Labor Share and Technology Dynamics

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(Preliminary)

In This Talk:

- Labor Share: $\zeta = \frac{WNH}{Y}$
- Technology: $z = \widetilde{y} - \zeta \, \widetilde{nh} - (1 - \zeta) \, \widetilde{k}$
- we use the following de-trending procedure (running OLS):

$$\ln(X_t) = c_x + \beta t + \widetilde{x}_t$$

Labor Share in the U.S.

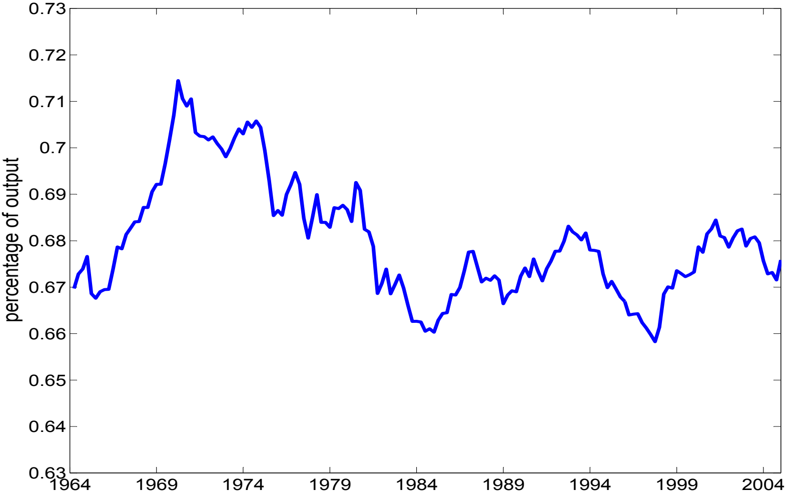


Figure: Labor Share, US data, 1964:I to 2004:IV

Labor Share and Technology Facts: Results from a VAR(1)

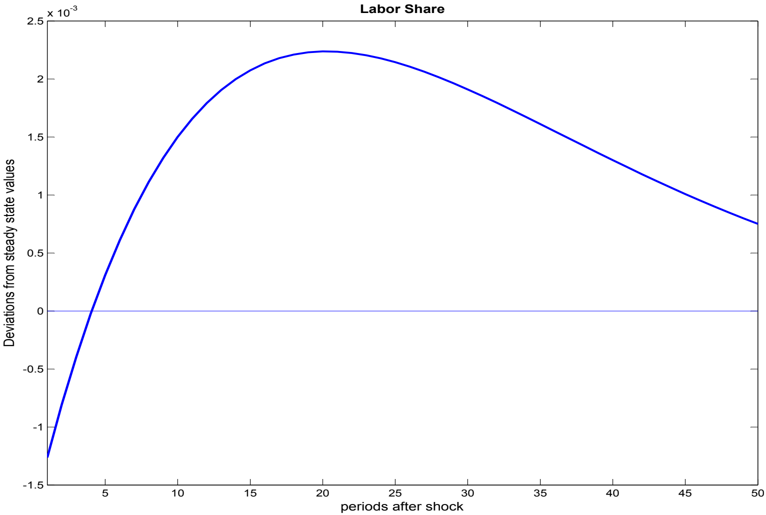


Figure: IRF to shock in technology, US data, 1964:I to 2004:IV

Why?

- We want to understand the co-movement of labor share (and its components) with technology shocks at business cycle frequency
- To rethink how we model aggregate technology and production functions
- To further understand aggregate labor market implications of wage rigidities
- We shed light on which should be the relevant framework for the Shimer (2005) "volatility puzzle"

What we do today:

- Show why standard labor search models cannot produce overshooting
- Present a model with putty-clay technology: a variation on Gourio (2007) and Gilchrist and Williams (2000)
- Show that a sensible parameterization of the latter model delivers overshooting of labor share and discuss the implications for future research

A Benchmark Model

- Standard Labor Search Model
- Firms rent capital and search/match with workers. Matching frictions create a law of motion for bodies

$$N' = (1 - \chi)N + M(V, 1 - N)$$

- Aggregate production function subject to technology shocks

$$y = e^z F(K, Nh)$$

(F is Cobb-Douglas)

