How do Business Cycles Become Global? Common Shocks or Spillovers?

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Global Business Cycles

- Many papers have shown a substantial amount of comovement in macro variables across countries (Kose, Otrok, Whiteman 2003)
  - We also can decompose this comovement into global, regional or country or even sectoral factors
- Less is known about **why** countries comove
  - Are there cross-country spillovers of country specific shocks?
  - Or, are countries subject to common shocks?
- This paper decomposes business cycle comovement into part due to common shocks, and part due to country shocks that spillover

Whats new here?

- Other studies have attempted to measure the importance of spillovers
- VAR: Shock country output, and see how shock transmits to other countries
- We develop a framework that first isolates the country specific shock and then allows that shock to spillover to other countries
  - US output is driven by both Global shocks and country-specific shocks
  - A shock to US output combines both the global and country shocks
  - We define a spillover as the US specific shock affecting other countries

Multiple Channels for Potential Spillovers

- We model propagation of country-specific shocks through different channels
- Direct versus indirect spillovers
  - US $\Rightarrow$ *Canada*
  - US $\Rightarrow$ *World* $\Rightarrow$ *Canada*
- Our model is general enough that we can allow for many types of channels
  - US $\Rightarrow$ *UK* $\Rightarrow$ *Canada*
  - US $\Rightarrow$ *RegionalFactor* $\Rightarrow$ *Canada*

Spillover Literature

- Typical approaches to measuring cross-country spillovers:
  - VAR: trace impact of US output shock on other countries
  - GVAR: trace impact of shock to index of US economic activity on other countries
- Limitations:
  - Does not separate out global and country components
  - Factors are averages of data with assumed weights

What is a Spillover?

- Event A originates in country 1, which then in turns affects country 2
  - Often with a time lag
- A Structual view of global and country shocks
  - Multi-country New Keynesian model of Lubik and Schorfheide (2005)

$$Y_{H,t} = A_{W,t} A_{H,t} N_{H,t}$$

$$Y_{F,t} = A_{W,t} A_{F,t} N_{F,t}$$

- A spillover is a shock to $A_{H,t}$ that transmits to the Foreign country
- $A_{W,t}$ is a common shock
- Movements in $Y_{H,t}$ are driven by both $A_{W,t}$ and $A_{H,t}$
- More generally a country will have many sectors and sources of shocks

Spillover Literature

- Use a parametric dynamic factor model to separate global and country components in country data
- Parametric model allows us to simulatneously measure the spillover
- We then study how country-specific movements are transmitted to other countries
- Benefits
  - Allows us to distinguish between common global shocks and spillovers
  - Identifies the channels of transmission of spillovers

Dynamic Factor Model

- Vector of data (Y_t) linked to vector of unobserved factors (F_t) via factor loadings (B)

$$Y_t = BF_t + \Gamma_t \tag{1}$$

- where Γ_t is a vector of idiosyncratic shocks that follow independent AR(P) processes
- The latent factors evolve as an autoregressive process

$$F_t = \Psi(L)F_{t-1} + V_t \tag{2}$$

- V_t are iid and uncorrelated
- We study output, consumption and invest in the G7 in this paper

Identifying Factors

- Group factors are identified by placing 0 restrictions on the factor loading coefficients
- World factor: all variables have unrestricted coefficients
- Country factor: variables not in country impose 0 factor loading
  - Many factors can be identified this way: regional, sectoral, financial
- Interpretation of country factor
  - Comovement within country **not** accounted for by the world factor
  - Think of the country factor as being estimated on data 'purged' of the world factor
  - In large datasets would want regional factors as well
  - This is the approach in Kose, Otrok and Whiteman (2003)

Identifying Factors

$$Y_t = BF_t + \Gamma_t$$

$$\begin{bmatrix}
b^W_{US,Y} & 0 & 0 & b^{US}_{US,Y} & 0 & 0 & 0 & 0 & \dots & 0 \\
b^W_{US,C} & 0 & 0 & b^{US}_{US,C} & 0 & 0 & 0 & 0 & \dots & 0 \\
b^W_{US,I} & 0 & 0 & b^{US}_{US,I} & 0 & 0 & 0 & 0 & \dots & 0 \\
b^W_{Fr,Y} & 0 & 0 & 0 & 0 & 0 & b^{Fr}_{Fr,Y} & 0 & \dots & 0 \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
b^W_{UK,Y} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \dots & b^{Uk}_{UK,Y} \\
b^W_{UK,C} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \dots & b^{Uk}_{UK,C} \\
b^W_{UK,I} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \dots & b^{Uk}_{UK,I}
\end{bmatrix}
\begin{bmatrix}
F^W_t \\ F^W_{t-1} \\ F^W_{t-2} \\ F^{US}_t \\ F^{US}_{t-1} \\ F^{US}_{t-2} \\ F^{FR}_t \\ \vdots \\ F^{UK}_{t-1} \\ F^{UK}_{t-2}
\end{bmatrix}$$

Identifying Spillovers

- Traditional factor model has $\Psi(L)$ block diagonal

$$F_t = \Psi(L)F_{t-1} + V_t$$

- By allowing off diagonal elements to be non-zero we can allow spillovers across factors
  - We can allow the factor evolution equation for country i to depend on country j
  - We can allow the world factor evolution to depend on country j
- We differentiate between common shocks and spillovers using a timing assumption

Measuring Spillovers

- Country shocks spillover to the world common cycle
  - Country shock has proportional impact on all other countries
  - Scale of response depends on countries factor loading on world
- Country shocks spillover directly to other countries

$$
\begin{bmatrix}
\phi_1^{w,w} & \phi_2^{w,w} & \phi_3^{w,w} & \phi_1^{w,us} & \phi_1^{w,us} & \phi_1^{w,us} & 0 & \dots & \dots & 0 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & \dots & \dots & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & \dots & \dots & 0 \\
0 & 0 & 0 & \phi_1^{us,us} & \phi_2^{us,us} & \phi_3^{us,us} & 0 & \dots & \dots & 0 \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \dots & \vdots \\
0 & 0 & 0 & \phi_1^{ca,us} & \phi_2^{ca,us} & \phi_3^{ca,us} & \dots & \vdots & \vdots & \vdots \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \dots & \vdots \\
0 & 0 & 0 & \phi_1^{uk,us} & \phi_2^{uk,us} & \phi_3^{uk,us} & \dots & \phi_1^{uk,uk} & \phi_2^{uk,uk} & \phi_3^{uk,uk} \\
0 & 0 & 0 & 0 & 0 & 0 & \dots & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & \dots & 0 & 1 & 0
\end{bmatrix}
$$

