Putting the New Keynesian Model to a Test

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Motivation

- Workhorse in applied macroeconomics: New Keynesian Dynamic Stochastic General Equilibrium Models (NK DSGE)
  - Christiano, Eichenbaum and Evans (2005)
  - Smets and Wouters (2003)
- Frequently used tool in empirical macroeconomics: Vector Auto Regressions (VARs)
  - Impulse response functions, Variance decompositions, Historical decompositions, …
  - Often used to evaluate the outcome of theoretical models
    - Gali (1992), Blanchard and Perotti (2002), Gali (1999), Canova (2002), …
- This paper: test the conditional properties of the NK DSGE model
  - United States and euro area

Motivation

- How to use a medium-scale theoretical NK DSGE model to identify a large set of shocks at sufficient disaggregate level
    - Problem in traditional literature
    - Sign restrictions obtained from the theoretical model
        - Restrictions are much more general and easier to implement
        - Monetary policy, preference, government spending, investment, price mark-up, technology and labor supply shocks
        - Only (some) signs from the DSGE model are used
    - Select a minimum set of general restrictions
        - Not all constraints and responses from a particular DSGE model are in line with existing empirical evidence or alternative theoretical models
        - Sign of impulse responses can be sensitive to parameterization of the model
        - Also introduce restrictions on the relative response of variables
    - Evaluate the unconstrained responses

Motivation

- Findings
  - Most unconstrained responses are consistent with the theoretical NK DSGE model
    - Including negative impact of government spending shocks on private consumption and investment
  - Some interesting differences
    - Positive effect of a technology shock on hours
    - Positive impact of preference shock on investment
    - Positive effect of an investment shock on private consumption
  - Adding more restrictions from the DSGE model has an effect on the magnitude of output effects and the relative importance of the shocks

Motivation

- Rest of my talk
  - Description of the theoretical NK DSGE model and its conditional properties
  - Derived (minimum set of) sign restrictions
  - Empirical evidence for the US and Euro area
  - Does it really matter?

The conditional properties of the DSGE model

- New Keynesian DSGE model
  - Christiano, Eichenbaum and Evans (2005)
  - Smets and Wouters (2003)
- Features of the model
  - Households optimize consumption and leisure over time
  - Habit formation in consumption
  - Imperfect competition in labour markets and intermediate goods sector
  - Sticky prices and sticky wages
  - Capital adjustment costs and variable capital utilization
  - Taylor-type monetary policy rule
- 7 shocks: monetary policy, preference, government spending, investment, price mark-up, technology and labor supply

