

# Business Cycles around the Globe: A Regime Switching Approach

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# Introduction

- How do business cycles in developing and emerging market economies differ from those industrialized countries?
- Benczur and Ratfai (2009) use the “Real Business Cycle” approach to examine the business cycle characteristics of 62 countries.



# Introduction

- We examine 22 countries as a way of uncovering the sources of business cycle fluctuations.
- We consider a representative set of developed and emerging market economies.
- We employ a simple nonlinear regime switching approach to describe stylized facts of business cycles in these countries.

# Introduction

- Dating of business cycles:
  - Artis, Marcellino, and Proietti (2003) discuss parametric and nonparametric approaches to dating euro area business cycles.
  - Dynamic factor model introduced by Sargent and Sims (1977)
  - Altug (1989) estimates a version of the Kydland-Prescott model using maximum likelihood by treating the economy-wide technology shock as an unobserved factor
  - Markov processes to describe the underlying state of the economy. [Neftçi (1982) and Hamilton (1989)]
  - Non-parametric Bry-Boschan method [Rand and Tarp (2002)]



# Introduction

- Harding and Pagan (2002a, 2002b, 2005): A business cycle is defined as a pattern in the level of aggregate activity.
- This contrasts with much recent work which identifies business cycles in terms of the cyclical time series behavior of the main macroeconomic variables and their co-movement with cyclical output.

# A Markov regime switching model

- Suppose  $n_t$  depends on an unobserved Markov state variable denoted  $s_t$   $n_t = \alpha_1 s_t + \alpha_0 + n_{t-1}$
- $y_t^* = n_t + z_t^*$  where  $z_t^*$  follows an ARIMA( $r, 1, 0$ ) process.
- Differencing yields:  
$$y_t = \alpha_0 + \alpha_1 s_t + z_t = \mu(s_t) + z_t$$
where  $y_t = y_t^* - y_{t-1}^*$  and  $z_t$  is a stationary AR( $p$ ) process in (log) differences.

# A Markov regime switching model

- Assuming  $A(L) z_t = \varepsilon_t$  where  $\{\varepsilon_t\}$  is an i.i.d.  $N(0, \sigma^2)$  process, and applying  $A(L)$  to both sides of the above equation yields

$$y_t - \mu(s_t) = \sum_{j=1}^p a_j (y_{t-j} - \mu(s_{t-j} - \mu(s_{t-j}))) + \varepsilon_t$$

- In this case the unobserved state is defined as  $s_t = 1, 2$ , where  $s_t = 1$  denotes a “contraction” and “ $s_t = 2$ ” an “expansion”

# A Markov regime switching model

- More generally, suppose  $s_t = 1, \dots, m$ . For example, there might exist situations where a third regime is appropriate.
- In this case we may have “low growth”, “normal growth” and “high growth” states.

$$y_t = v(s_t) + \phi(s_t)\delta(t) + \sum_{j=1}^p a_j(s_{t-j})y_{t-j} + \sigma(s_t)\varepsilon_t,$$

where  $\{\varepsilon_t\}_{t=0}^{\infty}$  is an i.i.d. process such that  $\varepsilon_t | s_t \sim N(0, \sigma(s_t)^2)$ .



# Data

Country	Data Source	Sample Period	Country	Data Source	Sample Period
Australia	OECD	1960:1-2009:2	Brazil	CB	1991:1-2009:1
Canada	OECD	1961:1-2009:2	Chile	IFS	1980:1-2009:2
France	OECD	1970:1-2009:2	Hong Kong	SO	1973:1-2009:1
Germany	OECD	1960:1-1991:3,1991:1-2009:2	Malaysia	IFS	1991:1-2009:2
Italy	OECD	1960:1-1991:3,1981:1-2009:2	Mexico	OECD	1980:1-2009:2
Japan	OECD	1970:1-2009:2	S. Korea	OECD	1975:2-2009:2
Netherlands	OECD	1960:1-1991:3,1988:1-2009:2	Singapore	IFS	1983:3-2009:2
Spain	OECD	1960:1-1991:3,1980:1-2009:2	S. Africa	CB	1970:1-2009:2
U.K.	OECD	1960:1-2009:1	Taiwan	SO	1981:2-2009:1
U.S.	OECD	1960:1-2009:2	Turkey	CB	1987:1-2009:2
Argentina	SO	1980:1-2009:2	Uruguay	CB	1987:1-2008:4