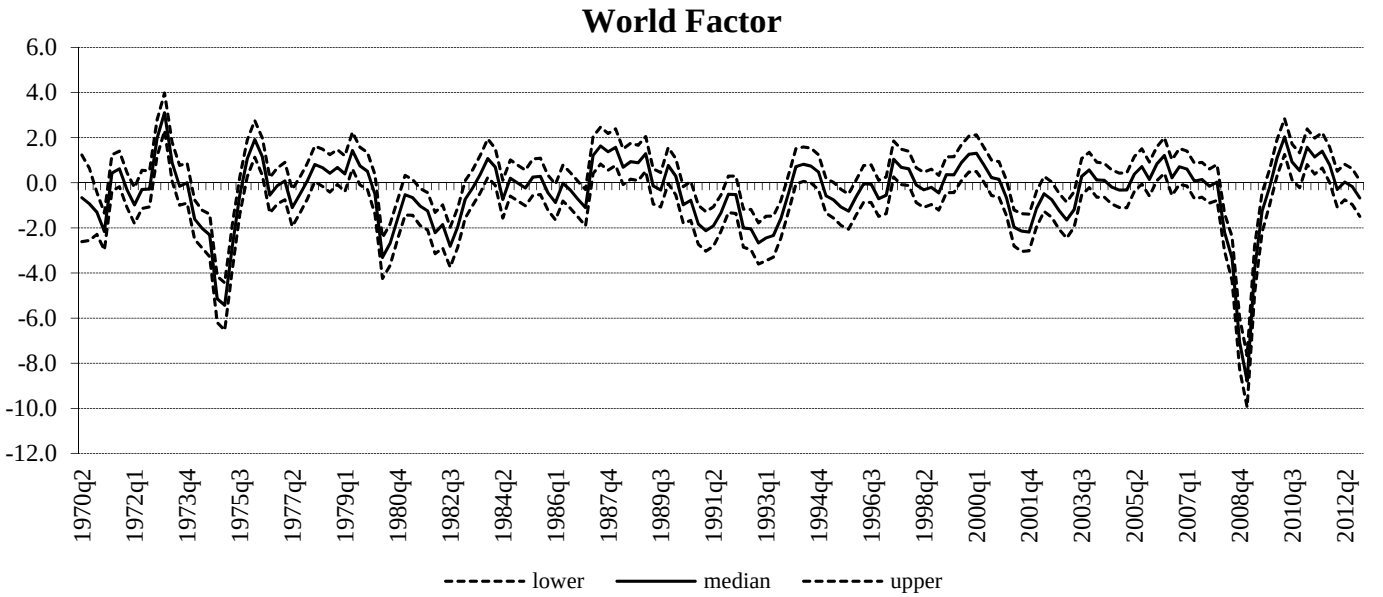
Data

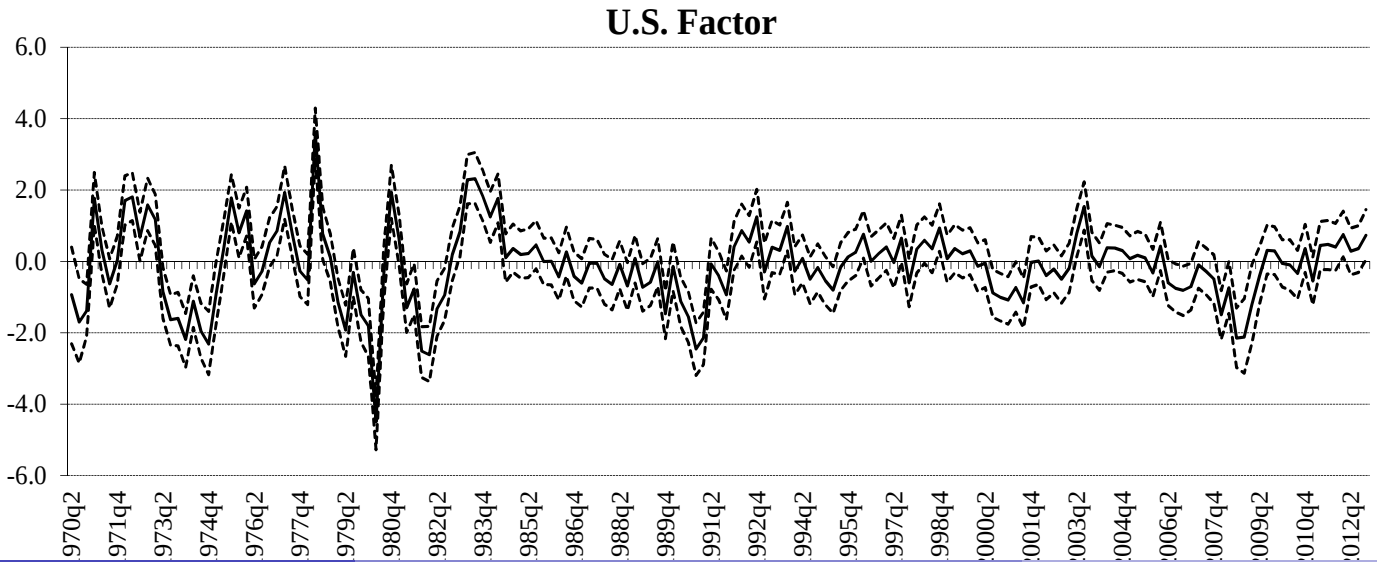
- Real output, consumption and investment growth in G7 countries
- 1970-2012
- Quarterly data

Spillover Model Summary for this application

- US factor spills over to World factor
  - Innovations to US have symmetric impacts on all countries
- US factor spills over directly to other countries
  - Innovations to US have asymmetric impact to each country
- German factor has same spillovers
  - Any country can be a source of spillovers, we focus on those that mattered empirically
- We will first look at total comovement in 3 models
  - No Spillovers, only world channel, both channels for US and GE

