AGGREGATE DEMAND, IDLE TIME, AND UNEMPLOYMENT

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UNEMPLOYMENT FLUCTUATIONS REMAIN INSUFFICIENTLY UNDERSTOOD
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technology? aggregate demand?
UNEMPLOYMENT FLUCTUATIONS REMAIN INSUFFICIENTLY UNDERSTOOD
MODERN MODELS

- matching model of the labor market
  - tractable
  - but no aggregate demand
- New Keynesian model with matching frictions on the labor market
  - many shocks, including aggregate demand
  - but complex
vast literature after Barro & Grossman [1971]
  - revival after the Great Recession
\item captures effect of aggregate demand on unemployment
\item but supply-side factors are irrelevant in demand-determined regimes
\item and difficult to analyze because of multiple regimes
THIS PAPER’S MODEL

- Barro-Grossman architecture
- matching structure on product market & labor market
  - instead of disequilibrium structure
  - markets can be too slack or too tight but remain in equilibrium
- aggregate demand affects unemployment
  - as do labor productivity, mismatch, job search, and labor-force participation
- simple: graphical representation of equilibrium
BASIC MODEL: PRODUCT MARKET
• static model
• measure 1 of identical households
• households produce and consume services
  – no firms: services produced within households
  – households cannot consume their own services
• services are traded on matching market
• households visit other households to buy services
MATCHING FUNCTION & TIGHTNESS

$k$ services

$v$ visits
MATCHING FUNCTION & TIGHTNESS

\[ k \text{ services} \]

\[ \text{sales} \]

\[ \text{CRS matching function } h(k, \nu) \]

\[ \text{purchases} \]

\[ \nu \text{ visits} \]
MATCHING FUNCTION & TIGHTNESS

sales = \( k \cdot h(1, x) = k \cdot f(x) \)

output: \( y = h(k, v) \)

purchases = \( v \cdot h \left( \frac{1}{x}, 1 \right) = v \cdot q(x) \)

tightness: \( x = \frac{v}{k} \)

\( k \) services

\( v \) visits
EVIDENCE OF UNSOLD CAPACITY

- Idleness, non-manufacturing
- Idleness, manufacturing
- Unemployment
MATCHING COST: $\rho \in (0, 1)$ SERVICE PER VISIT

- consumption $\equiv$ output net of matching services
  - consumption, not output, yields utility
- key relationship: output $= [1 + \tau(x)] \cdot$ consumption
- matching wedge $\tau(x)$ summarizes matching costs:

\[
\begin{align*}
y & = \underbrace{c}_{\text{output}} + \underbrace{\rho \cdot v}_{\text{matching services}} = c + \rho \cdot \frac{y}{q(x)} \\
\Rightarrow y & = \left[1 + \frac{\rho}{q(x) - \rho}\right] \cdot c \equiv \left[1 + \tau(x)\right] \cdot c
\end{align*}
\]
EVIDENCE OF MATCHING COSTS

Thousands of workers devoted to purchasing (matching on product market)

Thousands of workers devoted to recruiting (matching on the labor market)
CONSUMPTION < OUTPUT < CAPACITY

- output $y < k$ because the matching function prevents all services from being sold
  - selling probability $f(x) < 1$
- consumption $c < y$ because some services are devoted to matching so cannot provide utility
  - matching wedge $\tau(x) > 0$
- consumption is directly relevant for welfare
AGGREGATE SUPPLY

• aggregate supply ≡ number of services consumed at tightness x, given the supply of services k and matching process

\[ c^S(x) = \frac{f(x)}{1 + \tau(x)} \cdot k = [f(x) - \rho \cdot x] \cdot k \]

• could represent aggregate supply in terms of output instead of consumption, but consumption is linked to welfare
TIGHTNESS & AGGREGATE SUPPLY

product market tightness $x$

quantity of services

capacity: $k$
output: \( y = f(x) \cdot k \)

- capacity \( k \)
- product market tightness \( x \)
- quantity of services
- idle time
aggregate supply:
output $y$
capacity $k$
quantity of services
product market tightness $x$
matching cost
cost $c^s(x) = [f(x) - \rho x]k$
TIGHTNESS & AGGREGATE SUPPLY

aggregate supply $c^s(x)$ output $y$

cost

consumption

quantity of services

product market tightness $x$

idle time

capacity $k$
MONEY

- money is in fixed supply $\mu$
- households hold $m$ units of money
- the price of services in terms of money is $p$
- real money balances enter the utility function
  - Barro & Grossman [1971]
  - Blanchard & Kiyotaki [1987]
HOUSEHOLDS

- take price $p$ and tightness $x$ as given
- choose $c$, $m$ to maximize utility

$$\frac{\chi}{1+\chi} \cdot c \cdot \epsilon^{-1} + \frac{1}{1+\chi} \cdot \left( \frac{m}{p} \right)^{\epsilon^{-1}}$$

services \hspace{1cm} real money balances

- subject to budget constraint

$$m + p \cdot (1 + \tau(x)) \cdot c = \mu + f(x) \cdot p \cdot k$$

money \hspace{1cm} expenditure on services \hspace{1cm} endowment \hspace{1cm} labor income
AGGREGATE DEMAND

• optimal consumption decision:

\[
\left(1 + \tau(x)\right) \cdot \frac{1}{1 + \chi} \cdot \left(\frac{m}{p}\right)^{-\frac{1}{\epsilon}} = \frac{\chi}{1 + \chi} \cdot c^{-\frac{1}{\epsilon}}
\]

relative price
MU of real money
MU of services

• money market clears: \( m = \mu \)