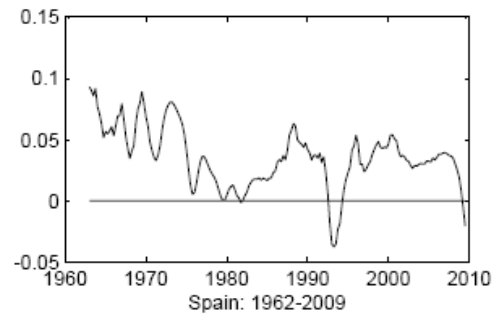
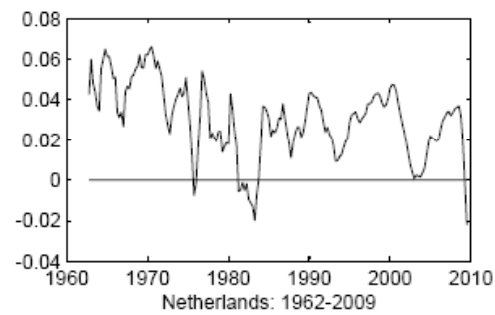
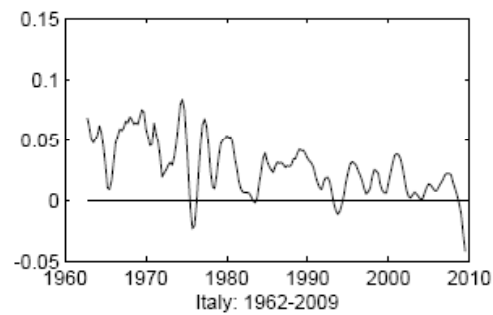
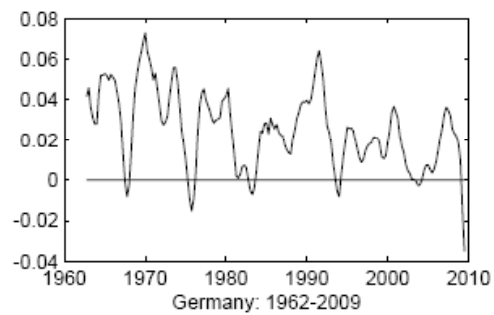
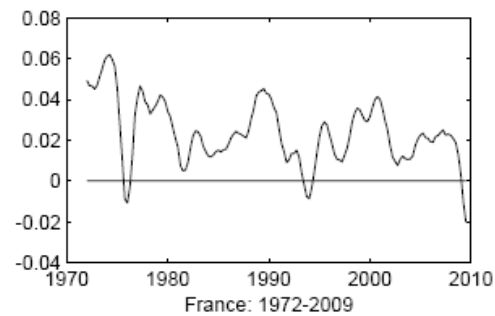
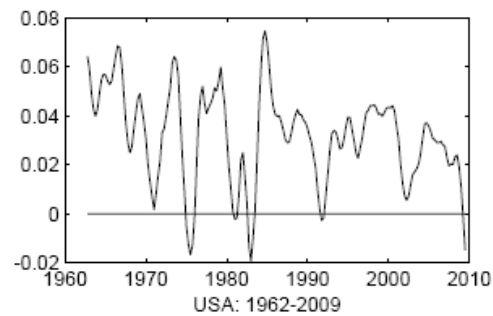
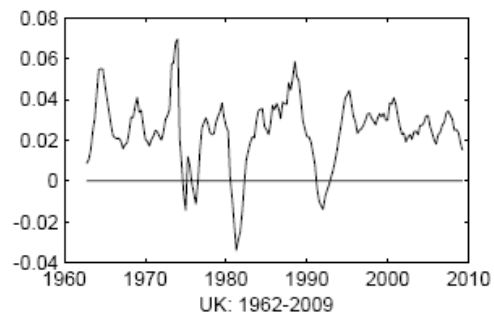
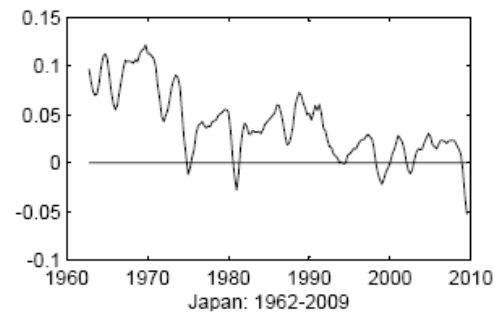
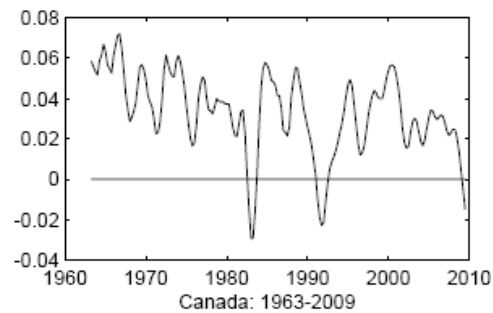
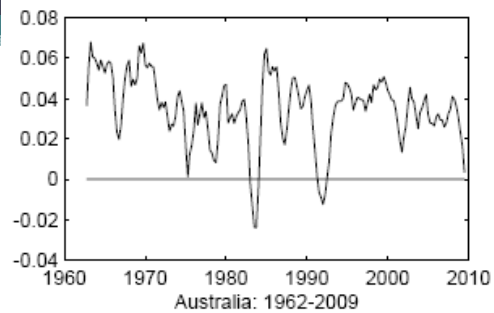
CB: Central Bank; SO: Statistical Offices