- Households rent their assets to the firms, consume and supply bodies to be matched with firms
- two-stage procedure: firms and workers bargain (a la Nash) over wages and workweeks bilaterally; given these values, households and firms solve their dynamic problems

What These Ingredients Do

- Search & matching makes 'bodies' look like capital: we get **'humped-shaped'** response of N after a shock to z
- Wage/workweek setting through Nash-bargaining creates some degree of rigidity in wages: wh moves less than y and we get **counter-cyclical** labor share
- The model delivers most of the empirical facts wrt labor share...

Outcome: No Response of Factor Shares

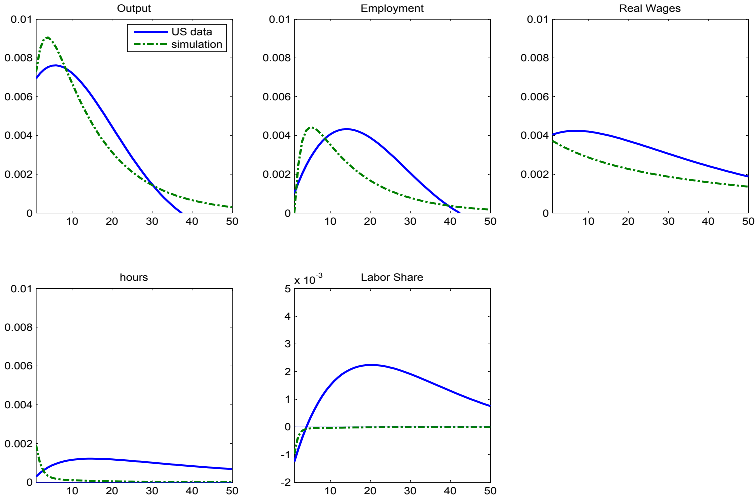


Figure: IRFs to shock in technology, standard labor search model

Culprit: Everyone is a suspect!

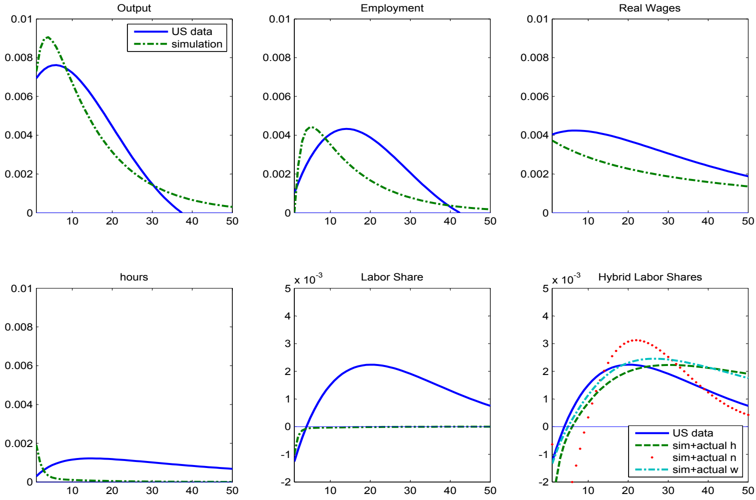


Figure: IRFs to shock in technology, standard labor search model

Standard Labor Search Model with Nash Bargained Wages

- The model cannot replicate labor share dynamics
- Failure lays in hours per worker and the trade-off between getting real wages vs. employment right
- This result is related to the Shimer (2005) "volatility puzzle"