US and World Factors

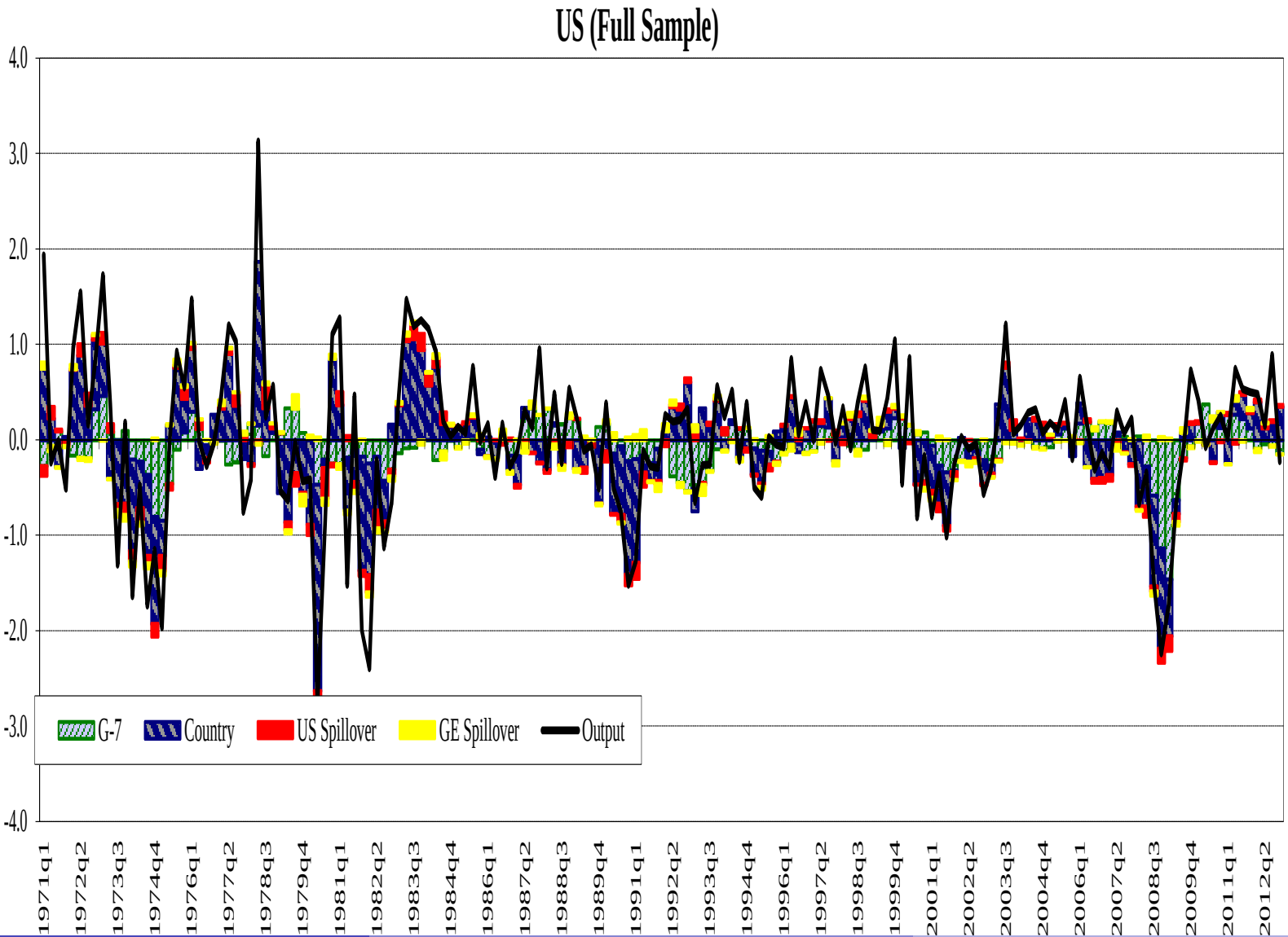




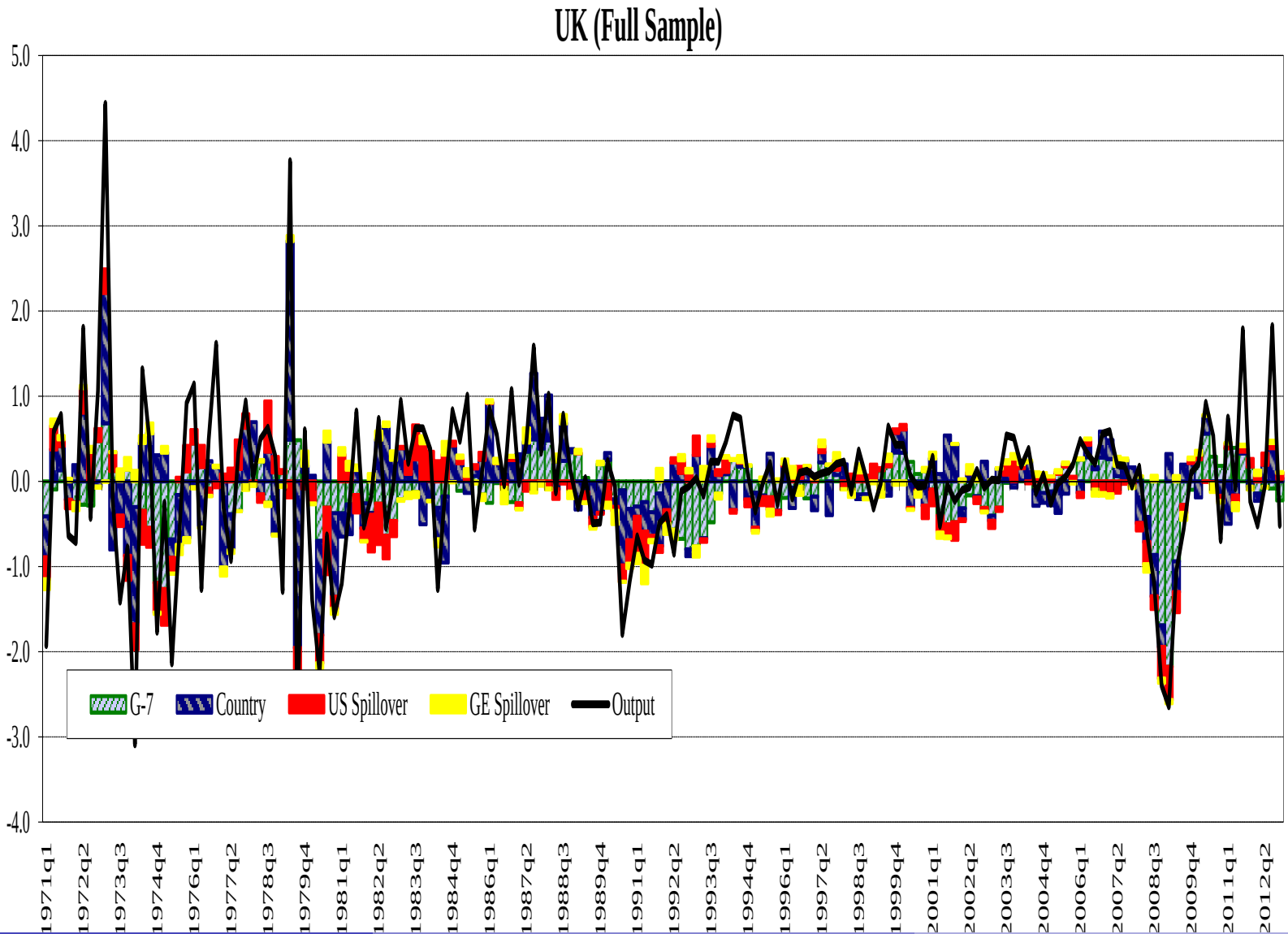
Interpretation of Crisis

- The US factor does not fall much in the recent crisis
  - Did the US exerience a crisis? Yes, but it is largely accounted for by the global factor
  - A factor model estimated on only US data would show a larger drop
  - Not accounting for the world component overstates the country specific decline in the US
    - ★ This will overstate the US role in generating spillovers
- We will see later that the US lead the crisis

US Full Sample Time Series Decomposition



UK Full Sample Time Series Decomposition



Variance Decomposition: Common Shocks Dominate Spillovers

	idio	W	C	US-W	US-C	US-T	Ge-W	Ge-C	Ge-T
US	29.1	12.2	51.5	3.7	0.0	3.7	0.2	1.1	1.5
Ca	29.0	22.7	34.5	7.3	3.2	11.4	0.5	0.5	1.2
Fr	15.9	35.4	32.7	11.6	0.5	12.2	0.7	1.0	2.0
Ge	38.6	30.9	17.7	9.9	0.3	10.4	0.6	0.0	0.6
It	42.7	27.5	17.0	8.9	0.4	9.4	0.6	0.2	0.9
Jp	14.2	12.2	65.6	3.9	1.2	5.5	0.2	1.2	1.6
UK	38.7	18.6	31.8	6.0	1.3	7.7	0.4	1.5	2.1
G7	29.7	22.8	35.8	7.3	1.0	8.6	0.5	0.8	1.4

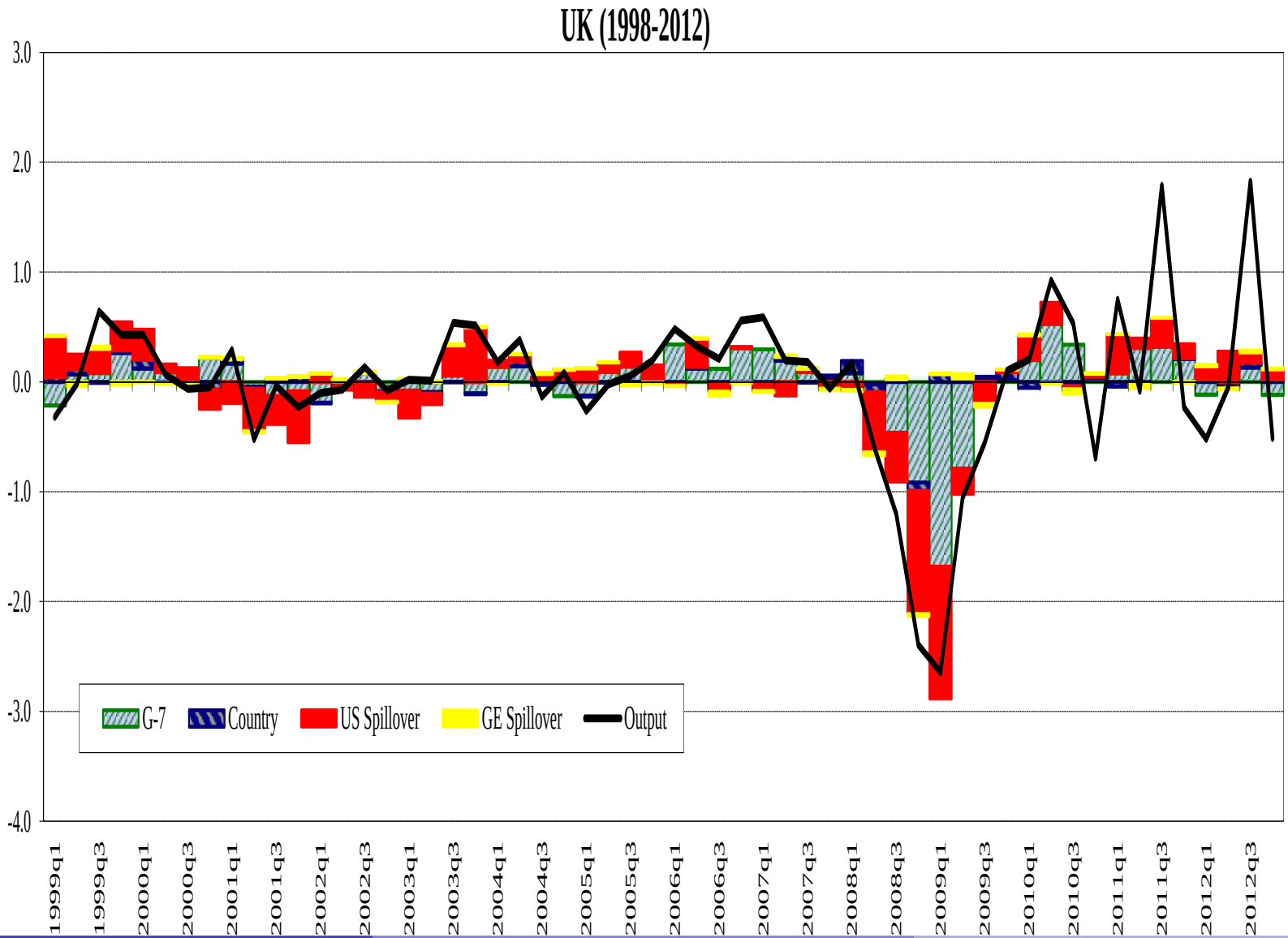
Variance Decomposition: Spillover and No Spillover Models

