

Medium Sized NK Model

Lawrence Christiano

Why Has the NK Model Become the ‘New Consensus Model’?

- The simple NK model without capital enormously useful for illustrating principles
 - This does not fully explain its success as a tool used in monetary policy.
- Straightforward extension of the model:
 - Resolves an age-old puzzle in monetary economics
 - VAR analysis plays a key role in documenting this.
 - Useful for forecasting.
 - Fits data well by standard econometric criteria.

Hume essay, *Of Money*

- ...money... must first quicken the diligence of every individual, before it encrease the price of labour.
- The farmer and gardener, finding, that all their commodities are taken off, apply themselves with alacrity to the raising more...
- Friedman's AEA Presidential Address expresses similar view.

Early Monetary DSGE Models

- Generally inconsistent with Hume/Friedman observation.
- In those models, monetary expansion produced an immediate rise in P and little rise in output.
 - Not surprisingly, early academic models little use to practical people.
 - Examples: Friedman-Lucas-Phelps ‘island model’, early Keynesian ‘sticky wage’ model.
- VARs key to quantifying Hume/Friedman observation and assessing consistency of NK model with it.

Identifying Monetary Policy Shocks

- Most influential strategy (Bernanke-Blinder): estimate parameters of Fed's feedback rule
 - Rule that relates Fed's actions to state of the economy:

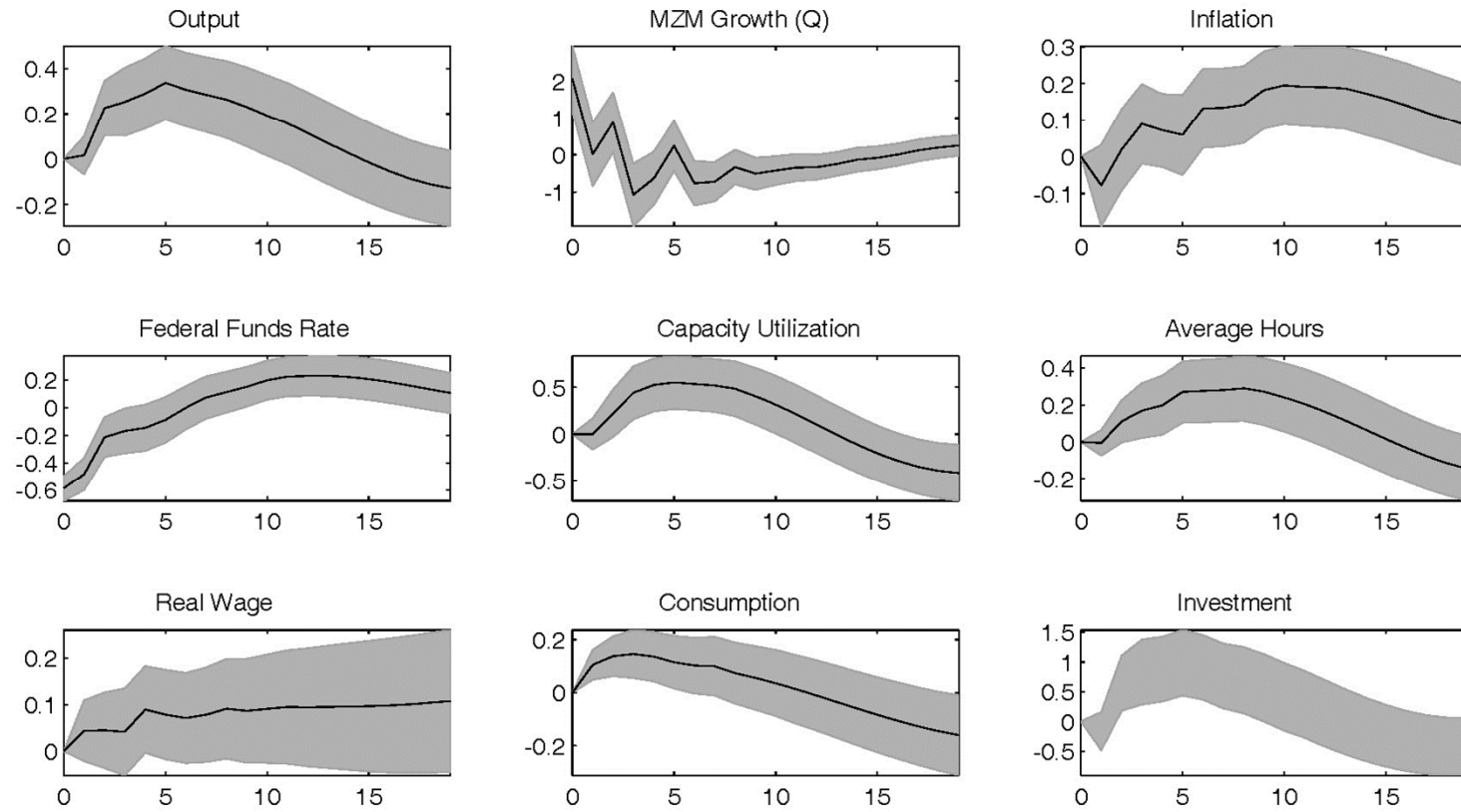
Fed information set

Policy shock


$$R_t = f(\Omega_t) + e_t^R$$

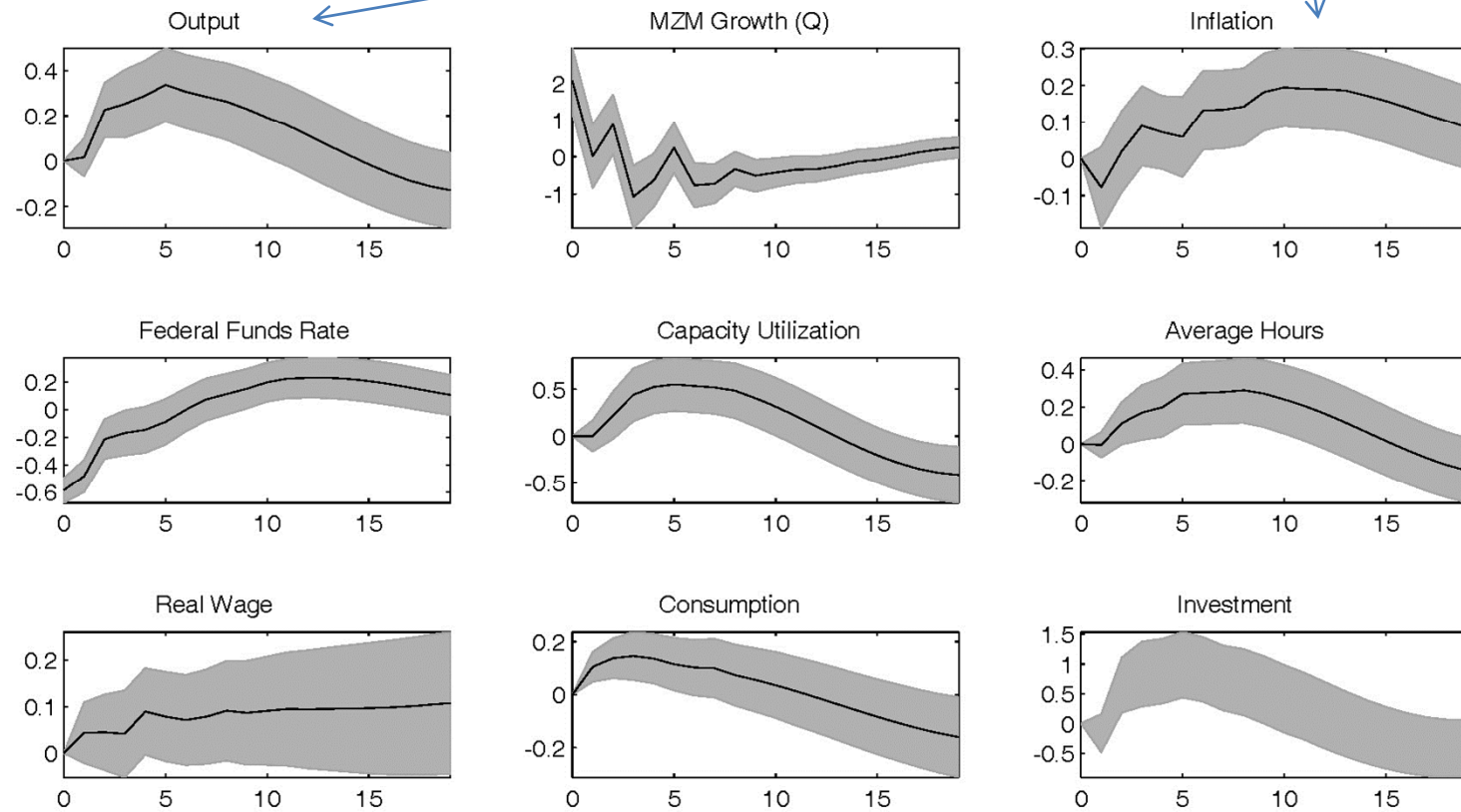
- f linear
- e_t^R orthogonal to Fed information, Ω_t
- Ω_t contains current prices and wages, aggregate quantities, lagged stuff
- e_t^R estimated by OLS regression
- Regress X_t on $e_t^R, e_{t-1}^R, e_{t-2}^R, \dots$