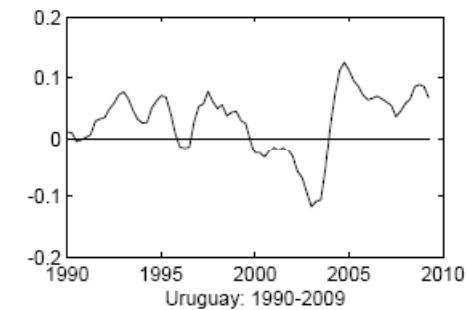
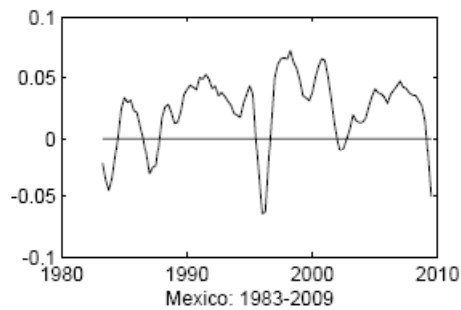
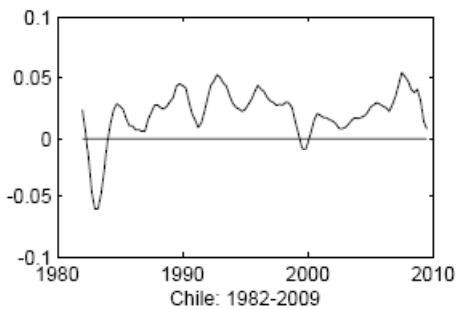
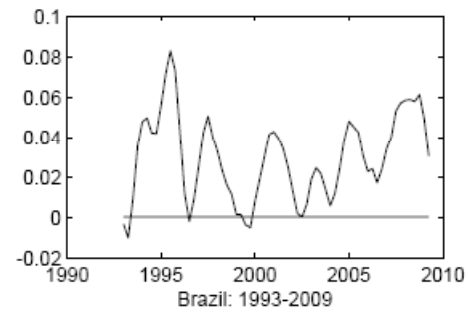
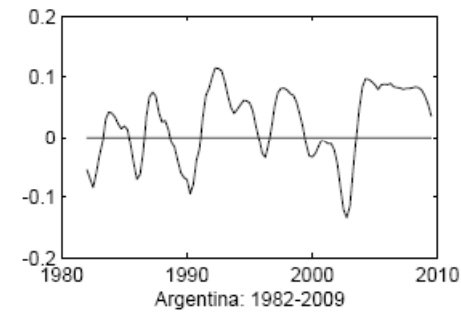
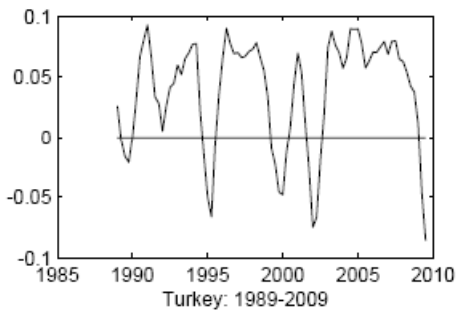
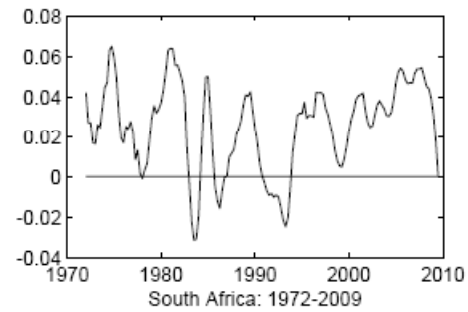
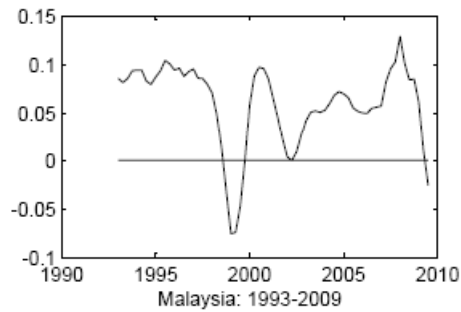