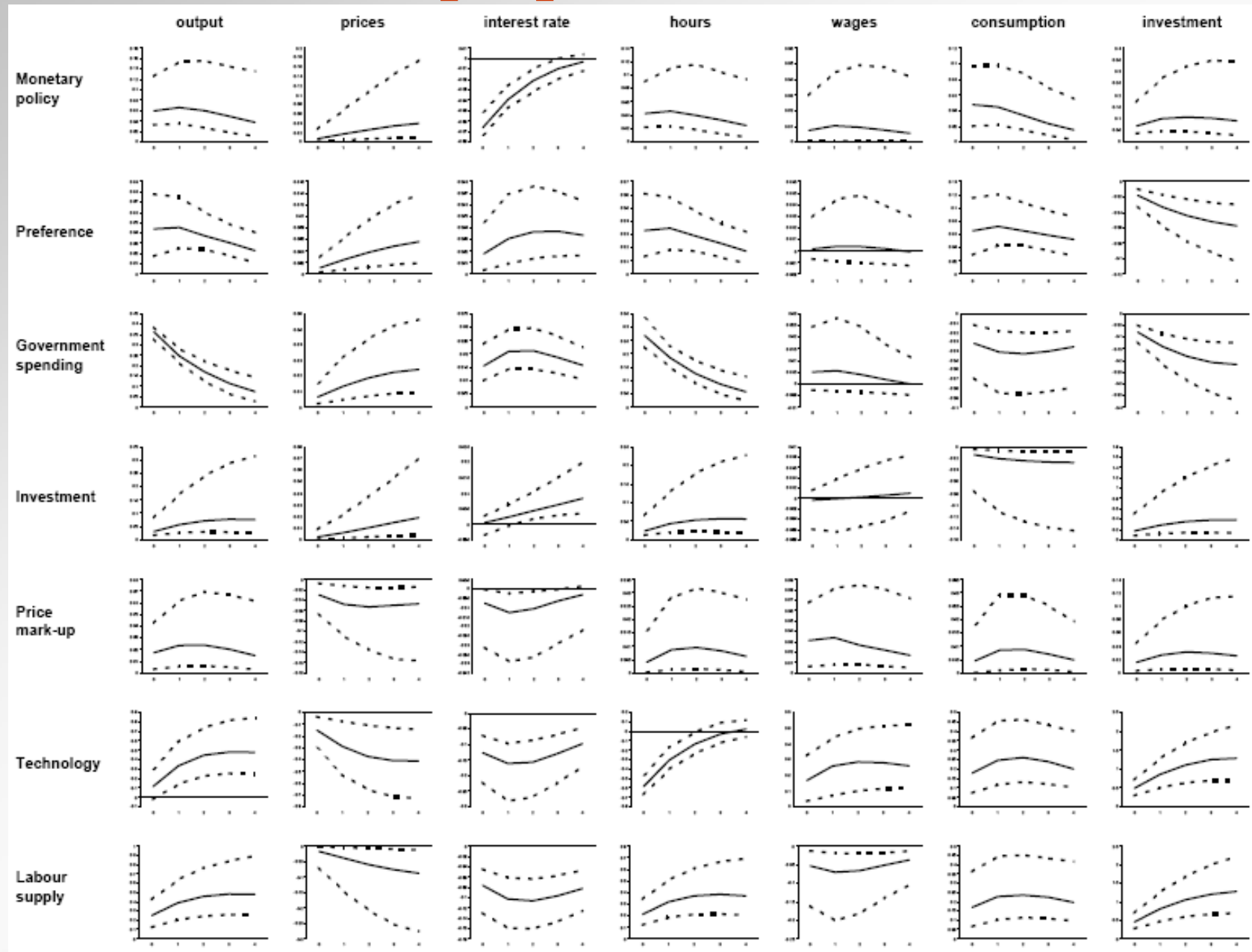# The conditional properties of the DSGE model

- Predictions of the model
  - simulation of conditional properties
  - Sensible range of parameter values
    - Values taken from the literature
      - Smets and Wouters (2003, 2004), Christiano et. al. (2005), Altig et. al. (2002), Onatski and Williams (2004), Coenen and Straub (2005) as a benchmark
    - Even wider ranges based on other more specific estimations (investment adjustment cost, habit persistence, capacity utilization costs, monetary policy rule, AR(1) parameter of shock processes,…)
  - 100000 random draws from a uniform distribution for all parameter values
    - Calculate conditional responses
    - Check the signs of the median, 16th and 84th percentiles

The conditional properties of the DSGE model

Table 1: Parameter ranges for DSGE simulations

β	0.99
σ	$[1-4]$
γ_c	$[0-0.9]$
ζ	$[1-3]$
α	0.3
ϕ	$[1-1.8]$
λ_w	0.5
δ	0.025
Υ	$[0.12-0.28]$
Ψ	$[2.8-10]$
ξ_p	$[0.4-0.95]$
ξ_w	$[0.4-0.95]$
γ_p	$[0-0.99]$
γ_w	$[0-0.99]$
ϕ_r	$[0.6-0.99]$
ϕ_y	$[0-0.8]$
ϕ_π	$[1-4]$
$\phi_{\Delta y}$	$[0-0.2]$
$\phi_{\Delta\pi}$	$[0-1]$
ρ^{shock}	$[0.6-0.99]$
ρ^{ε^p}	$[0-0.99]$

The conditional properties of the DSGE model

The conditional properties of the DSGE model

Table 2: Signs of theoretical impulse response functions

	Y	P	R	N	W	C	I
monetary policy	↑	↑	↓	↑	↑	↑	↑
preference	↑	↑	↑	↑	↑↓	↑	↓
government spending	↑	↑	↑	↑	↑↓	↓	↓
investment	↑	↑	↑	↑	↑↓	↓	↑
price mark-up	↑	↓	↓	↑	↑	↑	↑
technology	↑	↓	↓	↓	↑	↑	↑
labor supply	↑	↓	↓	↑	↓	↑	↑