Response to a monetary policy shock

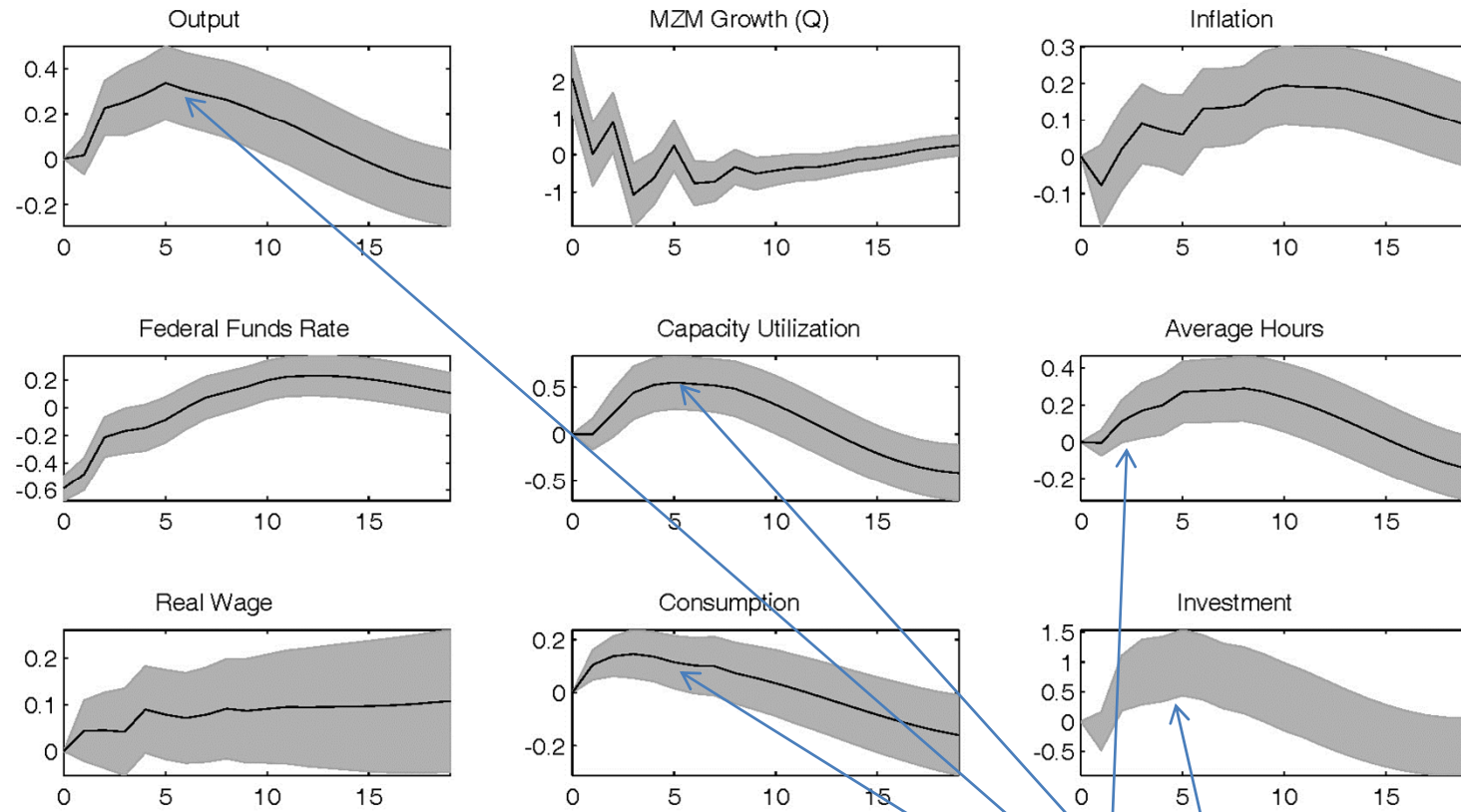


Response to a monetary policy shock

Hume/Friedman observation

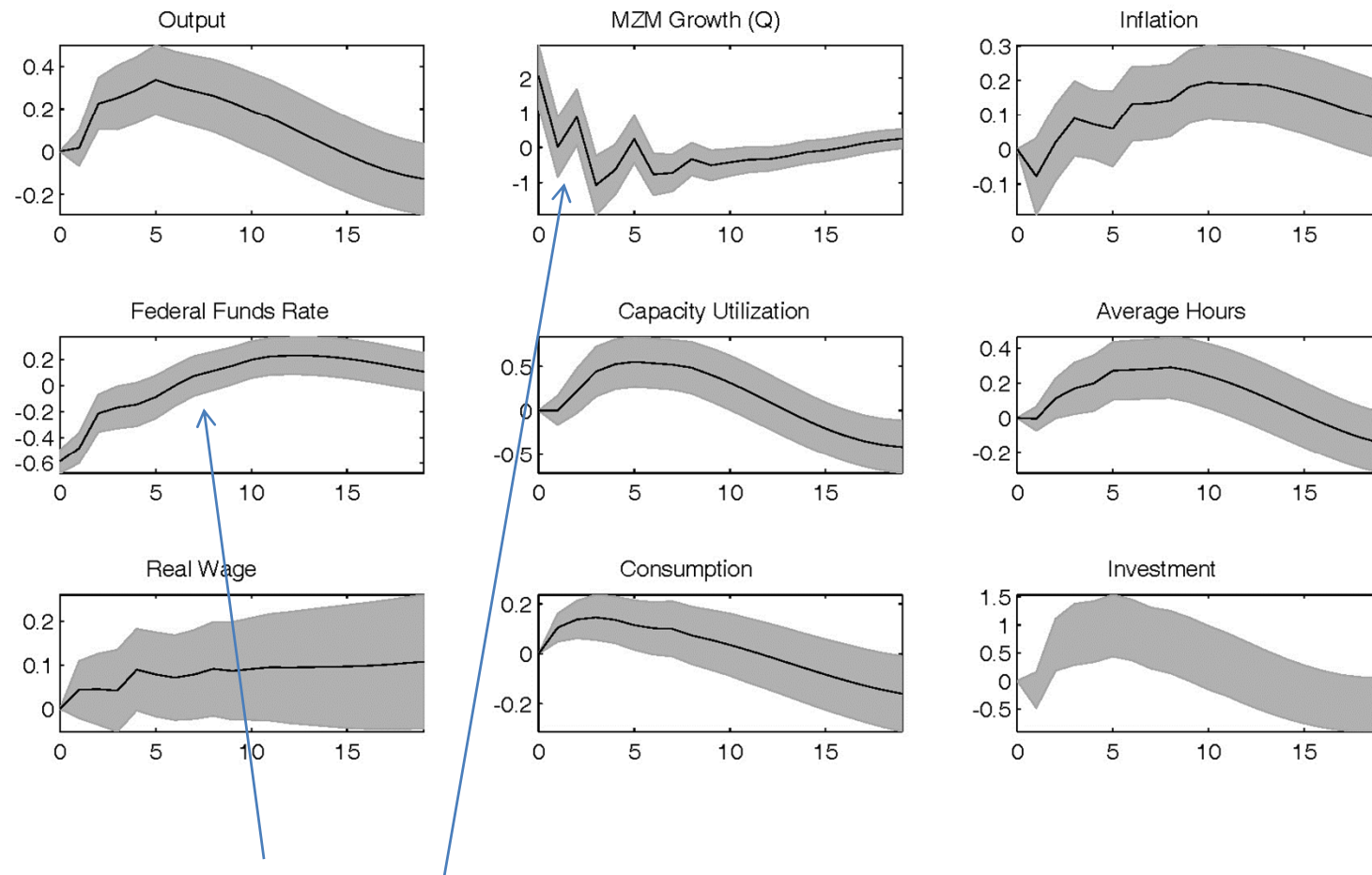


Response to a monetary policy shock



Humps!

Response to a monetary policy shock



The levers of monetary policy (interest rate/money growth) move for a relatively short amount of time, while the economy responds much longer.

An empirically successful model must deliver a lot of **internal persistence**.