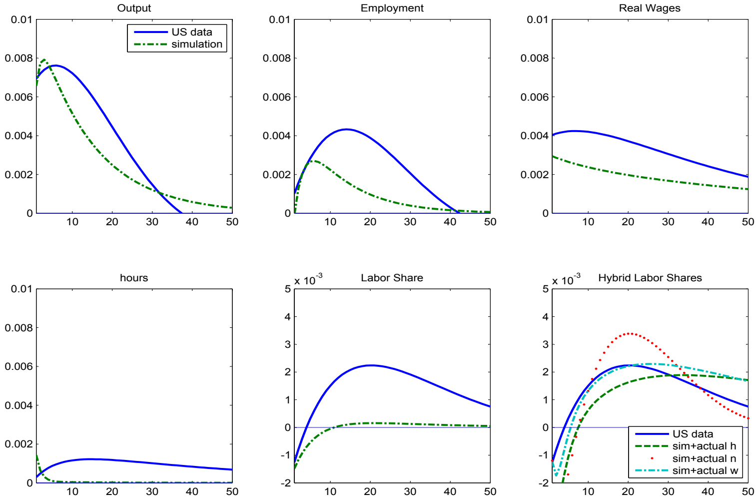
Another Candidate: Search model with CES production function

- Instead of Cobb-Douglas, introduce a CES production function:

$$y = \left[\alpha k^{-\nu} + (1-\alpha)(\widetilde{A}Nh)^{-\nu}\right]^{-\frac{1}{\nu}}$$

where $\widetilde{A}$ is a technology shock (different from Solow residual)

Another Candidate: Search model with CES production function



- Outcome of the simulation is still poor and similar to the previous model

- BUT: we get "some" overshooting $\rightarrow$ maybe we should move away from Cobb-Douglas technology (at least, Cobb-Douglas for all time horizons)

Putty-Clay Technology

- It seems that a necessary property to get the dynamics of labor share right is that employment is attractive
- We explore the possibility that increased productivity is associated mainly to NEW workers
- This requires investment in BOTH workers and machines
- This is the idea behind putty-clay: to take advantage of extra machines installed during an expansion, one needs new workers *in fixed proportions*

Putty-Clay Model

- Production is the result of individual units
- These units combine some capital intensity k and *one unit of labor* to produce the only commodity in the economy using a cobb-douglas production function, $y_k = zk^\alpha$
- Units take one period to become operational
- Once installed, capacity (and unit) remain in place until they break down (constant probability of destruction δ)
- The menu of production is flexible ex-ante ('putty'), but fixed ex-post ('clay')

Investment

- Intensive margin: size of new machines to install this period (k)
- Extensive margin: how many machines to install (q)
- Start by defining the value of an installed machine (attached to a worker):

$$\Pi(z,k) = zk^{\alpha} - w(z,k) + (1-\delta)E\left[R'\Pi(z',k)\right]$$

where $w(z,k)$ is the wage of the worker (idiosyncratic) and R' is the market discount rate

Investment decision

- the optimal size of new machines is defined by the following problem

$$\max_{i} \quad -i + E\left[R'\Pi(z', i)\right]$$

with first order condition

$$1 = ER'\{z'\alpha i^{\alpha-1} - w_2(z', i) + (1-\delta)E\left[R''\Pi_2(z'', i)\right]\}$$

- the number of new machines of size k to install (q) is determined by a zero profit condition

$$E\left[R'\Pi(z', i)\right] = k$$

- Note that given homogeneity of firms and independence of plants in production, each period only one (k, q) pair is chosen by all firms

Wages

- We define a Nash Bargaining game between the firm and the worker

$$w(z,k) = \arg\max_{w} \ (zk^{\alpha} - w)^{1-\mu} \ (w-b)^{\mu}$$

where μ is the bargaining power of the worker

- b is the leisure value (in terms of goods) of having an additional worker in the family. This value depends on the utility function of the household (specifically, on how leisure enters the utility function). Since there is no intensive margin and we assume perfect capital markets, b is common to all family members

Wages: characterization

- The solution to this problem is very similar to the standard case:

$$w(z, k) = \mu z k^{\alpha} + (1 - \mu) b$$

- Current profits of a machine-worker pair are given by

$$z k^{\alpha} - w(z, k) = (1 - \mu)\left(z k^{\alpha} - b\right)$$

- We can guess and verify that $zk^{\alpha} - b$ is always positive (depends on household utility for leisure)
- Then, firms will use every machine until they break down

Aggregation and Dynamics:

- Let $X(s)$ be the current measure of machines smaller than s
- We can define this measure recursively:

$$X'(s) = (1 - \delta)X(s) + x_s$$

  where x_s is the measure of units installed this period that are smaller than s
- This solves the curse of dimensionality: The firm doesn't need to keep track of the whole distribution of productive units, employment nor the wage bill

- Total production:

$$Y = z \int_0^\infty s^\alpha dX(s)$$

- Employment:

$$N = \int_0^\infty dX(s)$$

- The wage bill:

$$\begin{aligned} W &= \int_0^\infty w(z,s) dX(s) \\ &= \int_0^\infty \{\mu z s^\alpha + (1-\mu) b\} dX(s) \\ &= \mu Y + (1-\mu) bN \end{aligned}$$

- Moreover, production and employment follow simple recursive dynamics:

$$\begin{aligned} Y' &= (1-\delta) Y + q k^\alpha \\ N' &= (1-\delta) N + q \end{aligned}$$

Relation with Search Framework:

- Employment is equal to number of installed units (a unit is like a vacancy in the search framework)
- Lag of one period in installing productive units creates a lagged response of employment, much like the lag due to search frictions
- Euler equation for the number of machines to install this period (q) is analogous to recursive surplus equation of labor search and matching models
- However, a key difference is that average wage and average productivity are *not equal* than the marginals

Households

- To close the model, we define the household problem:
- Households (HH) have preferences for consumption and number of employed individuals. Members pool income and share consumption
- Households own diversified portfolios with claims on all firm's profits, hence
$$\Rightarrow 1 = \beta E\left[\frac{u_c(c')}{u_c(c)}(1+r')\right]$$

Household Preferences

- Key for Nash Bargaining outcome and wage dynamics is the value of b

- Our baseline is the Andolfatto (1996) case

$$U(c, n) = log(c) + Nv_n + (1 - N)v_u \Rightarrow b = \frac{v_u - v_n}{u_c}$$

Parameterization

- Model period corresponds to one quarter
- We pick $\{\beta, \delta, \alpha, v_u\}$ to match long run averages of
  1. consumption-output ratio (0.75)
  2. capital-output ratio (9.24)
  3. labor share (0.68)
  4. employment (0.95)
- With respect to μ, we set it to 0.12 in order to match the contemporaneous effect of real wages to productivity shocks