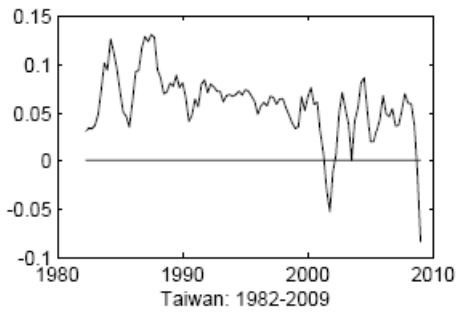
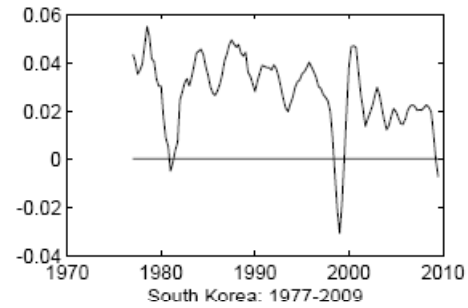
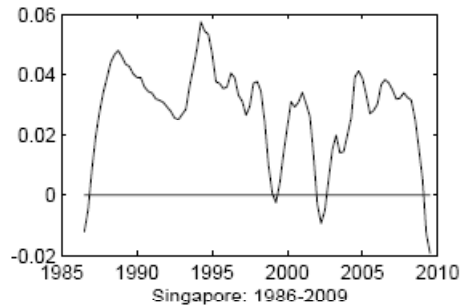
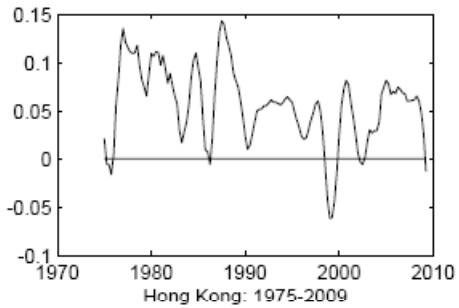
Base years: OECD 2000, IFS 2005, Argentina 1993, Brazil 2007, Hong Kong 2007, S. Africa 2005, Taiwan 2001, Turkey 1998, Uruguay 1983