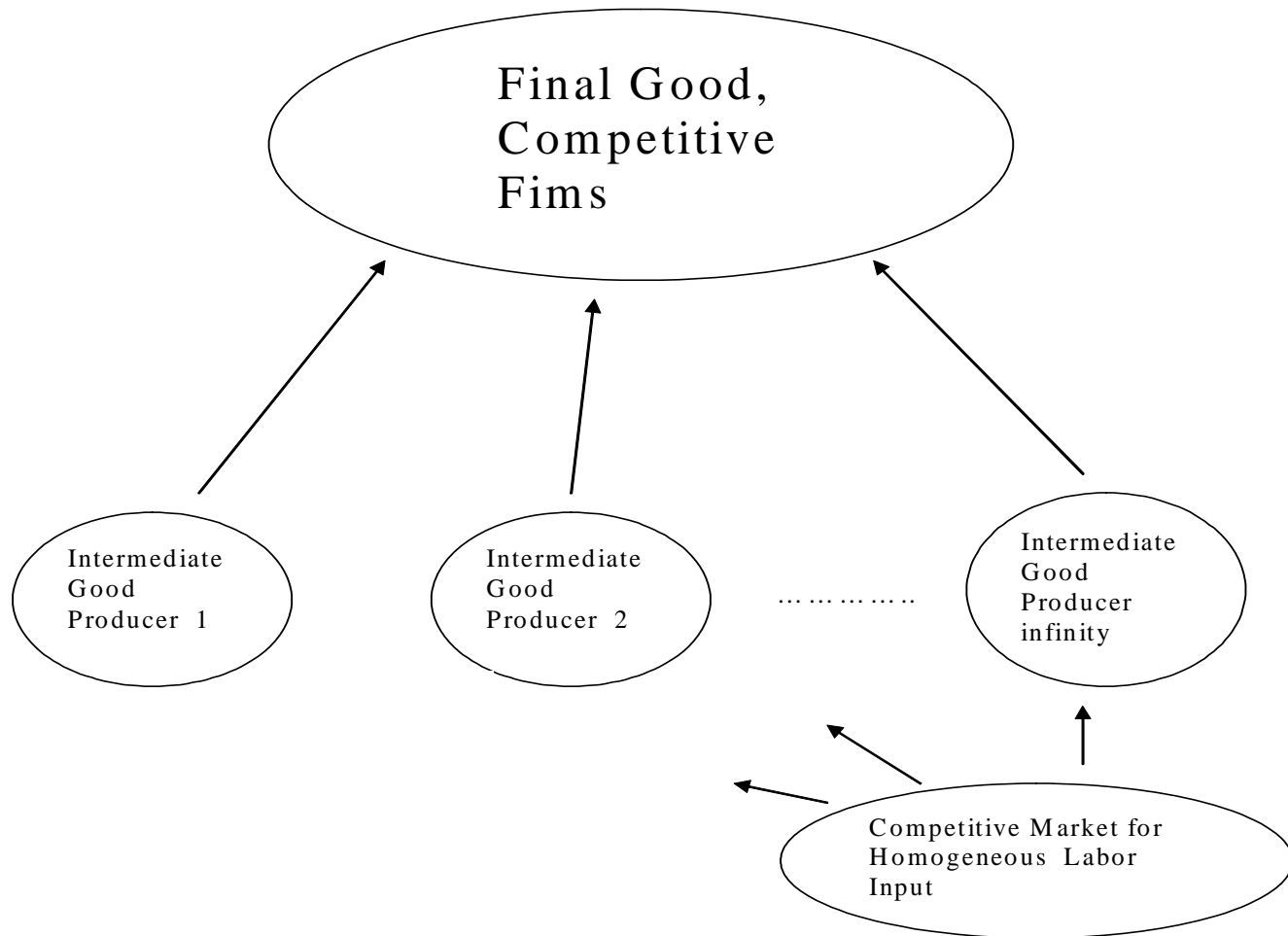
Modifications to Simple NK Model to Bring it to Data

- Introduce capital.
 - Fluctuations in investment are a fundamental feature of business cycles.
- To confront data, must have some additional features/modifications:
 - Sticky wages essential to success of NK model (arguably more important than sticky prices).
 - Must adopt habit persistence in preferences ('C-dot' model utility)
 - Must adopt 'I-dot' model of investment.