Checking that $zk^\alpha - b > 0$

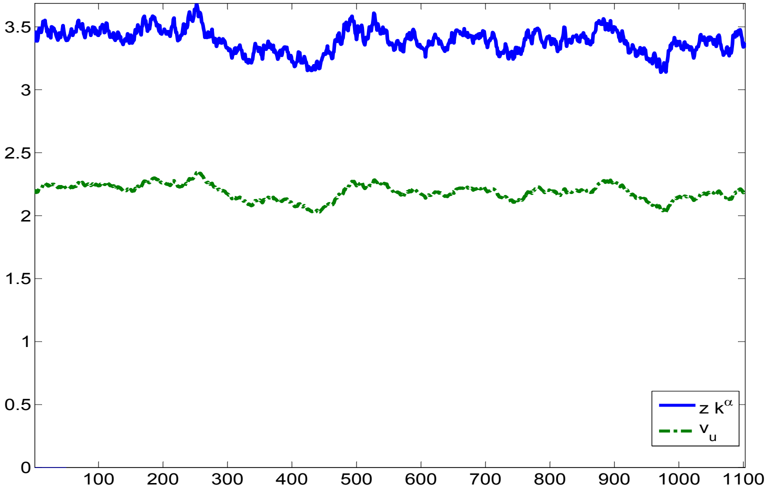


Figure: Simulated paths of model

Marginal wages

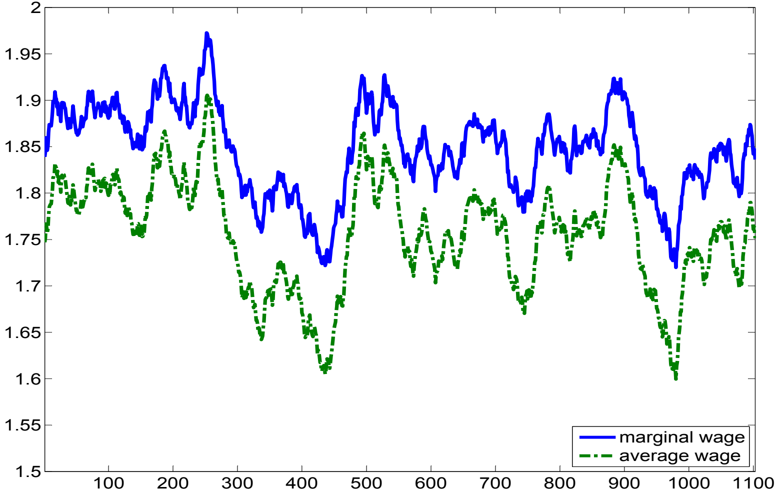


Figure: Simulated wages

Marginal versus Average

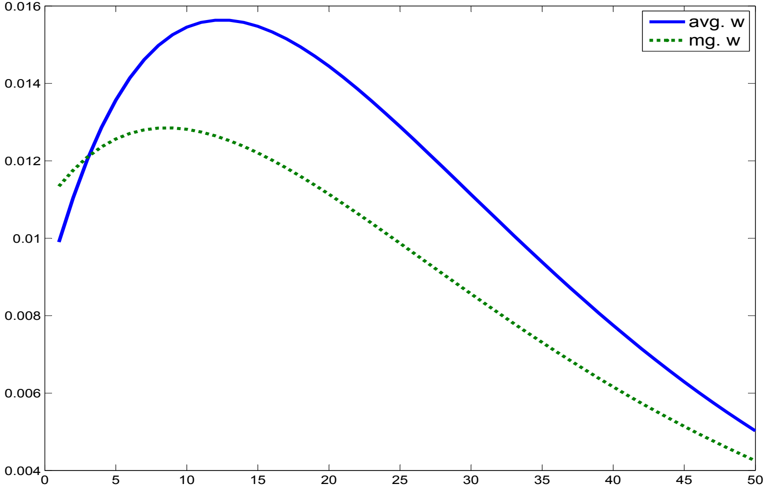


Figure: Response of simulated wages

Simulating the Putty-Clay model: Baseline with $\mu = 0.12$

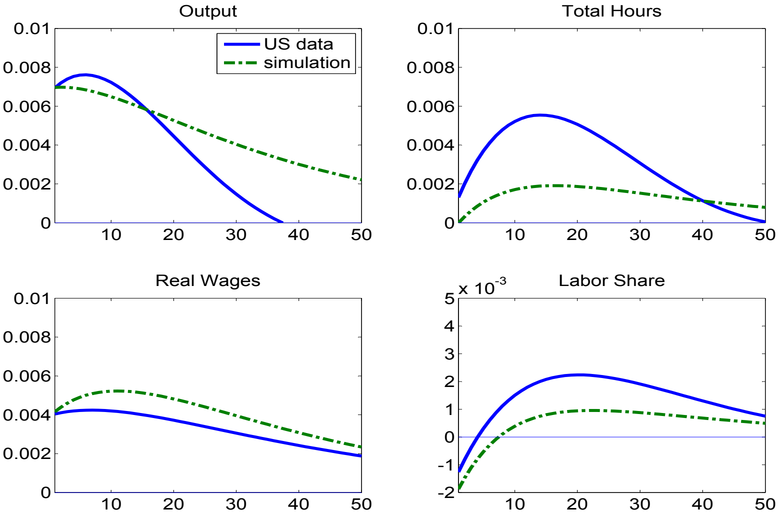


Figure: IRFs to shock in technology, putty-clay model

What we learn from the model

- Putty-Clay framework accounts for a significant fraction of labor share overshooting
- The model produces higher output persistence than in the data
- Failure in employment creation

Conclusion

- Factor share and Technology dynamics provide a good starting point to think about different RBC models
- The Putty-Clay framework underscores the need for a better model of technology (away from Cobb-Douglas)
- Are we using the right framework to analyze the Shimer puzzle?
- Homework: Hours per worker? different (n, k) combinations?