Table 1: Sample of Countries

# Data

- Let  $y_{i,t} = \ln(Y_{i,t})$  where  $(Y_{i,t})$  denotes the real GDP of country  $i$  in quarter  $t$ .
- Quarterly GDP at constant prices measured in units of national currency
- We take the annual quarter-to-quarter growth rate of GDP for country  $i$  as  $\Delta y_{i,t} = \ln(Y_{i,t}) - \ln(Y_{i,t-4})$ .
- For seasonally unadjusted data, this transformation tends to eliminate any seasonal effects that might exist at the quarterly frequency.
- Following Stock and Watson (2005) we smoothed out high frequency movements in the different series by taking four-quarter averages of the annual quarter-to-quarter growth rates.







# Results

- The business cycle characteristics of the developed countries are similar in terms of the expected growth rates of real output in the different phases and the durations of the phases.
- Excluding Spain, recessions are milder in the EU
- Business cycle in Europe tends to lag the business cycle in the U.S.



# Results

- Emerging economies are different from the developed countries.
- Köse, Otrok and Prasad (2008) find that during the period of globalization (1985-2005):
  - Business cycle convergence within industrialized economies,
  - Business cycle convergence within emerging market economies,
  - Divergence between them



# Results

- Our findings show that:
  - the business cycle characteristics of different groups of emerging economies quite distinct from each other
  - even among well defined country groupings, individual countries appear to display highly heterogeneous responses to similar international and regional conditions



# Anglophone countries plus Japan

- 3-regime models fit best for Australia, Canada and Japan whereas 2-regime models are adequate to describe the business dynamics of (de-trended) output growth for the UK and the US.
- The magnitude of change in expected growth during a recessions varies across the different countries.
  - Australia and Canada display negative expected growth during a recession but this is only significant for Canada.
  - Japan tends to grow less during recessions.
- With the exception of the UK, de-trended expected growth rates of output during expansions tend to be similar.





# Anglophone countries plus Japan

- The model is successful in identifying the major recessions of 1973-1975, 1980-1982, 1990, 2001 as well as 2008.
- Nevertheless some heterogeneity in the experiences of the different countries.
  - The 1990 recession is observed to be more severe for Canada than the remaining countries.
  - The 2001 recession registers formally for the US and Japan but not for Australia, Canada or the UK.
- The duration of recessions for Australia and the US are around 3 quarters . Longer recessions for Canada, Japan and the UK. Severe and lengthy recession for Canada in 1990. A long period of low growth and stagnation for Japan in the 1990's.

# The EU countries

- The existence of a European business cycle has been an important topic in the recent business cycle literature (Artis and Zhang, 1997 or Artis, Kontolemis, and Osborn, 1997).
  - Canova, Ciccarelli, and Ortega (2007) use a panel VAR setting with a time-varying index structure on the underlying VAR coefficients to uncover the factors underlying cyclical fluctuations in the G-7 countries.
  - In contrast to other work, they find no evidence for the independent effect of a European cycle driving the behavior of a key set of aggregate variables for France, Germany and Italy



# The EU countries

- Contractions tend to be milder in the EU countries.
- Unlike Krolzig and Toro (2005), we cannot find any significant differences in the duration of recessions.
- The worldwide recessions associated with the oil shocks of 1973-1975 and 1980-1982 and the 1982 recession register for the EU countries as does the effects of the financial crisis of 2007-2008.
- Three recessions identified by CEPR Business Cycle Dating Committee: 1974:3-1975:1, 1980:1-1982:3, and 1992:1-1993:3.
- These recessions are captured, on the whole, by our chronology.



# The EU countries

- The countries are not uniform in their response to such events as oil shocks.
- France experiences a double-dipped recession during the 1980-1982 period as in the US.
- Recessions in Italy and the Netherlands are spread out over the entire 1980-1983 or 1984 period.
- Unlike ECRI, we do not identify a recession for Spain in the early 1980's.
- The main recession in the 1990' for the EU countries is the one associated with the ERM crisis of 1992.



## The developed East Asian countries and other emerging economies

- Unlike Girardin (2005) we find that 2-regime models are adequate to describe the business cycle dynamics of de-trended real output growth for S.Korea and Taiwan.
- All East Asian countries except Singapore display positive growth in the “low” growth state as noted by Girardin (2005).
- Average expected growth across the four developed East Asian countries is 3.56 percent in the low growth regime, and 8.46 percent in the normal growth regime.



## The developed East Asian countries and other emerging economies

- The average duration of recessions is 3.74 quarters, which is significantly shorter than that for the developed economies.
- The average duration of the “normal” growth regime is around eighteen quarters.
- The East Asian economies display episodes of “high” growth averaging six and a half quarters.
- The 1997 East Asian crisis registers as a recession for all four developed E. Asian countries.
- Hong Kong, Singapore, and Taiwan also exhibit recessions during 2000-2001.