Introduction of Sticky Wages

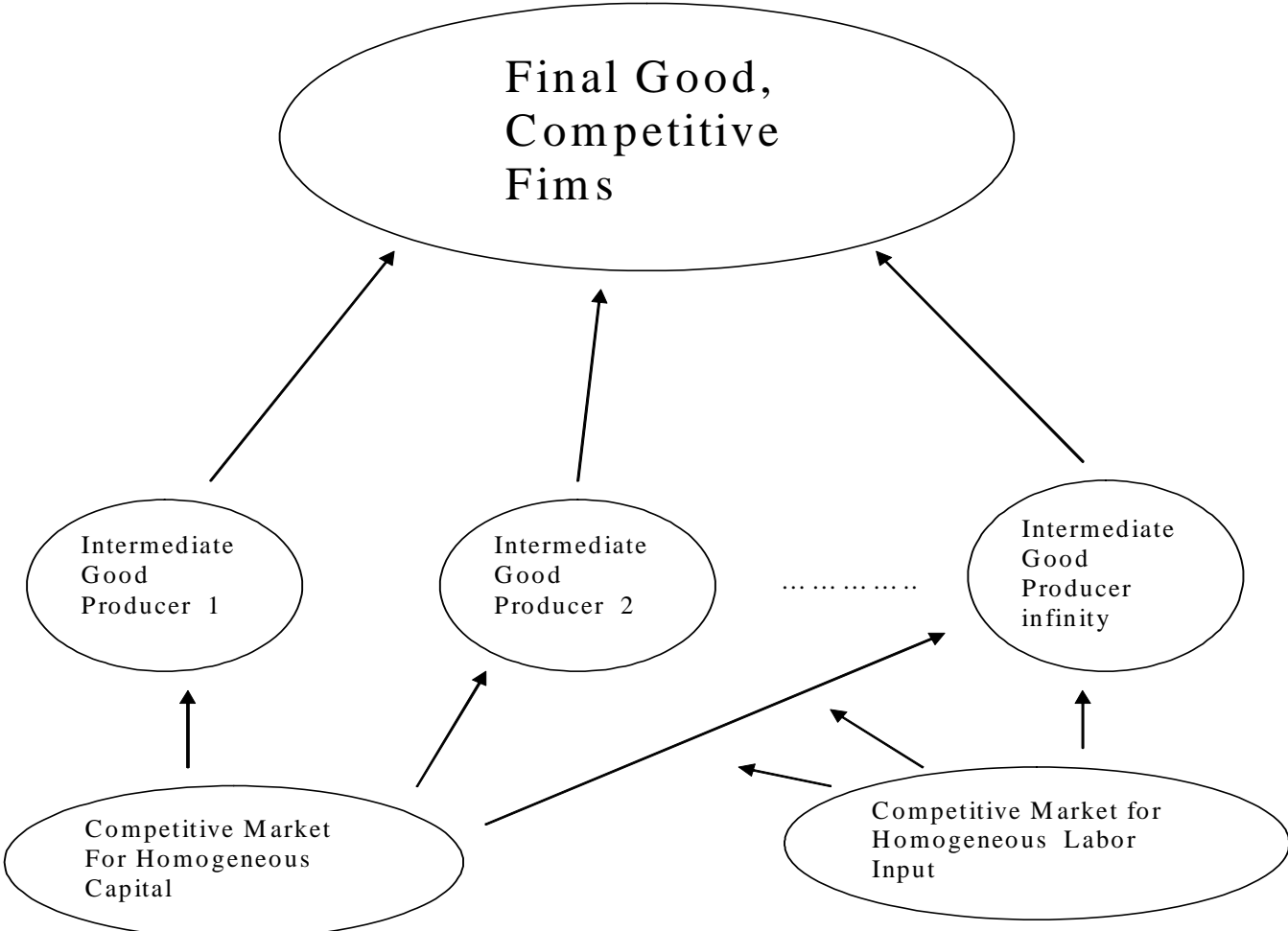
- Follows Erceg, Henderson and Levin.....
- Alternatives have been pursued, involving search and matching.
 - Gertler-Trigari, Gertler-Sala-Trigari, Christiano-Ilut-Motto-Rostagno (closed economy).
 - Christiano-Trabandt-Walentin (small open economy).

Firm Sector



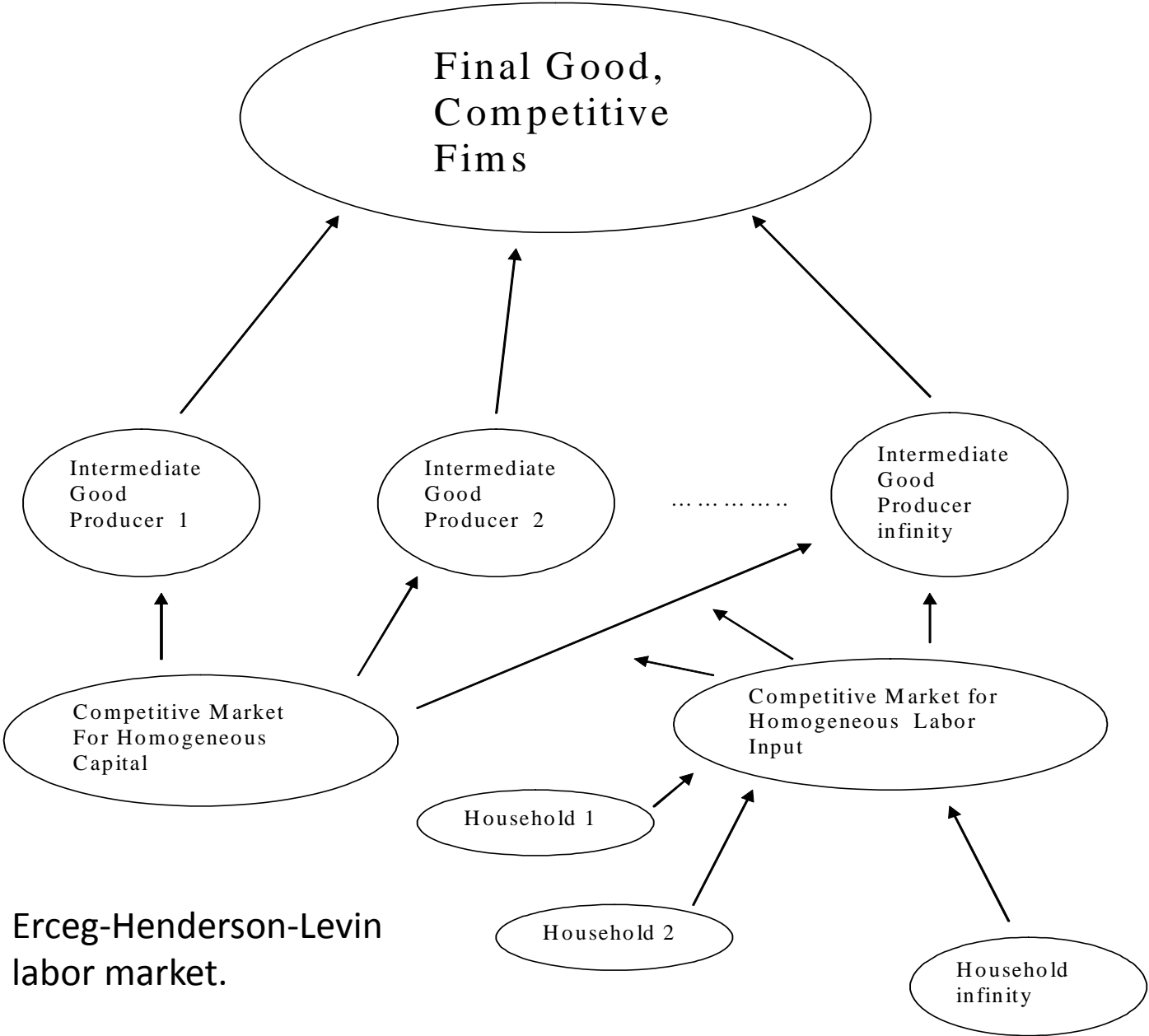
This is a picture of the simple NK model without capital.

