Labor Share and Technology Dynamics

Sekyu Choi       José-Víctor Ríos-Rull

UAB, University of Minnesota, FRBM, CAERP, CEPR, NBER

Conference on Structural Models of the Labour Market and Policy Analysis
October 3, 2009
Labor Share Overshooting

Figure: IRFs to shock in technology, US data, 1964:I to 2004:IV
Facts: Labor Share Overshooting

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

Goal: to understand the co-movement of labor share (and its components) with technology shocks at business cycle frequency

What we know so far: standard labor search models, although tailored to emulate salient features of labor markets, cannot deal with overshooting fact (Choi and Ríos-Rull, 2009)

We explore whether modifying the technology of the environment might do the trick
Roadmap

- We show why standard labor search models cannot produce overshooting
- We present a model with putty-clay technology: a variation on Gourio (2007) and Gilchrist and Williams (2000)
- We show that a sensible parameterization of the latter model delivers overshooting of labor share... but is far from a perfect model
- ⇒ we can assess the importance of different assumptions on technology and market arrangements for achieving our objective
- Still, a big homework left to solve!!!
A Benchmark Model

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

\[ \dot{N} = (1 - \chi)N + M(V, 1 - N) \]

- 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

- The labor share is \( \frac{whN}{y} \) (wage bill times employment over output)

- 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

- Side note: In terms of employment volatility, this model doesn't have the problems claimed by Shimer (2005). This is because it is calibrated following Andolfatto (1996) and Cheron and Langot (2004) (High SS unemployment target). See Costain and Reiter (2008)

- Failure lays in hours per worker and the trade-off between getting real wages vs. employment right

- Shao and Silos (2008) provide a nice setup that might do the trick: Labor Search model + Monopolistic Competition in final goods: they introduce a non-trivial value of vacancies (since firms have to pay sunk costs to post vacancies). This is similar to what Fujita and Ramey (2007)
Shao and Silos (2008) provide a nice setup that might do the trick: Labor Search model + Monopolistic Competition in final goods.

They introduce a non-trivial value of vacancies, since firms have to pay sunk costs to post them. This is similar to what Fujita and Ramey (2007) propose.
Search and Monopolistic Competition: Shao and Silos (2008)

Figure: IRFs to shock in technology, Shao and Silos model

Sekyu Choi, José-Víctor Ríos-Rull
UAB, Minnesota, FRBM, CAERP

Labor Share and Technology Dynamics
Sandbjerg Manor–October 3, 2009
• Some overshooting

• No employment!
Another Candidate: Search model with CES production function

Figure: IRFs to shock in technology, standard labor search model + CES tech.

Sekyu Choi, José-Victor Ríos-Rull
UAB, Minnesota, FRBM, CAERP

Labor Share and Technology Dynamics

Sandbjerg Manor–October 3, 2009
The model introduces a CES production function:

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

where \( \tilde{z} \) is a technology shock.

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 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, $y = k^\alpha$.
- Units take one period to become operational.
- Once installed, capacity (and unit) remain in place until they break down (constant probability $\delta$).
- The menu of production is flexible ex-ante (‘putty’), but fixed ex-post (‘clay’).
The Firm:

- The representative firm is a collection of productive units.

- Total output is given by:

\[ Y = z \int_0^\infty s^\alpha dX(s) \equiv zY \]

where \( z \) is an aggregate shock to production and \( X(s) \) is the measure of productive units with capital intensity less than \( s \).

- On the other hand, given the wage rate \( (w) \), the wage bill for the firm is:

\[ W = w \int_0^\infty sdX(s) \equiv wN \]
Aggregation and Dynamics:

- Under certain assumptions, both $\bar{Y}$ and $N$ can be defined recursively

\[
\bar{Y}' = (1 - \delta)\bar{Y} + qk^\alpha \\
N' = (1 - \delta)N + q
\]

where $q$ is the measure of units installed this period and $k$ its intensity

- This solves the curse of dimensionality: The firm doesn’t need to keep track of the whole distribution of productive units

- The state space is then $\mathcal{S} \equiv \{z, \bar{Y}, N\}$
Recursive Problem of the Firm:

- For a representative firm (and given rental rates $w$ and $R$) the problem entails deciding two policy functions: one for the intensity of installation ($k$) and another for the quantity to be installed ($q$):

$$\Pi(S) = \max_{\{q,k\}} \{ z\bar{Y} - wN - qk + E[R'\Pi(S')] \}$$

subject to the laws of motion for $\bar{Y}$ and $N$

- FOC’s for $k$ and $q$ are respectively:

$$q = E \left[ R' \left( \Pi_2(S') \frac{\partial \bar{Y}'}{\partial k} \right) \right]$$

$$k = E \left[ R' \left( \Pi_2(S') \frac{\partial \bar{Y}'}{\partial q} + \Pi_3(S') \frac{\partial N'}{\partial q} \right) \right]$$
Rewriting the FOCs:

\[ q = q_0 k^{\alpha - 1} E \left[ R' \Pi_2 (S') \right] \]
\[ k = E \left[ R' \left( \Pi_2 (S') k^\alpha + \Pi_3 (S') \right) \right] \]

After some algebra:

\[ \frac{1}{\alpha k^{\alpha - 1}} = E \left[ R' \Pi_2 (S') \right] \]
\[ k \left( \frac{\alpha - 1}{\alpha} \right) = E \left[ R' \Pi_3 (S') \right] \]
Envelope conditions:

\[ \Pi_2 = z + E \left[ R'\Pi_2(S') \frac{\partial Y'}{\partial Y} \right] \]
\[ = z + (1 - \delta)E \left[ R'\Pi_2(S') \right] \]

and

\[ \Pi_3 = -w + E \left[ R'\Pi_3(S') \frac{\partial N'}{\partial N} \right] \]
\[ = -w + (1 - \delta)E \left[ R'\Pi_3(S') \right] \]
Using FOC’s, Envelopes and the fact that installed capital quality $k$ doesn’t change in time, we get

- Euler equations for $k$

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

- Euler for $q$

\[
k = E \left[ R' \left( z' k^\alpha - w' + (1 - \delta)k \right) \right]
\]
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 \( q \) is analogous to recursive surplus equation of labor search and matching models
To close the model, we define the household problem:

- Households (HH) have preferences for consumption and leisure. Members pool income and share consumption

- Given employment level \((n)\), instantaneous utility is given by

\[
U(c, n) = u(c) + v(1 - n)
\]
Households own diversified portfolios with claims on all firm’s profits, hence

\[ R' = \beta E \left[ \frac{u_c(c')}{u_c(c)} \right] \]

Also, we get the optimality condition for HH leisure:

\[ w = \frac{v_n}{u_c} \]
Utility:

\[
\begin{align*}
    u(c) &= \log(c) \\
    \nu(1 - n) &= n\nu_n + (1 - n)\nu_u
\end{align*}
\]

- We normalize \( \nu_n = 0; \) \( \nu_u \) determines SS employment
- Besides this parameters, the rest of the parameterization is standard
Simulating the Putty-Clay model

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

- Key model ingredient: zero substitutability b/w capital and labor → firms cannot substitute between inputs when one is getting relatively more expensive

- Still, the model fails in recreating employment dynamics (level and timing of response)
Putty-Clay Model: some extensions

- Consider an ad-hoc rule for wages

\[ w = \mu \left[ \frac{v_n}{u_c} \right] + (1 - \mu) \left[ z(1 - \alpha) \left( \frac{K}{N} \right)^\alpha \right] \]

where \( \mu \in (0, 1) \) can be considered the firm’s bargaining power.

- This formulation resembles axiomatic Nash-bargaining. In our baseline calibration, we have \( \mu = 1 \), which means that the wage setting favors firms over workers.

- Also, let’s assume some sort of ”Garrison” effect in the utility of leisure:

\[ v(1 - n) = nv_n + (1 - n)^\kappa v_u \]
Baseline Putty-Clay: \((\mu = 1, \kappa = 1)\)

Figure: IRFs to shock in technology, putty-clay model
Extended Putty-Clay models ($\mu = 0.5, \kappa = 1$)

Figure: IRFs to shock in technology, extended putty-clay model
Extended Putty-Clay models ($\mu = 1$, $\kappa = 0.5$)

Figure: IRFs to shock in technology, extended putty-clay model
Extended Putty-Clay models ($\mu = 0.5$, $\kappa = 0.5$)

Figure: IRFs to shock in technology, extended putty-clay model
Different wage setting rules help with employment creation but not overall performance of the model wrt labor share.

Garrison effect helps with overshooting, but at the expense of employment and real wages.

As in the search framework, there is a tension between employment dynamics and wage setting rules.
Conclusion

- Still looking for a good theory of the cyclical volatility of factor shares

- The Putty-Clay framework underscores the need for a better model of technology (away from Cobb-Douglas)

- It’s not clear how wage setting should look like