# The developed East Asian countries and other emerging economies

- We can select 2-regime model for Turkey, Malaysia and S.Africa.
- This is in line with evidence obtained by Girardin (2005) for Malaysia, by Moolman (2004) for South Africa, and by Taştan and Yıldırım (2008) for Turkey.
- Output losses during recessions for Malaysia and Turkey, and strong output growth during expansions for Malaysia.
- Duration of regimes tend to be similar. But:
  - Turkey experiences short-lived recessions amid short-lived expansions.
  - Longer recessions for Malaysia and S. Africa.



# The Latin American Countries


- 3- regime models can be selected for Chile, and Uruguay.
- 2-regime models are appropriate for Argentina, Brazil and Mexico.
- The expected growth rates of output in the bad regime are estimated to be significantly negative for all of Latin American countries.
- Recessions are associated with output declines ranging from around two percent for Mexico to close to seven percent for Argentina
- The duration of recessions averages nearly eight quarters.





# The Latin American Countries

- The duration of expansions averages only eleven quarters.
- Chile and Uruguay tend to display short episodes of “high” growth.
- Regional crises and idiosyncratic experiences:
  - 1980’s debt crisis
  - 1994-1995 Tequila crisis
  - 1998-2002: Argentina’s sovereign debt default
  - 1999:collapse of the Real Plan
  - 2000-2003: recessions in Brazil and Chile



## A comparison with the Harding-Pagan Approach

- Harding and Pagan (2002a,b) have advocated an alternative approach to characterizing business cycles that has closer parallels with the Burns-Mitchell methodology.
- They argue that the approach based on the Markov switching model may produce different business cycle characteristics relative to linear models depending on the assumed features such as conditional heteroskedasticity, persistence and non-normality of the process.
- Harding and Pagan (2002b) proposed a modification to the Bry-Boschan algorithm. (BBQ algorithm)



## BBQ algorithm

- The results obtained using the BBQ method are broadly consistent with the results reported in table 2-5.
- The BBQ dating underestimates the duration of recessions for Japan because it underestimates the recession that occurred in the early 2000's.
- Our estimate of average duration of expansions is 19 quarters versus 30 quarters according to the BBQ algorithm



## BBQ algorithm

- According to BBQ algorithm, the percentage decline in output during recessions ranges between 1% for the US to close to 3% for Canada.
- The BBQ algorithm predicts shorter recessions and somewhat longer expansions than the MS-AR approach for EU countries.
- Both approaches tend to agree on the point that recessions tend to be milder in the euro area countries.
- The results for the emerging economies are also similar.



# Business cycle dating

- Harding and Pagan (2002a,b, 2005) have argued that the Markov switching model is best viewed as a model that allowed for a simple way of introducing some nonlinearity.
- Artis, Krolzig, and Toro (2004) and Krolzig and Toro (2005) have argued that the Markov switching model is capable of identifying business cycle turning points.
- We examine the business cycle dating properties based on both approaches and also provide a further characterization of business cycles for developed and emerging market economies.