Firm Sector



Adding capital

Firm Sector

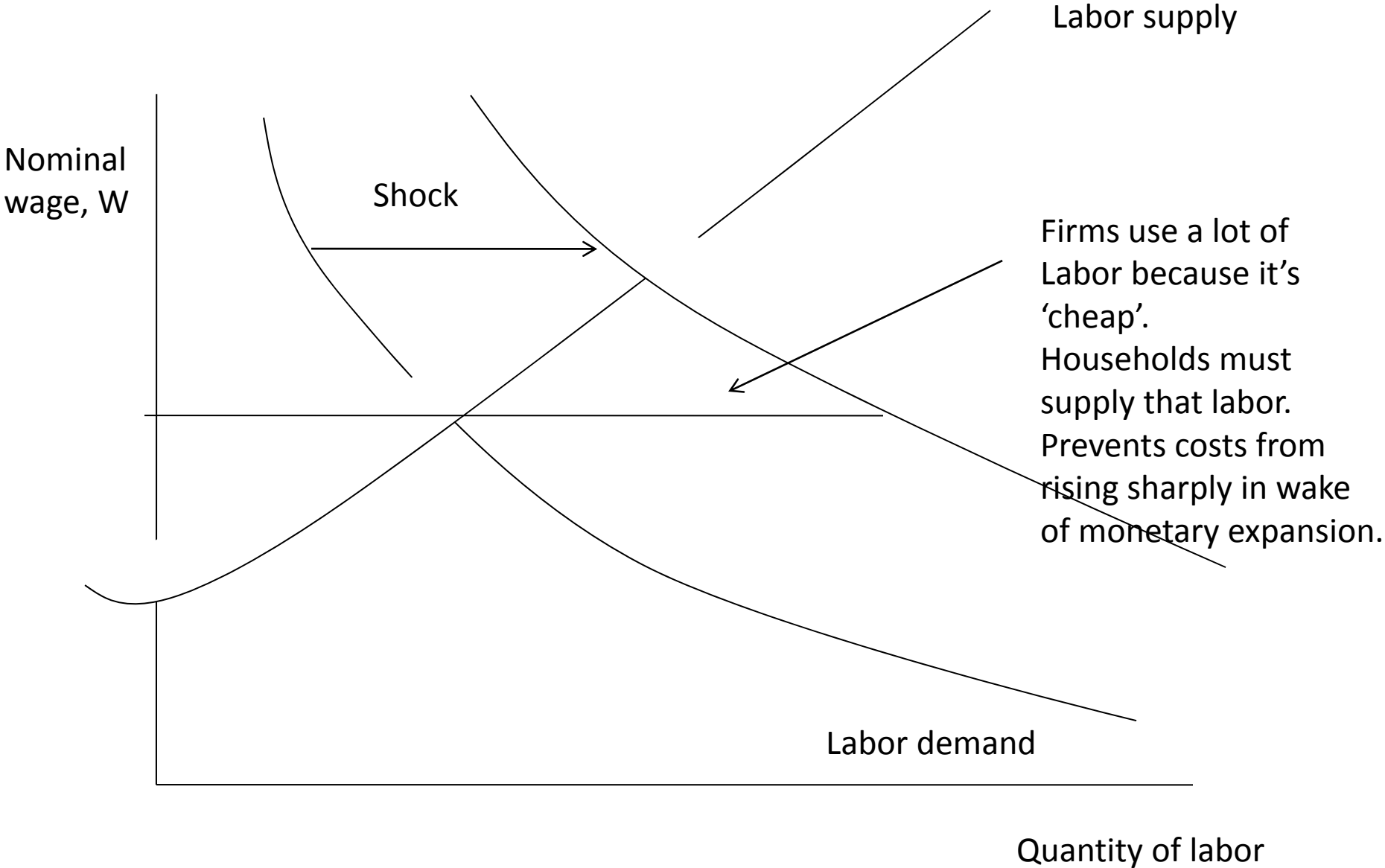


Erceg-Henderson-Levin labor market.

Wage Decisions

- Each household is a monopoly supplier of a specialized, differentiated labor service.
 - Sets wages subject to Calvo frictions.
 - Given specified wage, household must supply whatever quantity of labor is demanded.
- Household differentiated labor service is aggregated into homogeneous labor by a competitive labor ‘contractor’.

$$l_t = \left[\int_0^1 (h_{t,j})^{\frac{1}{\lambda_w}} dj \right]^{\lambda_w}, \quad 1 \leq \lambda_w < \infty.$$

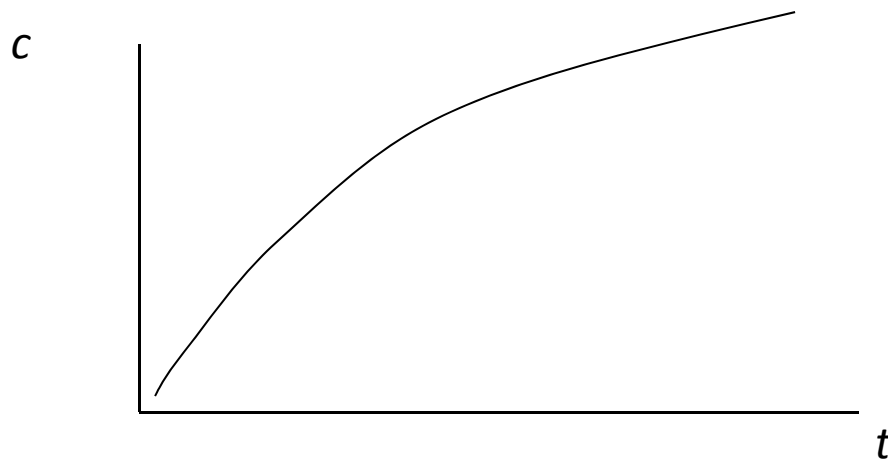


Consumption 'Puzzle'