- The signs of the conditional responses are sufficient to uniquely identify all the shocks
  - In order to evaluate (test) the model, some of the (redundant) restrictions can be dropped
  - Some of the remaining restrictions are, however, controversial and questioned in existing empirical and alternative theoretical literature

The conditional properties of the DSGE model

Table 2: Signs of theoretical impulse response functions

	Y	P	R	N	W	C	I
monetary policy	↑	↑	↓	↑	↑	↑	↑
preference	↑	↑	↑	↑	↑↓	↑	↓
government spending	↑	↑	↑	↑	↑↓	↓	↓
investment	↑	↑	↑	↑	↑↓	↓	↑
price mark-up	↑	↓	↓	↑	↑	↑	↑
technology	↑	↓	↓	↓	↑	↑	↑
labor supply	↑	↓	↓	↑	↓	↑	↑

- **Negative effects of government spending shocks on private consumption and investment**
  - Blanchard and Perotti (2002), Fatás and Mihov (2001), Gali et. al. (2004), Mountford and Uhlig (2005), Edelberg et. al. (1999): not consistent with empirical evidence
  - Gali et. al. (2004) extend standard NK model with rule-of thumb households

The conditional properties of the DSGE model

Table 2: Signs of theoretical impulse response functions

	Y	P	R	N	W	C	I
monetary policy	↑	↑	↓	↑	↑	↑	↑
preference	↑	↑	↑	↑	↑↓	↑	↓
government spending	↑	↑	↑	↑	↑↓	↓	↓
investment	↑	↑	↑	↑	↑↓	↓	↑
price mark-up	↑	↓	↓	↑	↑	↑	↑
technology	↑	↓	↓	↓	↑	↑	↑
labor supply	↑	↓	↓	↑	↓	↑	↑

- Negative reaction of hours to technology shock
  - RBC versus NK models
  - Empirical evidence is mixed
    - Gali (1999), Shea (1998), Basu et. al. (1999), Francis and Ramey (2002), Francis et. al. (2003)
    - Christiano et. al. (2004), Peersman and Straub (2004), Uhlig (2004), Dedola and Neri (2004), Canova and Gambetti (2004)

The conditional properties of the DSGE model

Table 2: Signs of theoretical impulse response functions

	Y	P	R	N	W	C	I
monetary policy	↑	↑	↓	↑	↑	↑	↑
preference	↑	↑	↑	↑	↑↓	↑	↓
government spending	↑	↑	↑	↑	↑↓	↓	↓
investment	↑	↑	↑	↑	↑↓	↓	↑
price mark-up	↑	↓	↓	↑	↑	↑	↑
technology	↑	↓	↓	↓	↑	↑	↑
labor supply	↑	↓	↓	↑	↓	↑	↑