	NBER	CEPR	ECRI	US†	ECRI	Australia	ECRI	Canada
	69:4-70:4 73:4-75:1 80:1-80:3 81:3-82:4 90:3-91:1 01:1-01:4 08:1-09:1	74:3-75:1 80:1-82:3 92:1-1993:3	69:4-70:4 73:4-75:1 80:1-80:3 81:3-82:4 90:3-91:1 01:1-01:4 07:4-	69:2-70:4 74:1-75:2 79:2-80:4 81:4-82:3 90:3-91:2 01:2-02:1 08:3-09:1	74:2-75:1	74:3-74:4 82:2-83:3 90:3-91:4 08:4-09:2	81:2-82:4 90:1-92:1 08:1-	82:1-82:4 90:3-93:1 08:2-09:1
Coin±1				8/13 = 62%		6/6 = 100%		3/5=60%
Coin±2				11/13 = 85%		6/6 = 100%		4/5 = 80%
	ECRI	Japan	ECRI	UK	ECRI	France†	ECRI	Germany
	73:4-75:1 92:2-94:1 97:1-99:3 00:3-03:2 08:2-	73:4-75:2 80:1-82:1 90:4-92:1 97:4-99:4 01:1-03:3 08:4-09:2	74:3-75:2 79:3-81:2 90:2-92:1 90:2-92:4 08:2-	73:4-74:1 75:1-75:4 80:2-82:3	74:3-75:2 79:3-80:2 82:2-84:4 92:1-93:3 02:3-03:2 08:1-	74:2-75:1 79:4-80:4 82:2-84:2 92:2-93:4 02:2-03:4 08:1-09:2	66:1-67:2 73:3-75:3 80:1-82:4 91:1-94:2 01:1-03:3 08:4-	67:1-68:2 72:4-75:4 82:1-82:3 92:4-93:1 08:4-09:1
Coin±1		4/9 = 44%		1/6 = 17%		8/11 = 73%		3/11=27%
Coin±2		5/9 = 56%		3/6 = 50%		11/11 = 100%		3/11 = 27%
	ECRI	Italy	Netherlands†	ECRI	Spain	Hong Kong	Malaysia	Singapore
	64:1-65:1 70:4-71:3 74:2-75:2 80:2-83:2 92:1-93:4 07:3-	64:2-65:2 70:4-71:4 73:4-74:2 77:3-77:4 80:4-81:1 92:2-92:3 93:4-94:1	66:1-66:1 74:4-75:3 76:4-77:3 80:2-81:1 82:1-83:1 84:2-85:1	80:1-84:2 91:3-93:4	92:1-94:1	77:1-77:1 82:1-83:1 84:4-86:1 89:3-90:1 97:4-99:1 03:2-03:3	97:2-98:4 00:4-01:4 08:4-09:2	85:3-86:2 98:2-99:1 01:3-02:1 08:2-09:2
Coin±1		6/11 = 54%			2/5 = 40%			
Coin±2		7/11 = 64%			3/5 = 60%			
	ECRI	S. Korea	ECRI	S. Africa	ECRI	Taiwan	Turkey	
	79:1-80:4 97:3-98:3 02:4-03:3 08:3-	77:4-78:1 79:2-80:4 81:2-81:3 97:2-98:1	76:2-77:4 77:1-81:4 84:2-86:2 89:1-92:3	72:1-72:2 74:4-75:1 76:2-77:1 77:3-77:4 82:1-83:3 84:3-86:4 89:3-93:1	82:1-83:3	00:3-01:3 08:1- 00:1-02:3 07:4-08:2	89:2-89:3 91:1-91:3 94:2-95:1 98:4-99:4 01:1-02:1 08:4-09:2	
Coin±1		4/7=57%		5/11 = 45%		1/3 = 33%		
Coin±2		5/7 = 71%		10/11 = 91%		2/3 = 66%		
	Argentina	ECRI	Brazil	Chile	ECRI	Mexico	Uruguay	
	82:4-83:2 84:4-86:3 87:3-90:1 90:4-92:3 95:1-96:1 98:3-02:4 08:3-09:2	95:1-95:3 97:4-99:2 01:1-01:4 02:4-03:2 08:3-09:1	95:4-96:2 97:3-99:3 01:2-02:3 03:2-03:4 05:3-06:2 08:4-09:2	81:4-83:1 98:3-99:4 08:3-09:2	82:1-83:3 85:4-86:4 92:4-93:4 94:4-95:3 98:1-98:4 00:3-03:3 08:2-	82:3-86:4 94:3-95:3 00:4-03:1 08:2-09:2	94:4-95:2 98:4-02:4 09:1-09:2	
Coin±1			4/10 = 40%			5/13 = 38%		
Coin±2			6/10 = 60%			7/13 = 54%		

Coin±k denotes the fraction of times the estimated business cycle dates are ±k quarters away from the ECRI dates.

Single quarter recessions: US 72:1-72:1, 77:1-77:1; France 91:1-91:1; Netherlands 63:3-63:3, 66:1-66:1, 79:1-79:1, 03:1-03:1.

Table 7: Business Cycle Dating



# A world business cycle?

- Köse, Otrok, and Whiteman (2003) use an unobservable index or dynamic factor model to identify a world factor as well as regional and country-specific factors.
- Canova, Ciccarelli, and Ortega (2009) examine a sample of 10 European countries to investigate the sources of changing business cycle characteristics using a panel VAR that incorporates an index or factor structure on the underlying time-varying VAR coefficients.