- In Estimated Impulse Responses:
 - Real Interest Rate Falls

$$R_t / \pi_{t+1}$$

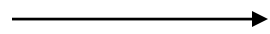
- Consumption Rises in Hump-Shape Pattern:



Consumption 'Puzzle'

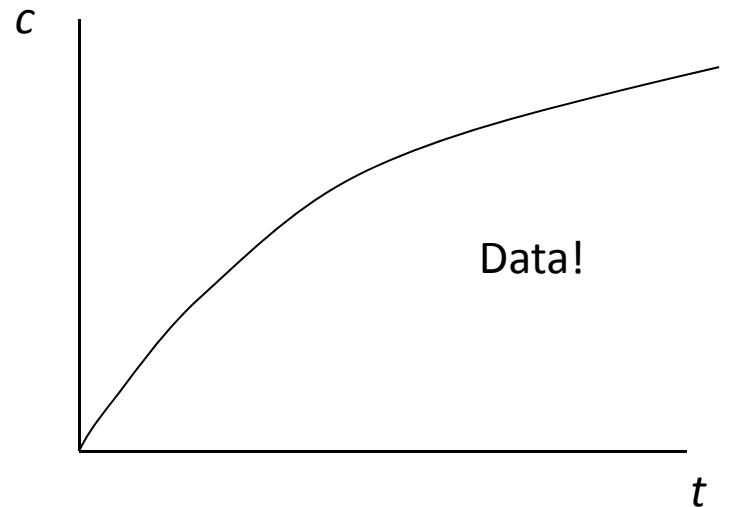
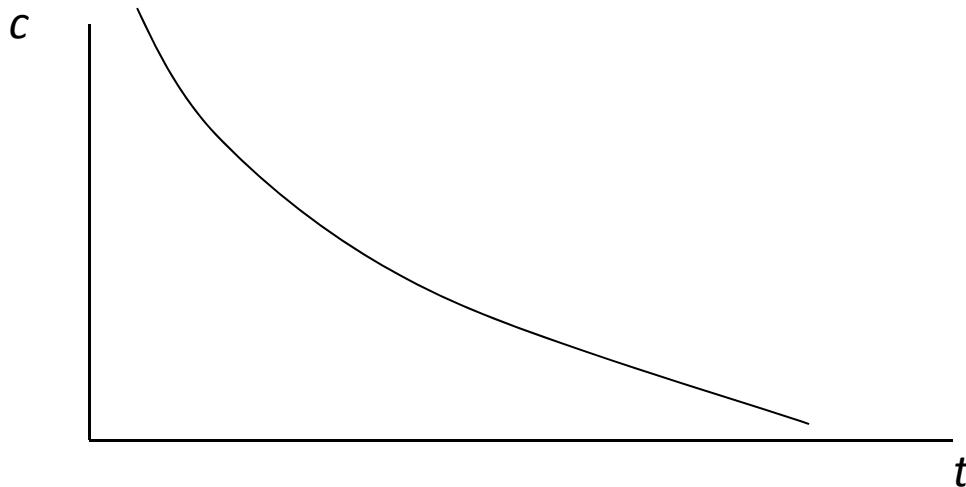
- Intertemporal First Order Condition:

'Standard' Preferences



$$\frac{c_{t+1}}{\beta c_t} = \frac{MU_{c,t}}{\beta MU_{c,t+1}} \approx R_t / \pi_{t+1}$$

- With Standard Preferences:



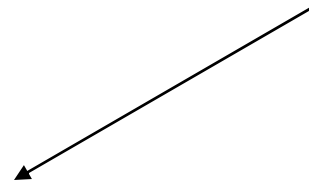
One Resolution to Consumption Puzzle

- Concave Consumption Response Displays:
 - Rising Consumption (problem)
 - Falling Slope of Consumption

- Habit Persistence in Consumption

$$U(c) = \log(c - b \times c_{-1})$$

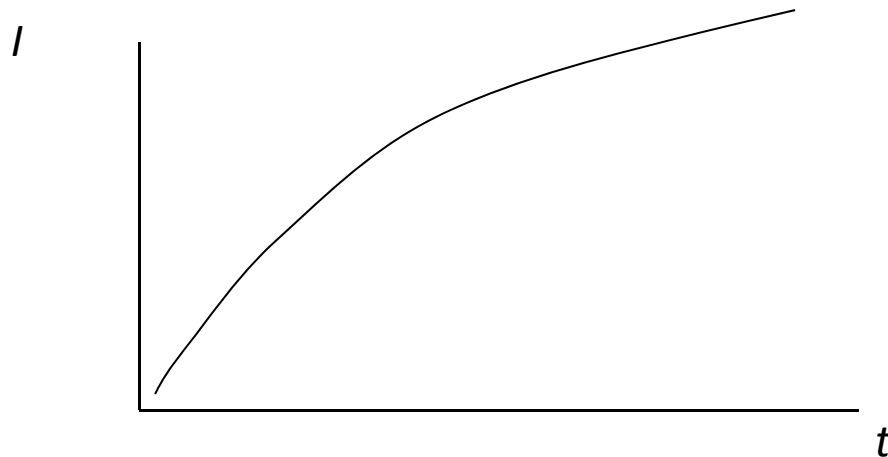
Habit parameter



- Marginal Utility Function of *Slope* of Consumption
 - Hump-Shape Consumption Response Not a Puzzle
- Econometric Estimation Strategy Given the Option, $b > 0$

Dynamic Response of Investment to Monetary Policy Shock

- In Estimated Impulse Responses:
 - Investment Rises in Hump-Shaped Pattern:



One Solution to Investment Puzzle...