						No Spillover Model		
	idio	W	C	US-Tot	Ge-Tot	idio	W	C
US	29.1	12.2	51.5	3.7	1.5	28.6	23.0	48.1
Ca	29.0	22.7	34.5	11.4	1.2	28.5	29.5	41.2
Fr	15.9	35.4	32.7	12.2	2.0	17.7	48.2	33.6
Ge	38.6	30.9	17.7	10.4	0.6	40.6	39.1	19.5
It	42.7	27.5	17.0	9.4	0.9	43.9	39.5	15.6
Jp	14.2	12.2	65.6	5.5	1.6	15.2	16.2	68.0
UK	38.7	18.6	31.8	7.7	2.1	41.2	23.6	34.2
G7	29.7	22.8	35.8	8.6	1.4	30.8	31.3	37.2

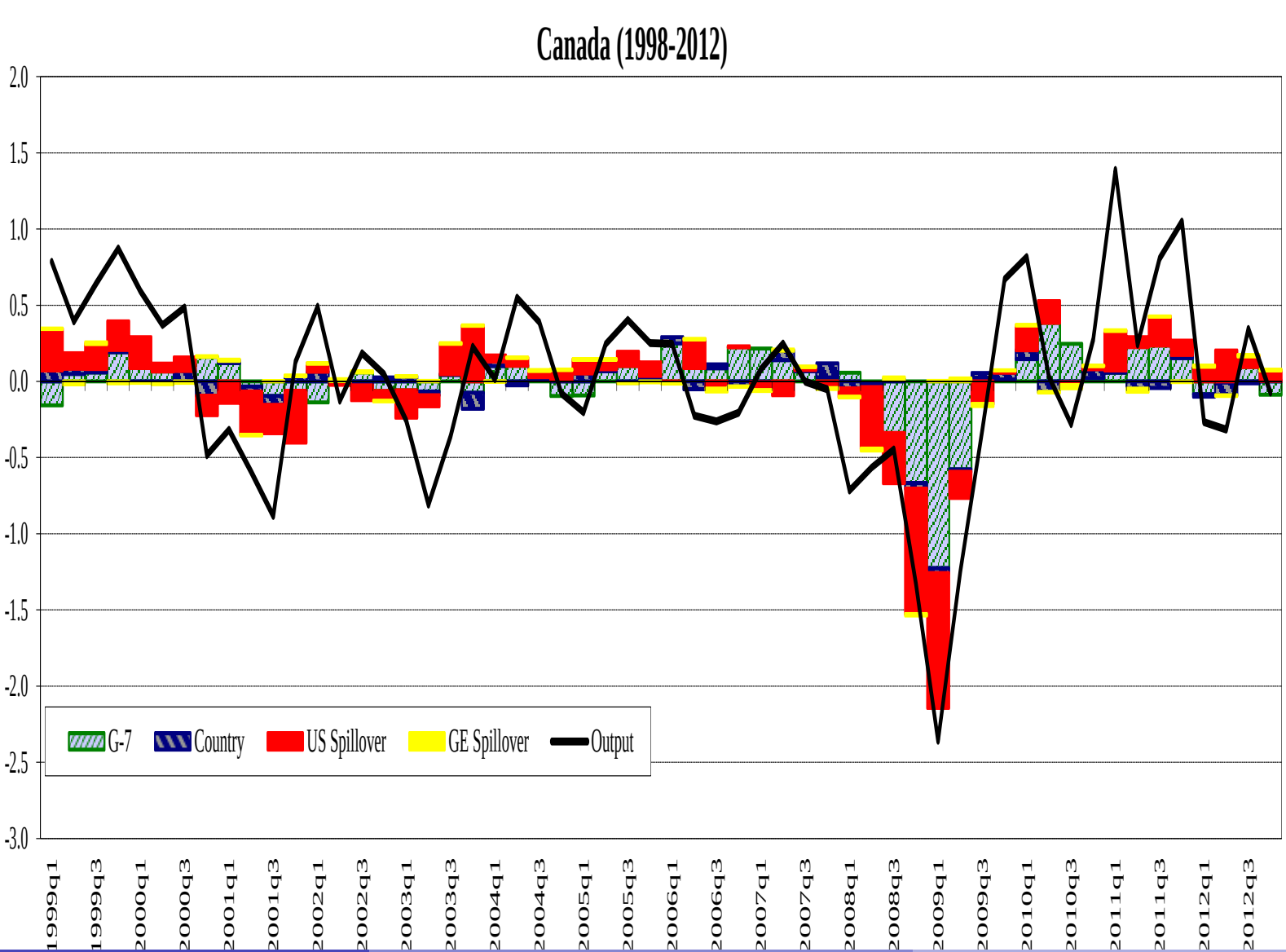
Subsample Analysis

- We have seen that Global comovement is driven by common shocks, not spillovers
- Has the global economy changed, increasing spillovers?
  - Kose, Prasad and Otrok (IER, 2012): movement away from common global shocks towards group specific business cycles
  - Hideaki, Kose and Otrok (2013): Rise of regionalization
    - ★ Rising trade linkages driving comovement post 1985?
  - Great Recession highlighted increased financial linkages
- We estimate the model over 14 year rolling subsamples

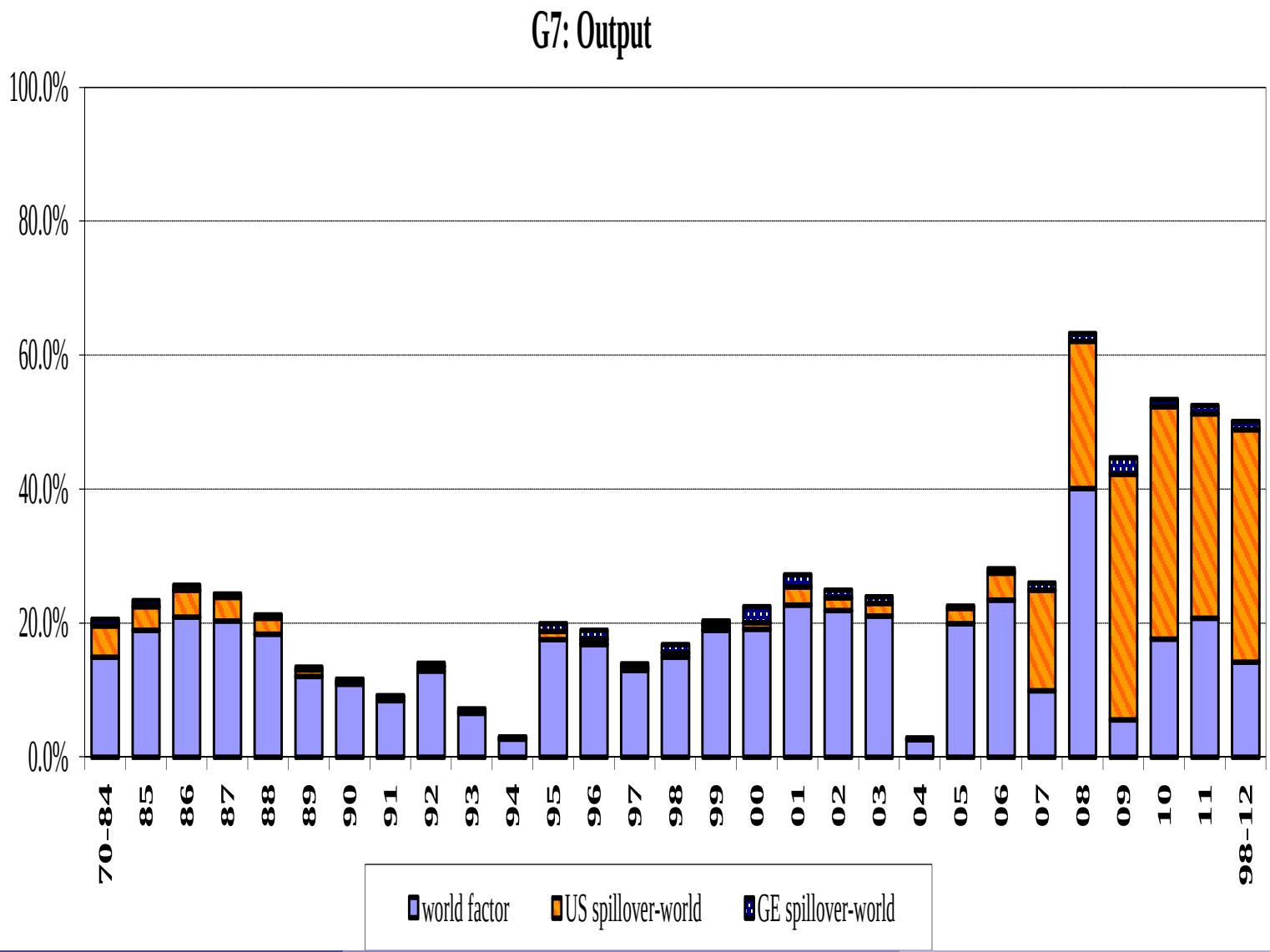
UK Crisis Period Time Series Decomposition



