchronicity.[16] The results show that among the chosen explanatory variables, only lagged oil prices were consistent in determining the synchronicity of output gap and were not model dependent.

The finding that real oil price matters for business cycle synchronisation across models is tributary to the fact that economies are affected by crude oil prices irrespective of their relative stage of development. It is a truism that a rise in the price of oil benefits exporters as it enables governments to raise revenues to finance education, health, infrastructure and welfare programmes. However, these boosts in oil revenues naturally come from importing countries, thereby producing adverse effects on their gross domestic products; hence, asynchronous business cycles take place across countries. However, increase in the price of oil also leads to increase in the price of energy and petrochemicals, and this tends to have the same effects on output of both groups of countries. Whether output ends up being synchronised or not is dependent on which factor(s) (higher oil export revenues, higher energy prices, crude oil-derivative other products and services in oil-producing countries, higher oil import expenses, and higher prices for goods and services exported by oil importers) dominate in each country. This complexity has been the subject of a handful of papers in the literature. For example, Bayoumi and Eichengreen (1994) noted it is difficult to distinguish between aggregate demand and aggregate supply shocks for oil-producing countries due to the reliance of the non-oil sector on the oil sector. Kilian (2009) identifies three main components of shocks to the real price of oil: oil supply shocks, shocks to the global demand for all industrial commodities and demand shocks that are specific to the crude oil markets. In his view, each shock manifests differently on the actual real price of oil and on US macroeconomic aggregates.

It is important to note that there are more oil-importing countries than oil-exporting countries in the world. Surely, in pooling the data for all countries according to some specific criterion of the reference cycle, the effects of oil prices on importing countries stochastically dominate in explaining the synchronicity of the business cycles.

Whereas all countries in some form or other are affected by the price of crude oil, this is not, however, the case when it comes to international trade across countries. A large number of countries trade little or do not actually trade with each other; hence, trade openness is

[16] For brevity, results for the entire samples and the subsamples are not fully presented in this paper but can be furnished upon request.

found to be statistically insignificant in explaining business cycle synchronicity. This finding is by and large supported in the literature. Backus and Kehoe (1992) find that net exports have generally been countercyclical. Kose et al. (2003a, p. 57), had the following to add when investigating how globalisation affects business cycles synchronisation:

> Economic theory does not provide definitive guidance concerning the impact of increased trade and financial linkages on the degree of business-cycle synchronisation. International trade linkages generate both demand- and supply-side spillovers across countries. For example, on the demand side, an investment or consumption boom in one country can generate increased demand for imports, boosting economies abroad. Through these types of spillover effects, stronger international trade linkages can result in more highly correlated business cycles across countries. However, trade flows could also induce increased specialisation of production resulting in changes in the nature of business-cycle correlations. If stronger trade linkages are associated with increased interindustry specialisation across countries, and industry-specific shocks are important in driving business cycles, then international business-cycle comovement might be expected to decrease.

For instance, Anderson et al. (1999) identified a significant relationship between trade openness and the synchronisation of economic cycles in a set of 37 countries. In testing the endogeneity hypothesis of OCA criteria in a cross-section of OECD countries in the 1990s, Fidmurc (2002) found no direct relationship between business cycles and bilateral trade intensity. As per Kose et al. (2003a), there is limited support for the conventional wisdom that globalisation has increased the degree of synchronisation of business cycles. They also find the evidence that trade and financial integration enhances global spillovers of macroeconomic fluctuations, which is mostly limited to industrial countries. Recently, Artis and Okubo (2011) provides evidence that trade openness explains synchronicity of business cycles.

4. CONCLUSION

This paper has investigated the commonality in the business cycles of a panel of countries that are classified according to their relative degree of economic development. There are five groups: high-income OECD, high-income non-OECD, upper middle income, lower middle income and low income. The methodology proposed by Mink et al. (2007) was used to determine whether (i) each group of countries follows the same business cycle and (ii) whether these cycles are independent of each other. We have also investigated whether there is a common determinant of the world business cycle.

Our findings show that countries of the same degree of economic development tend to move according to the same wavelength. We then tackled the next question as to whether there is a common unobserved component at the world level that governs the path of output *per capita* for each group of countries. The results show that a world recession or expansion has similar effects on both developed and developing economies. Overall, our research suggests that the disparity in the levels of economic development across countries is irrelevant for business cycles synchronisation.

Although this paper contains a clear contribution to the existing literature, it is imperative to interpret the results carefully within contexts. The paper is not intended to justify monetary union at the world level nor is it an argument in favour of a world currency. It can only contribute to the ongoing debate on these subjects. The message of this paper is that neither trade openness nor shocks to consumption seem to underlie international business cycle synchronisation, but rather shocks to oil prices.

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