- Cost-of-Change Adjustment Costs:

$$k' = (1 - \delta)k + F\left(\frac{I}{I_{-1}}\right)I$$

- This Does Produce a Hump-Shape Investment Response
 - Other Evidence Favors This Specification
 - Empirical: Matsuyama, Smets-Wouters, Topel-Rosen*
 - Theoretical: Matsuyama, David Lucca

*Topel, Robert and Sherwin Rosen, 1988, "Housing Investment in the United States," Journal of Political Economy, Vol. 96(4), pages 718-740, August.

Estimation

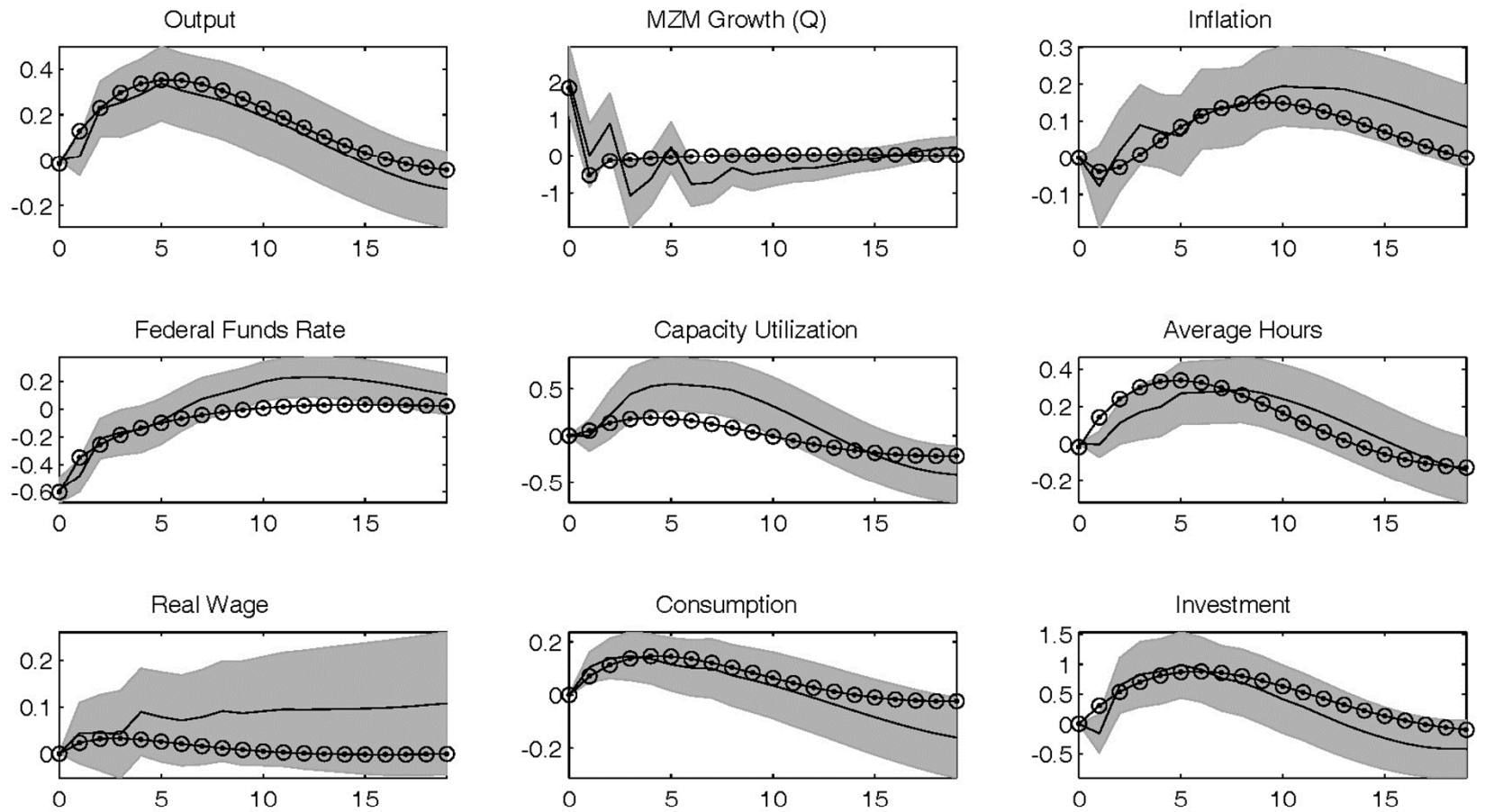
- Choose model parameters (most importantly, degree of stickiness in prices and wages), so that impulse responses from the model resemble the ones estimated in the data.
 - Do this for monetary and two other shocks.
 - Advantage of approach – can focus on key object of interest (Hume/Friedman observation), and need not take a stand on a lot of other shocks.
- Altig-Christiano-Eichenbaum-Linde, (RED 2011) and Christiano-Eichenbaum-Evans (JPE 2005).

Results for Monetary Policy Shock

- Key findings:
 - Can account for sluggish aggregate response to monetary policy shock without a lot of price stickiness*
 - Prices stuck on average 2.38 quarters
 - Wages stuck on average 1 year.
 - Can account for the observed effects of monetary policy on consumption, investment, output, etc.
 - Same model does well accounting for other shocks too*.

*For more details, see http://faculty.wcas.northwestern.edu/~lchrist/course/Gerzensee_2011/lectureACELhandout.pdf

Figure 1: Response to a monetary policy shock (o - Model, - VAR, grey area - 95 % Confidence Interval)



Conclusion

- About 10 years ago, it looked like the Hume/Friedman observation wouldn't be resolved anytime soon.
 - Mankiw (2000), "The Inexorable and Mysterious Tradeoff Between Inflation and Unemployment," National Bureau of Economic Research Working Paper 7884.
- Absent consistency with the Hume/Friedman observation, model unlikely to be of interest to monetary policymakers.
- Finding that NK models are consistent helped to take them from the realm of 'toys' into a tool for grownups to use in serious policy analysis.
 - VAR analysis is an important part of this story.