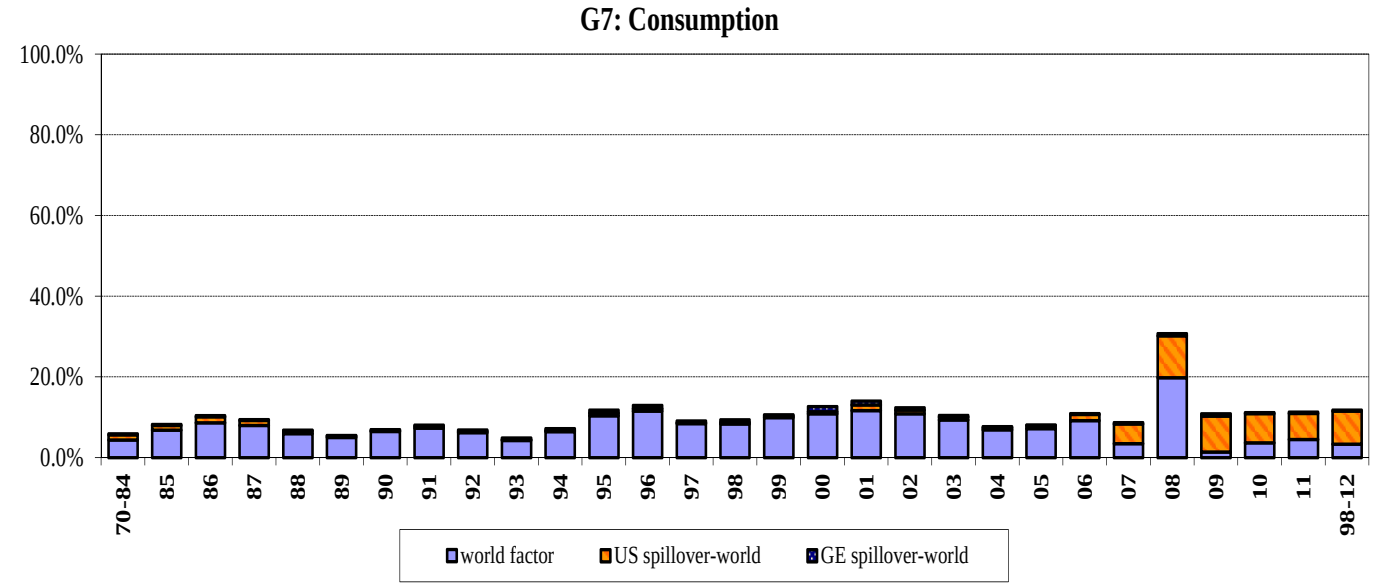
Canada Crisis Period Time Series Decomposition