- Other crowding-out effects
  - Investment falls after shock in preferences
  - Private consumption decreases following an investment shock
- Introduce more general restrictions on relative responses
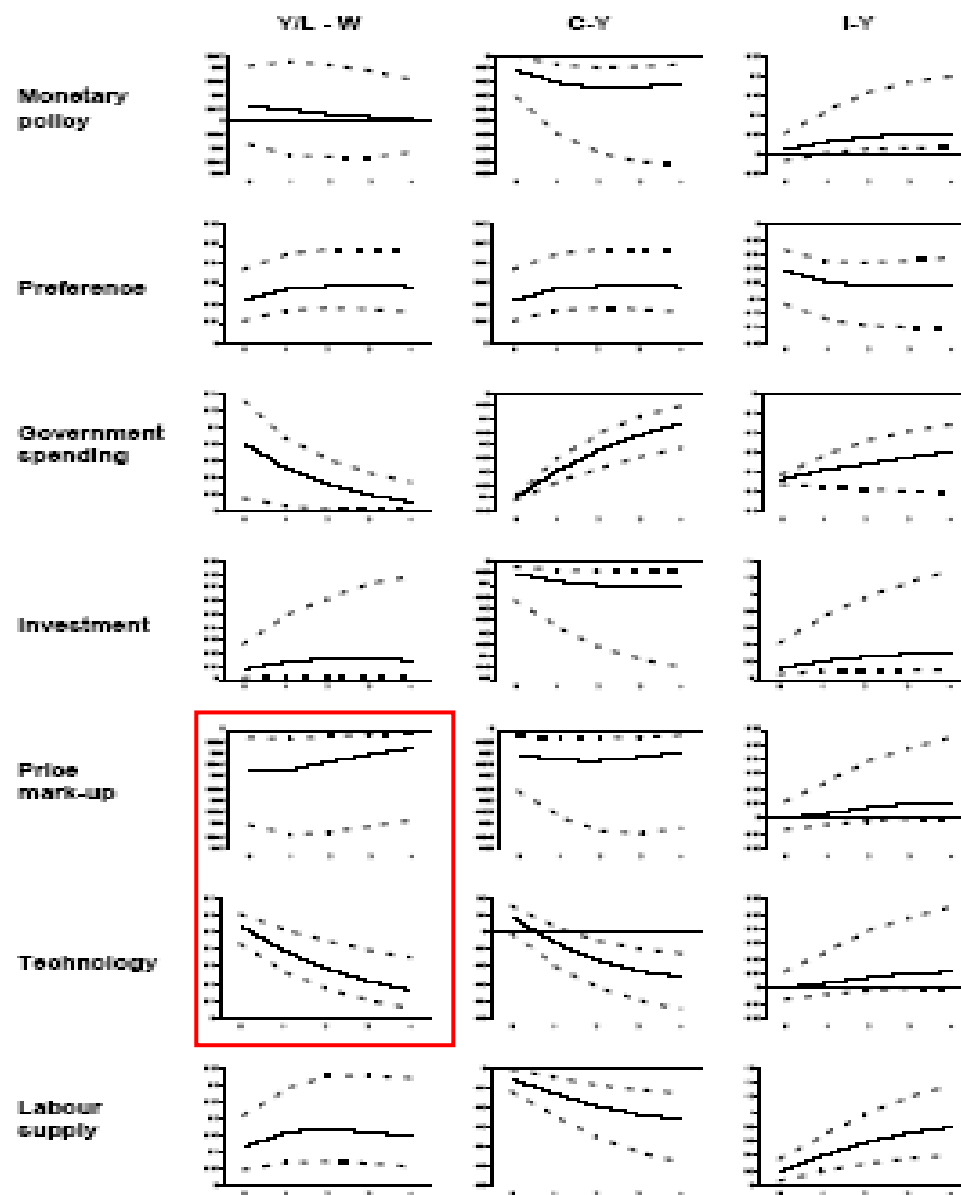 - Data can then determine the exact signs of the responses

More general restrictions

Table 3: Relaxed restrictions

|	Y	P	R	N	W	C	I	$\frac{Y}{L} - W$	$C - Y$	$I - Y$
monetary policy	↑	↑	↓							
preference	↑	↑	↑						↑	
govern. spending	↑	↑	↑						↓	↓
investment	↑	↑	↑						↓	↑
price mark-up	↑	↓			↑			↓		
technology	↑	↓			↑			↑		
labor supply	↑	↓			↓					

More general restrictions

Figure 2 - Theoretical relative impulse responses from DSGE model

Empirical results

- United States (1955-2004) and Euro area (1982-2003)
- Real GDP, GDP deflator, short-term nominal interest rate, hours, real wages, consumption and investment
- Monetary policy, preference, government spending, investment, price mark-up, technology and labour supply
- Restrictions are binding the first four quarters after the shock
- Bayesian procedure for estimations: Uhlig (2005) and Peersman (2005)
- Shock by shock approach