# A world business cycle?

- Lumsdaine and Prasad (2003) consider 17 OECD countries including the US, Japan, Canada and a group of EU countries. They construct a measure of common component of international business cycles by weighting output growth in each country using estimates time-varying conditional volatility obtained from univariate models.
- We examine the correlation of the recession probabilities for countries which have the relevant data.



Contemporaneous Correlations of the Recession Probabilities for Developed Countries, 1970-2009										
	Australia	Canada	Japan	UK	US	France	Germany	Italy	Nether.	Spain
Australia	1.0000									
Canada	0.2114	1.0000								
Japan	-0.0880	0.0326	1.0000							
UK	-0.2687	0.0028	0.3442	1.0000						
US	-0.3917	0.4115	0.4809	0.4191	1.0000					
France	-0.2523	0.1721	0.4207	0.4036	0.4799	1.0000				
Germany	-0.2533	0.1833	0.3300	0.2763	0.4975	0.4178	1.0000			
Italy	-0.1637	0.0324	0.2373	0.5058	0.3841	0.5810	0.4903	1.0000		
Nether.	-0.3047	-0.0150	0.2463	0.4045	0.3320	0.4106	0.3136	0.3199	1.0000	
Spain	0.0094	0.0569	-0.0733	0.4196	0.4028	0.3553	0.2807	0.4788	0.532171	1.0000
Contemporaneous Correlations of the Recession Probabilities for Emerging Economies and the U.S., 1990-2009										
	Hong Kong	Singapore	S. Korea	Taiwan	Malaysia	S. Africa	Turkey	Argentina	Brazil	Chile
Hong Kong	1.0000									
Singapore	0.5065	1.0000								
S. Korea	0.4598	0.4574	1.0000							
Taiwan	-0.2418	0.1471	-0.1779	1.0000						
Malaysia	0.3049	0.5670	0.4506	0.5495	1.0000					
S. Africa	0.6736	0.5878	0.3565	-0.2193	0.3356	1.0000				
Turkey	0.0355	0.4024	-0.1693	0.2077	-0.2160	0.1347	1.0000			
Argentina	0.0883	0.4137	-0.2341	0.4237	-0.3399	0.1368	0.4801	1.0000		
Brazil	0.3996	0.3274	0.1750	-0.0792	-0.1893	0.2025	0.3050	0.3455	1.0000	
Chile	0.0737	0.2602	-0.0718	0.3068	0.5970	0.2568	-0.0328	-0.0825	-0.2310	1.0000
Mexico	-0.1064	0.3264	-0.2217	0.4607	-0.1106	0.0454	0.3793	0.5238	0.0512	0.2584
Uruguay	-0.1545	0.0620	-0.2268	0.5239	-0.4305	-0.2361	0.2289	0.7825	0.1877	-0.2405
	Mexico	Uruguay	Correlations with US							
Hong Kong			0.2022							
Singapore			0.4646							
S. Korea			-0.0645							
Taiwan			0.3491							
Malaysia			0.3374							
S. Africa			0.5117							
Turkey			0.1897							
Argentina			0.3796							
Brazil			0.3235							
Chile			0.6385							
Mexico	1.0000		0.4015							
Uruguay	0.4015	1.0000	-0.0732							

Table 8: Contemporaneous Correlations of the Recession Probabilities



# Conclusion

- Significant differences in the business cycle behavior for individual countries.
- Characteristics of the developed countries differ from developing ones.
- They also tend to exhibit quite disparate behavior relative to each other.

# Conclusion

- Our analysis shows the importance of large global shocks in inducing major recessions- the oil shocks of the 1970's and 1980's as well as the financial shock of 2008.
- We documented many more individualized crises.
- In contrast to much earlier work where oil shocks were the focus of business cycle studies, our analysis has revealed that financial disturbances and the contagious effects of different types of crises are more important in the period following the 1980's and especially since 1990's.
- Even in short samples, the Markov switching model is capable of differentiating among heterogeneous business cycle experiences of developed and developing economies rather accurately.