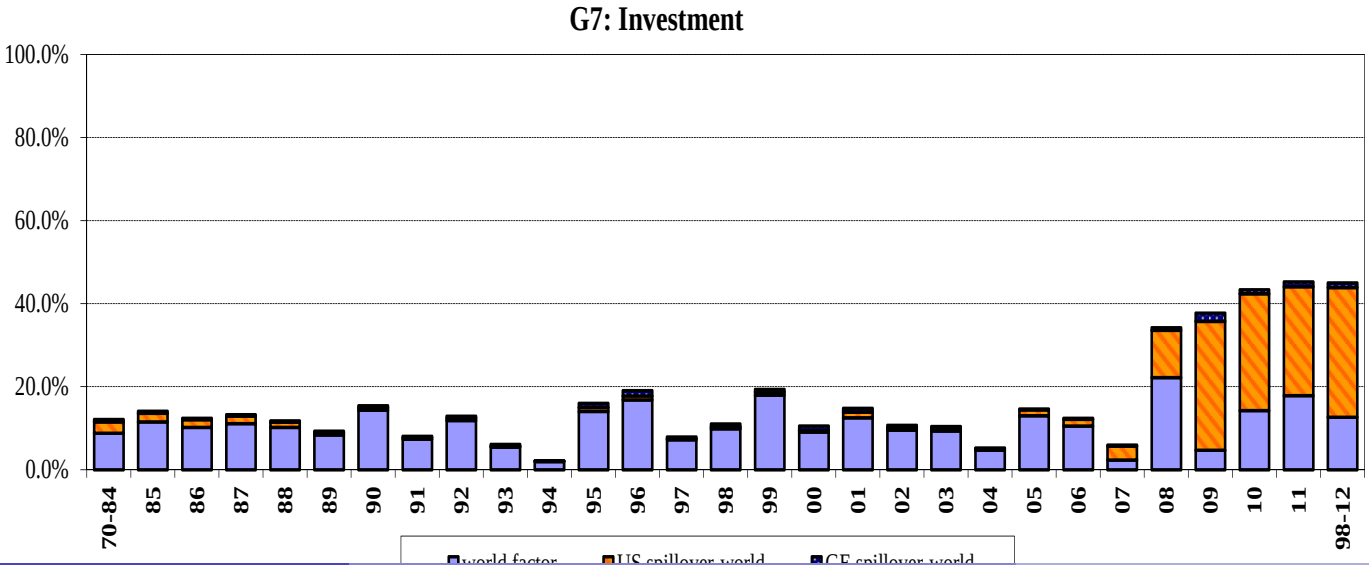


Variance Decomposition: Global Shocks and Country⇒World Spillovers

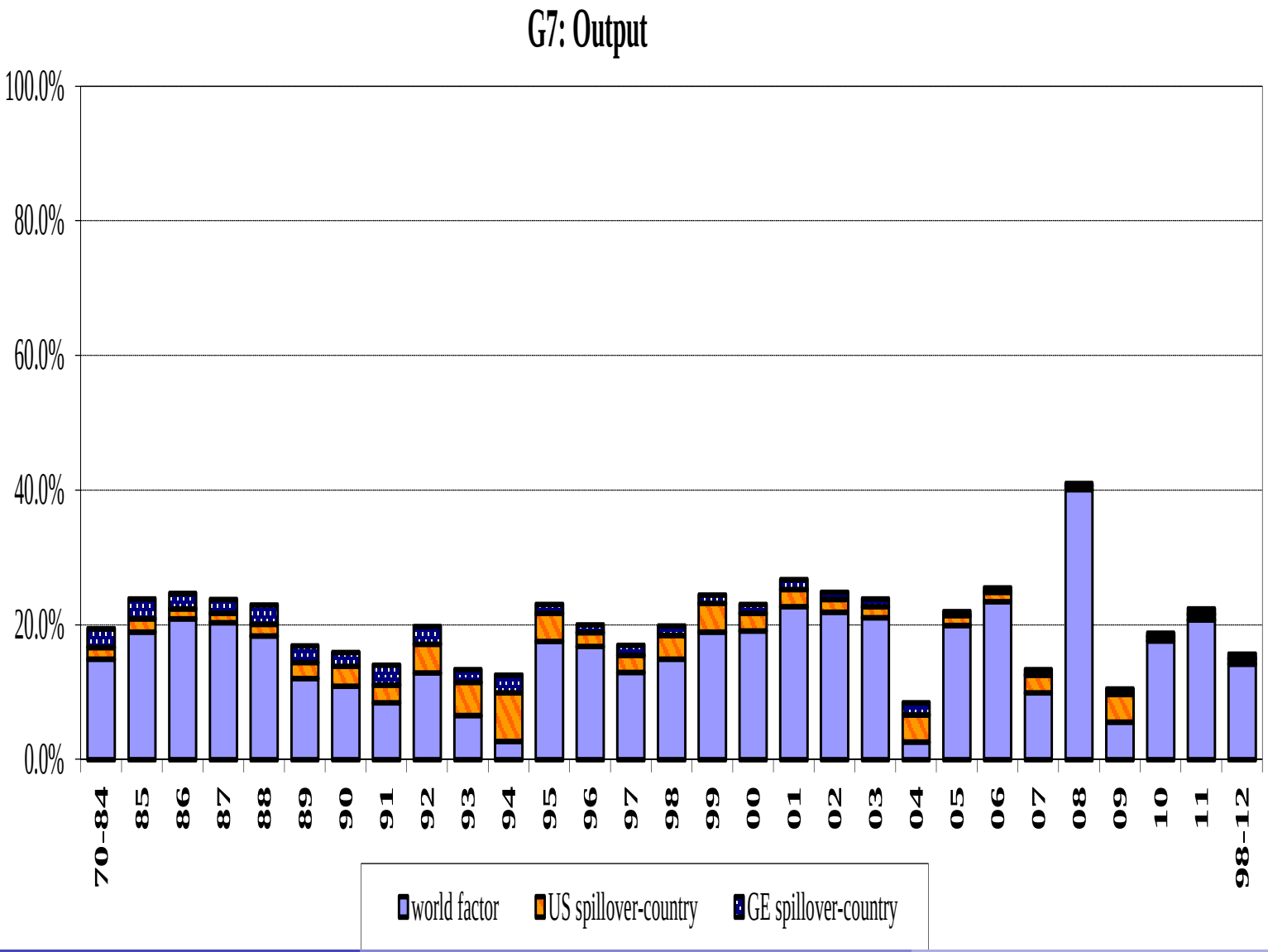


Variance Decomposition: Global Shocks and Country⇒World Spillovers

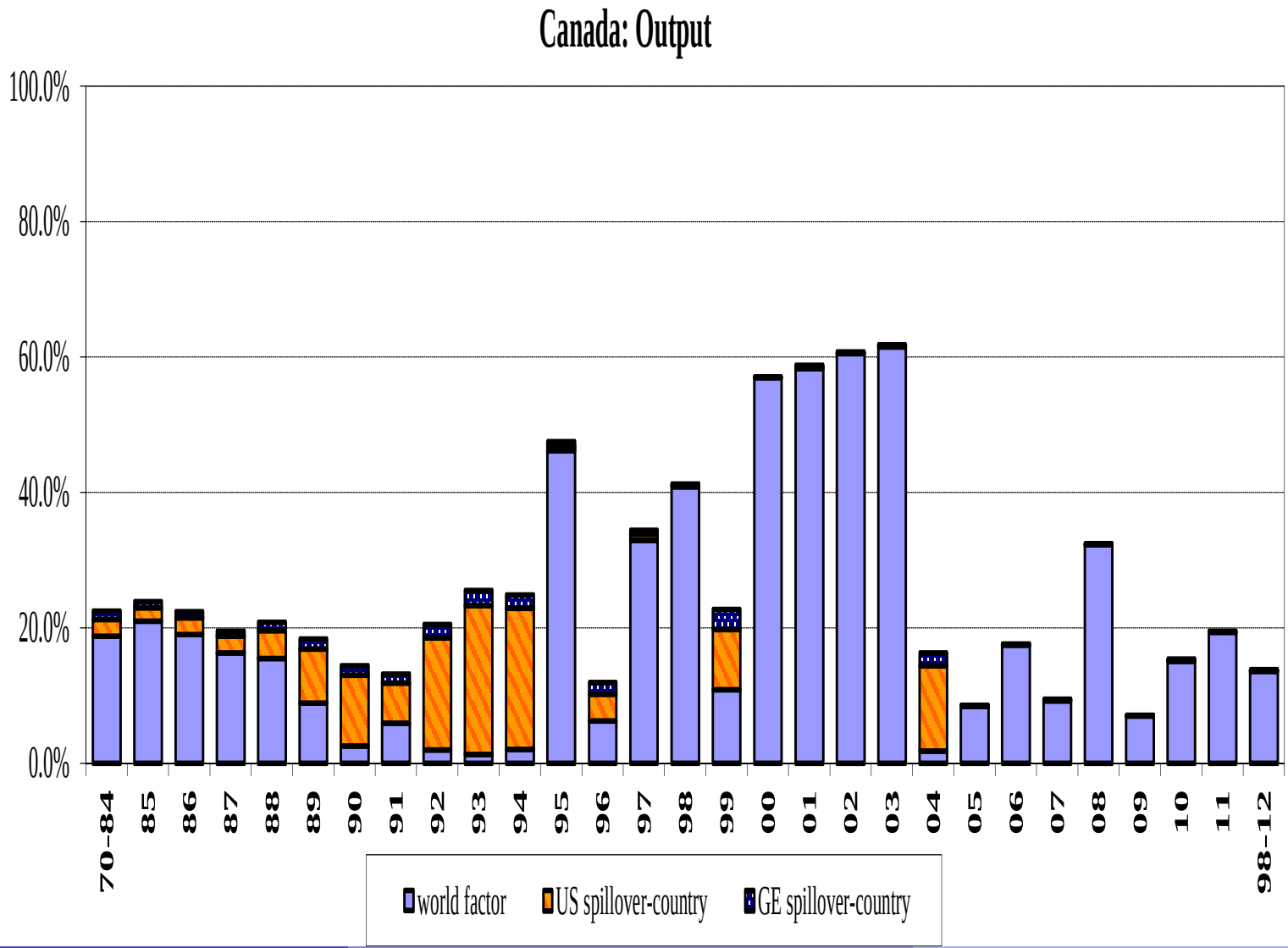




Variance Decomposition: Global Shocks and Country⇒Country Spillovers



Variance Decomposition: Canada Output



What did we learn from this?

- Spillovers are small even in the post 1985 globalization period
- Time periods that include the crisis find large spillovers
- The channel of spillovers is US⇒World⇒Country
- Country⇒Country spillovers are small, except for a brief period in US⇒Canada

How do Shocks Propagate?