Empirical results – United States

# Empirical results – Euro area
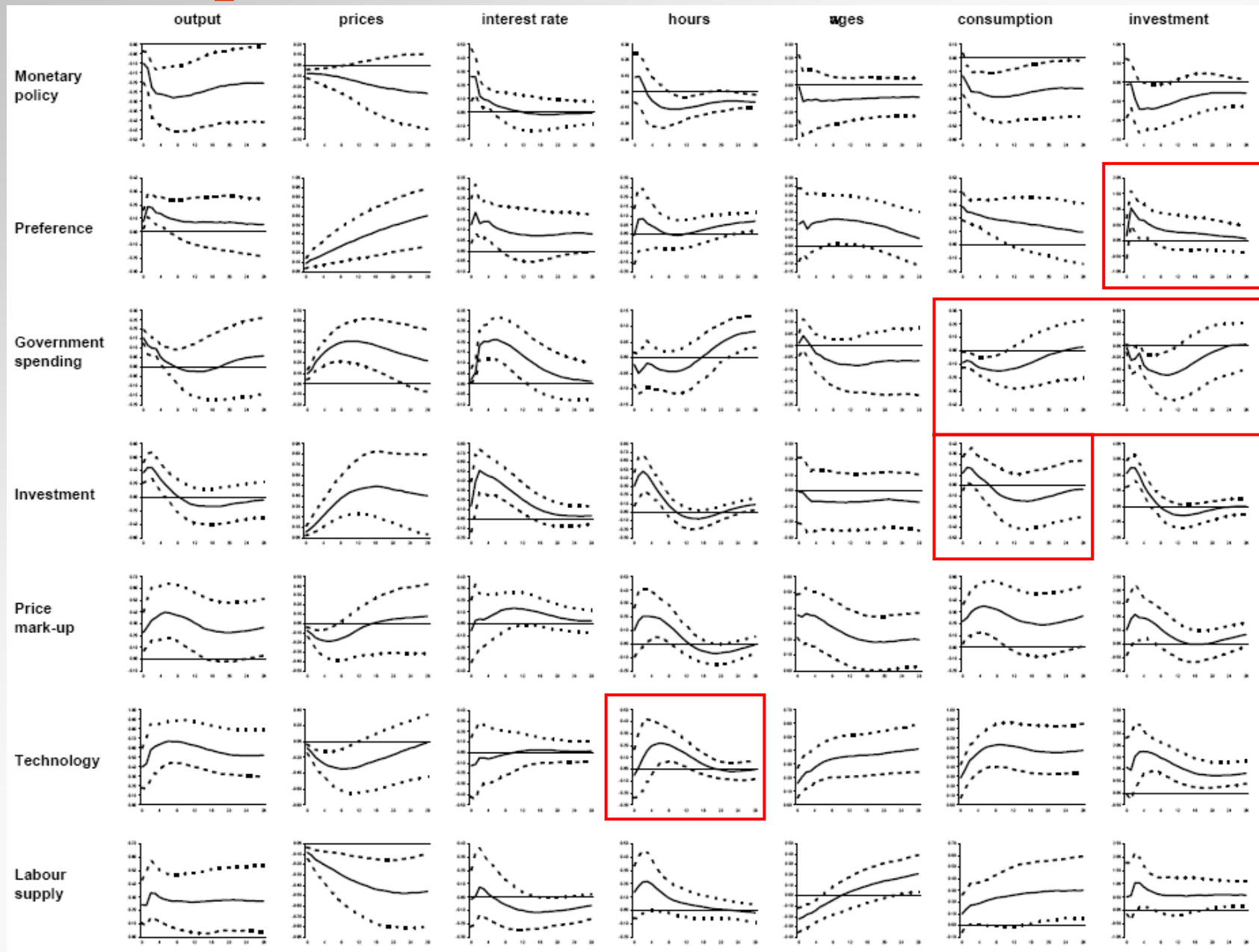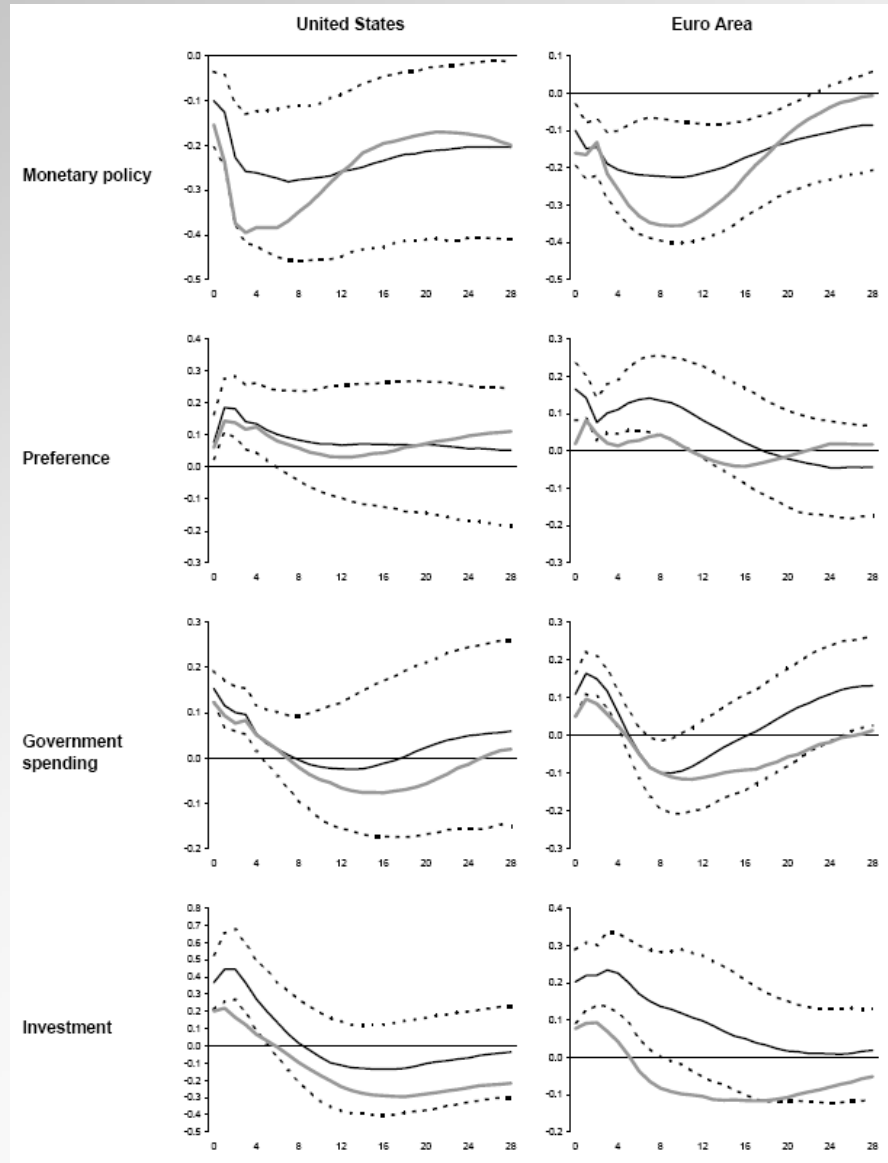
Does it really matter?

- What happens if we introduce *all* sign restrictions form the NK DSGE model?
    - Solutions do exist in the data, but it is very hard to find them

Table 4: Acceptance rates for all shocks			
	Relaxed restrictions	All restrictions	Relative acceptance (%)
United States			
monetary policy	13.89	349.95	3.97
preference	37.61	17141.24	0.20
government spending	25.32	3911.39	0.64
investment	1.98	230.48	0.86
price mark-up	2.58	45.61	5.66
technology	2.08	78.92	2.64
labor supply	2.41	55.05	4.38
euro area			
monetary policy	3.89	22.59	17.21
preference	20.92	7572392.0	0.00
government spending	17.22	36419.33	0.00
investment	3.57	1164.36	0.31
price mark-up	12.13	82.15	14.77
technology	361.20	46969.31	0.77
labor supply	3.17	17.51	18.10

Does it really matter?

- Impulse responses of output
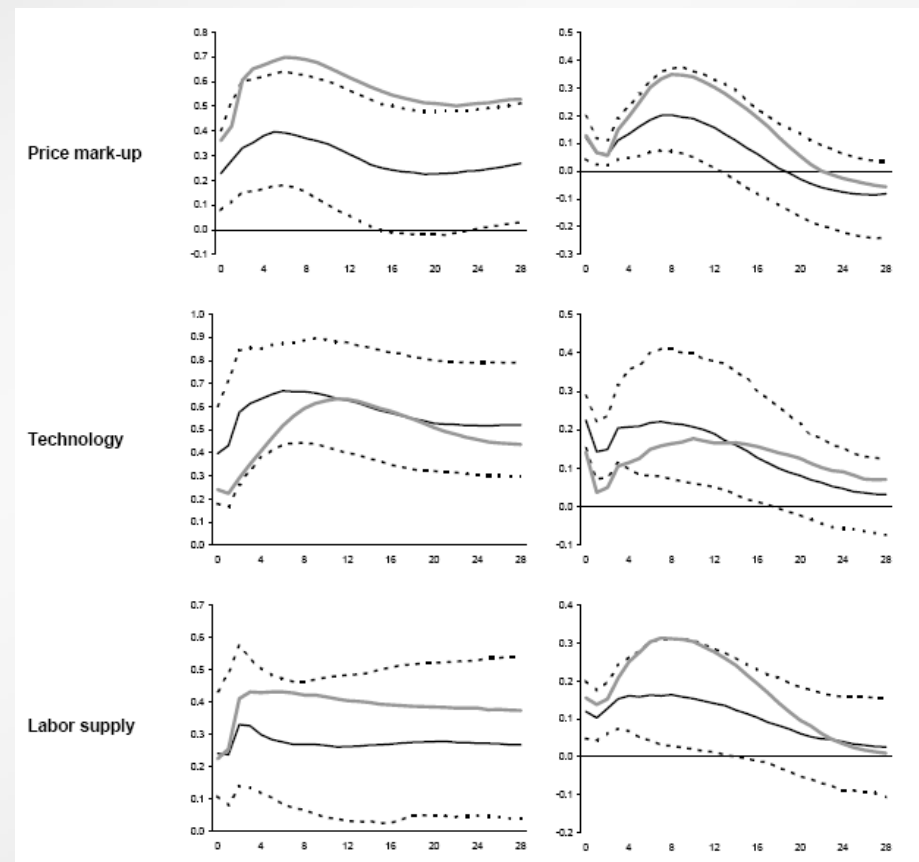
Does it really matter?

- Forecast error variance decomposition of output

	Relaxed restrictions			All restrictions		
	0Q	4Q	28Q	0Q	4Q	28Q
United States						
monetary policy	2.3	6.1	9.1	7.4	15.1	7.9
preference	1.3	3.2	1.4	1.1	2.1	0.8
government spending	5.3	1.7	0.5	4.7	1.1	0.4
investment	30.5	21.1	5.8	12.5	3.9	5.5
price mark-up	11.7	14.6	14.7	40.4	44.8	38.2
technology	35.7	41.5	55.9	18.0	13.9	29.6
labor supply	13.2	12.0	12.7	15.8	19.0	17.6
euro area						
monetary policy	5.9	15.4	26.3	27.1	33.3	31.4
preference	16.1	9.0	6.9	0.4	1.8	0.5
government spending	7.1	9.3	7.4	2.6	4.1	3.3
investment	24.2	28.6	13.4	6.2	5.4	4.8
price mark-up	8.6	6.2	12.8	17.5	15.5	24.9
technology	29.7	20.9	21.3	20.9	8.7	10.4
labor supply	8.4	10.6	11.9	25.3	31.2	24.7

Conclusions

- The popular NK DSGE model can be used to derive sign restrictions for the identification of a large set of structural shocks in an SVAR
- The conditional properties of the model can be tested by significantly relaxing the imposed restrictions
- Most of the responses remain consistent with the NK DSGE model
  – Including crowding-out effects of fiscal policy
- We find some interesting differences
  – Hours rise after a technology shock
  – Investment rises after a shock in preferences
  – Consumption rises after an investment shock
- It is very hard to find all conditional properties of the NK DSGE model back in the data
- It does matter to interpret output fluctuations
  – Impact and relative importance of some shocks are overestimated and underestimated for other shocks when all DSGE restrictions are imposed