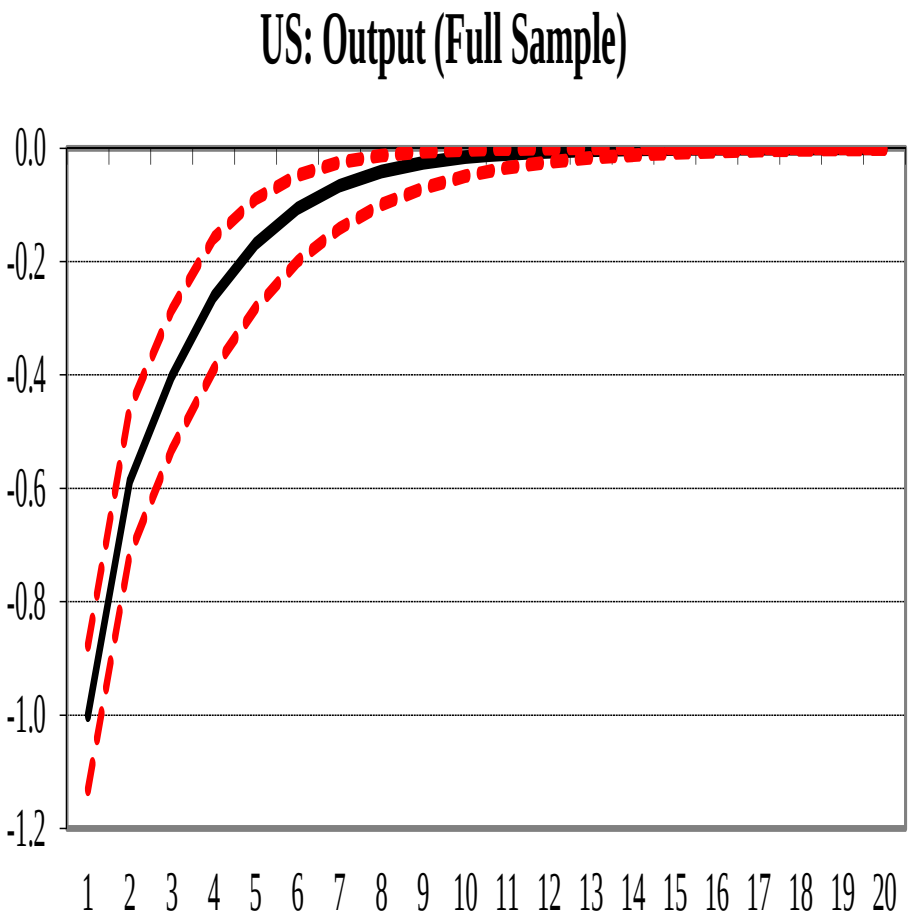
- Shock US country factor, trace impact onto other countries

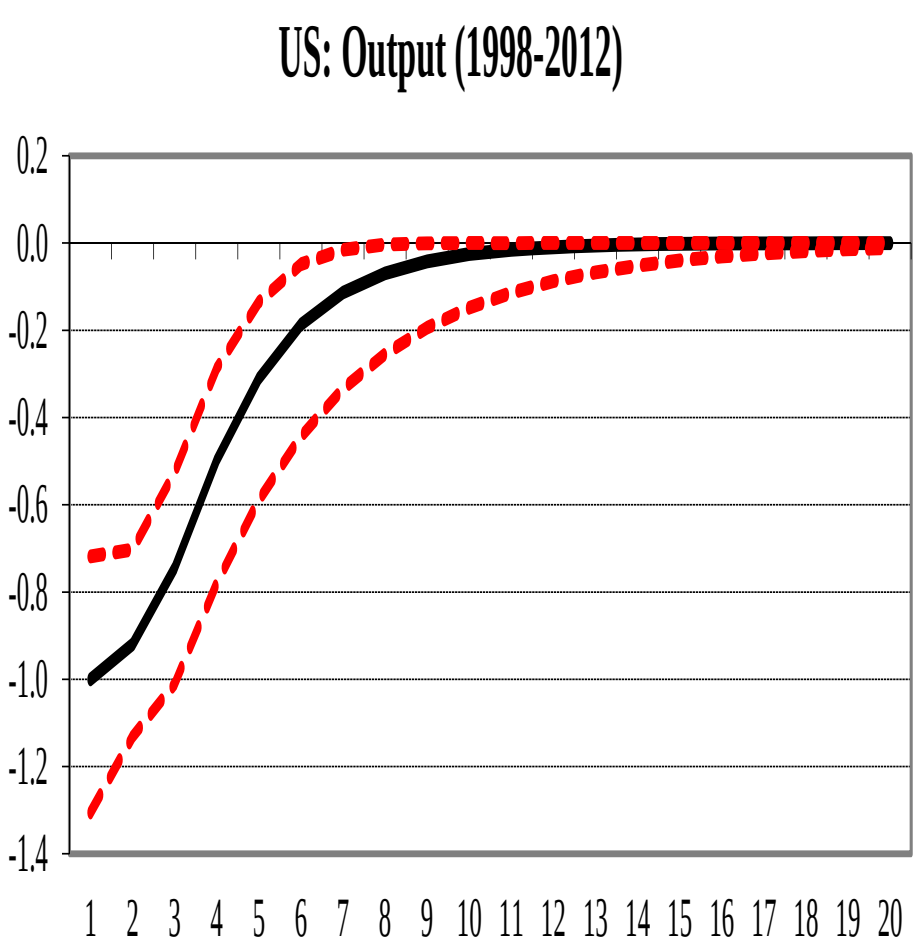
$$Y_t = BF_t + \Gamma_t$$

$$F_t = \Psi(L)F_{t-1} + V_t$$

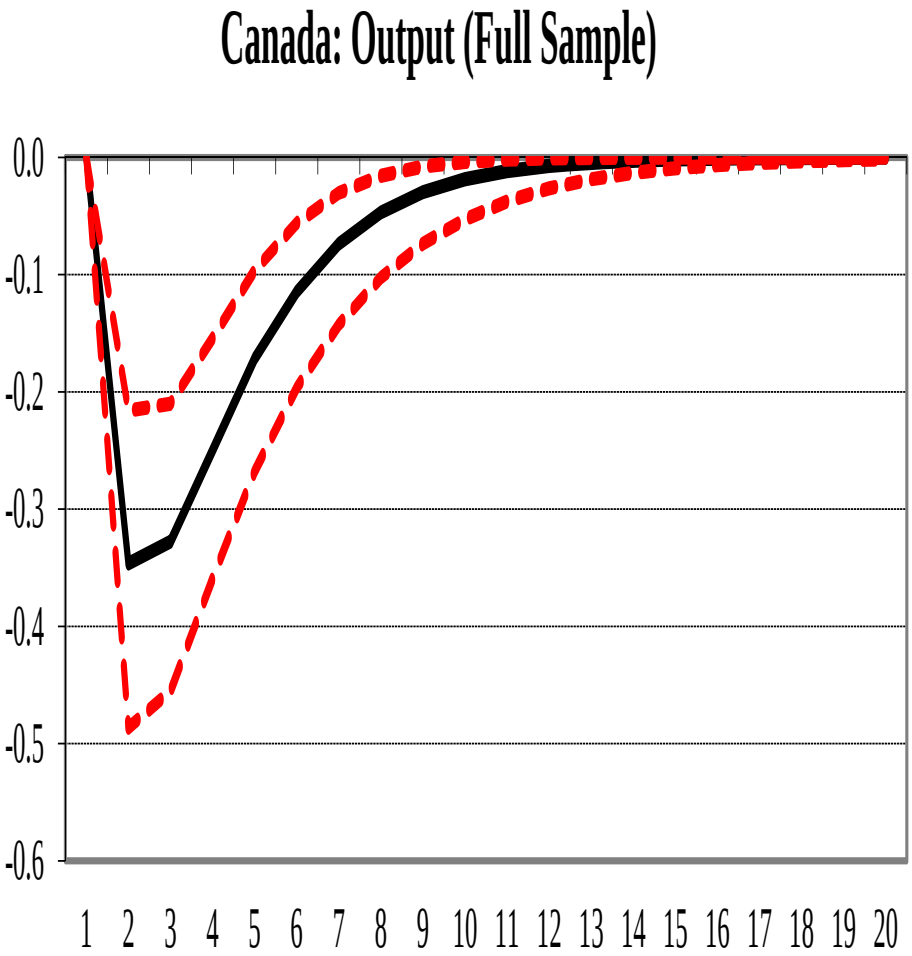
- Size of country shock is that it lower US output one percent
- Excercise emphasizes statistical signifcane of spillovers
- Exercise highlights channels of transmission

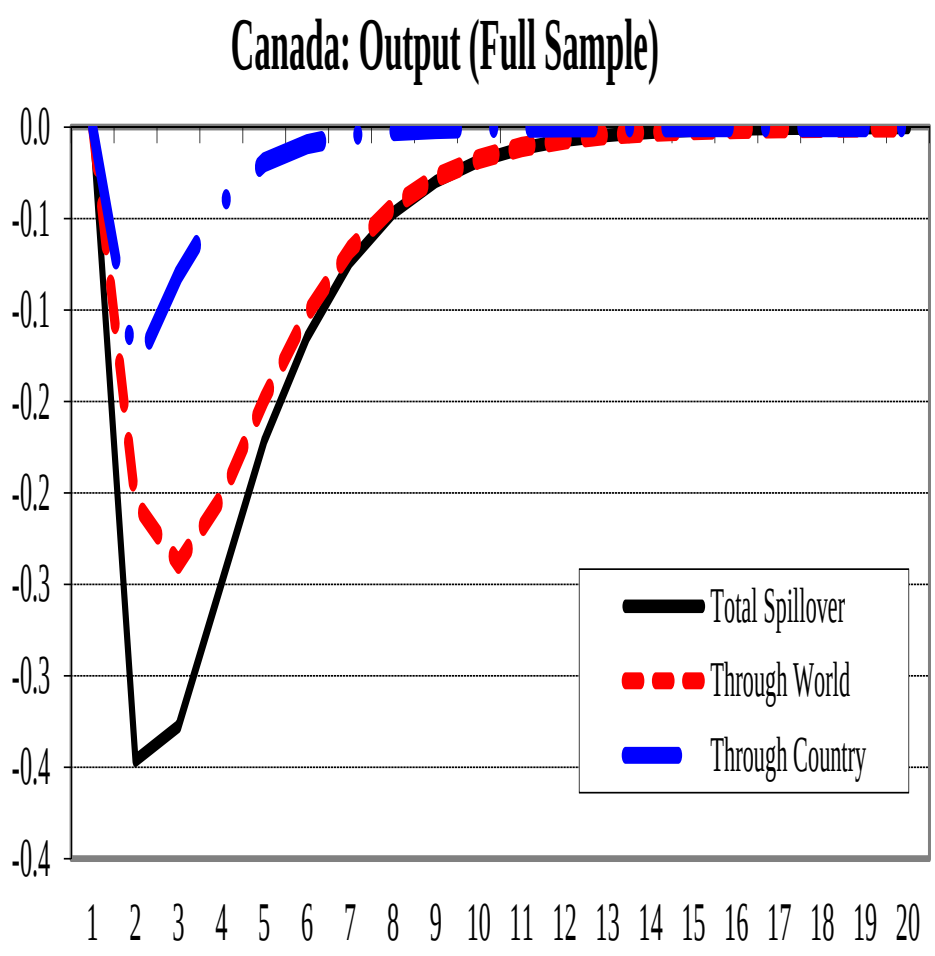
IRF US to US


US: Output (Full Sample)
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

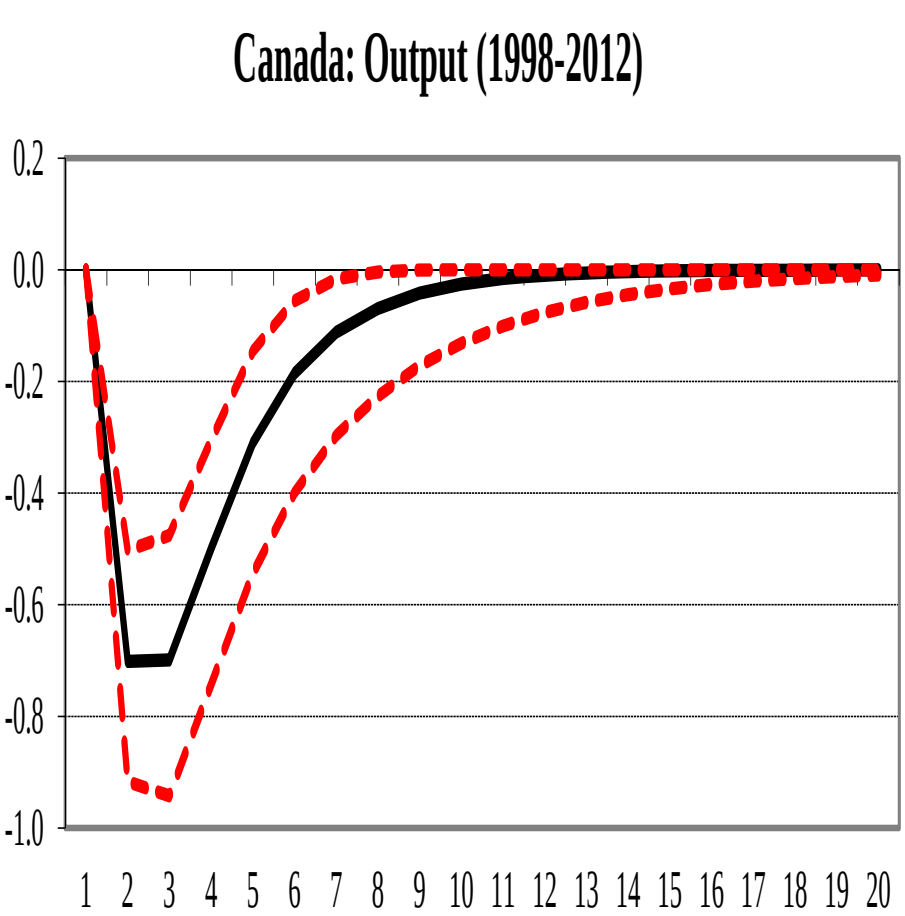

US: Output (1998-2012)
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

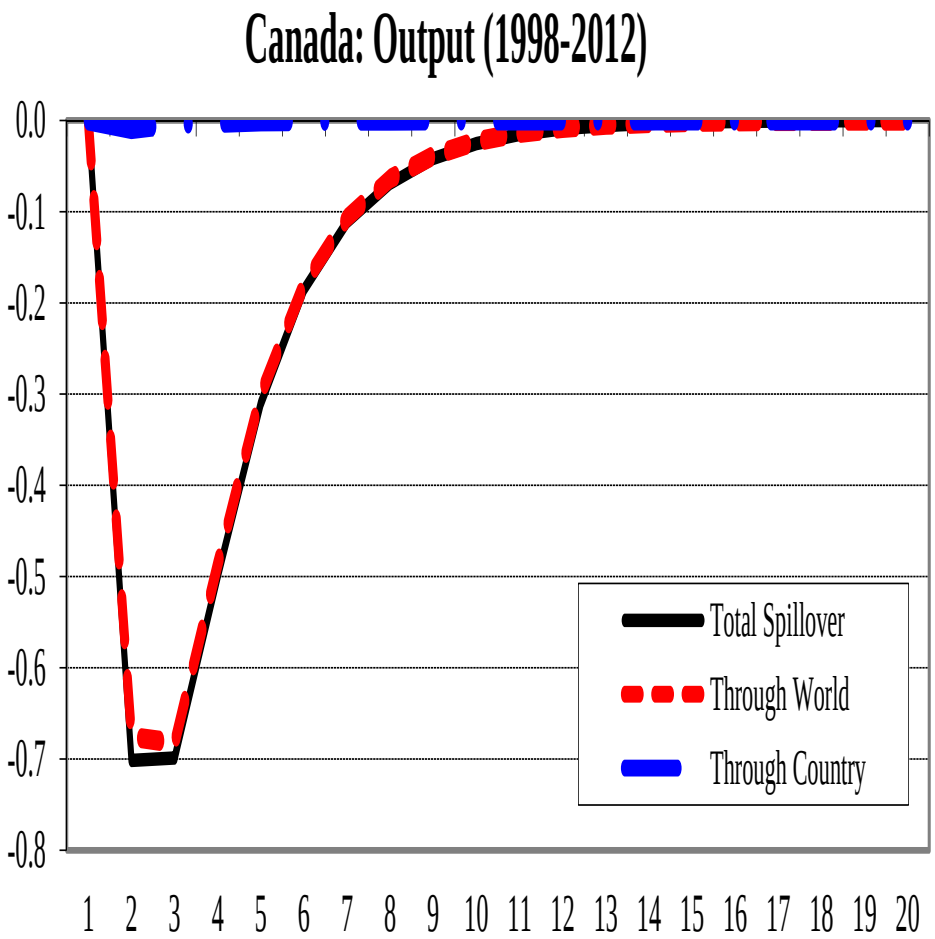
IRF US to Canada: Full Sample





IRF US to Canada: Crisis





Contribution of this paper

- New empirical model
- Spillover needs to be carefully defined
- Parametric approach allows for analysis of the channels of spillovers and changes in those channels
- For G7 business cycles we find common shocks generally explain comovement
- Spillovers are prevalent only in the great recession
- Channel is via world, not bilateral