• aggregate demand gives desired consumption of services given price \( p \) and tightness \( x \):

\[
c^d(x, p) = \left(\frac{\chi}{1 + \tau(x)}\right)^\epsilon \cdot \frac{\mu}{p}
\]
there is a direct link between consumption of services, purchase of services, and visits

if the desired consumption is \( c^d(x, p) \)

the desired number of purchases is

\[
(1 + \tau(x)) \cdot c^d(x, p)
\]

and the required number of visits is

\[
v = \frac{(1 + \tau(x)) \cdot c^d(x, p)}{q(x)}
\]
product market tightness $x$

consumption $c$

$c^d(x, p) = \left( \frac{\chi}{1 + \tau(x)} \right)^\epsilon \cdot \frac{\mu}{p}$
price $p$ + tightness $x$ equilibrate supply and demand:

$$c^s(x) = c^d(x, p)$$

the matching equilibrium is richer than the Walrasian equilibrium—where only price equilibrates supply and demand

- can describe “Walrasian situations” where price responds to shocks and tightness is constant
- but can also describe “Keynesian situations” where price is constant and tightness responds to shocks
we need a price mechanism to completely describe the equilibrium

here we consider two polar cases:
  – fixed price [Barro & Grossman 1971]
  – competitive price [Moen 1997]

in the paper we also consider:
  – bargaining (typical in the matching literature)
  – partially rigid price [Blanchard & Gali 2010]
COMPARATIVE STATICS
INCREASE IN AD WITH FIXED PRICE ($\chi \uparrow$)
INCREASE IN AD WITH FIXED PRICE ($\chi \uparrow$)
INCREASE IN AS WITH FIXED PRICE \( (k \uparrow) \)
## COMPARATIVE STATICS WITH FIXED PRICE

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<td>aggregate supply $k$</td>
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EFFICIENT EQUILIBRIUM: CONSUMPTION IS MAXIMUM

efficient equilibrium: price is competitive

product market tightness

consumption

$\chi^*$

$C^*$

AS

AD
SLACK EQUILIBRIUM: CONSUMPTION IS TOO LOW

slack equilibrium: price is too high

Product market tightness

consumption

$\chi^*$

$\gamma^*$
TIGHT EQUILIBRIUM: CONSUMPTION IS TOO LOW

tight equilibrium: price is too low

product market tightness

consumption
## Comparative Statics with Competitive Price

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COMPLETE MODEL: PRODUCT MARKET & LABOR MARKET
LABOR MARKET & UNEMPLOYMENT

- Labor supply $n^s(\theta)$
- Employment $l$
- Labor force $h$
- Producers
- Recruiters
- Unemployment

Diagram showing labor market tightness $\theta$ vs. workers with curves for labor supply, employment, and labor force.
FIRMS

- workers are hired on matching labor market
- production is sold on matching product market
- firms employ producers and recruiters
  - number of recruiters $= \hat{r}(\theta) \times$ producers
  - number of employees $= [1 + \hat{r}(\theta)] \times$ producers
- take real wage $w$ and tightnesses $x$ and $\theta$ as given
- choose number of producers $n$ to maximize profits

$$f(x) \cdot a \cdot n^\alpha - [1 + \hat{r}(\theta)] \cdot w \cdot n$$

selling probability production wage of producers + recruiters
LABOR DEMAND

• optimal employment decision:

\[ f(x) \cdot \alpha \cdot a \cdot n^{\alpha - 1} = (1 + \hat{\tau}(\theta)) \cdot w \]

  - selling probability
  - MPL
  - matching wedge
  - real wage

• same as Walrasian first-order condition, except for selling probability < 1 and matching wedge > 0

• labor demand gives the desired number of producers:

\[ n^d(\theta, x, w) = \left[ \frac{f(x) \cdot a \cdot \alpha}{(1 + \hat{\tau}(\theta)) \cdot w} \right]^{\frac{1}{1-\alpha}} \]
PARTIAL EQUILIBRIUM ON LABOR MARKET

![Graph showing labor market equilibrium](graph.png)
prices \((p, w)\) and tightnesses \((x, \theta)\) equilibrate supply and demand on product and labor markets:

\[
\begin{align*}
    c_s(x, \theta) &= c_d(x, p) \\
    n_s(\theta) &= n_d(\theta, x, w)
\end{align*}
\]

- need to specify price and wage mechanisms
  - fixed price and fixed wage
  - competitive price and competitive wage
AD increases so $x$ increases: it is easier for firms to sell output.
EFFECT OF AD WITH FIXED PRICES

 increases so LD and \( \theta \) increase: unemployment falls

employment

unemployment

labor force

workers

labor market tightness \( \theta \)
possible feedback: as employment changes, capacity and thus $x$ may adjust, dampening or amplifying the initial change in $x$. 

EFFECT OF AD WITH FIXED PRICES

- **AS**
- **AD**
- **product market tightness $x$**
- **output**
- **capacity**
- **quantity**
KEYNESIAN, CLASSICAL, & FRICTIONAL

UNEMPLOYMENT

- equilibrium unemployment rate:

\[ u = 1 - \frac{1}{h} \left( \frac{f(x) \cdot a \cdot \alpha}{w} \right)^{\frac{1}{1-\alpha}} \cdot \left( \frac{1}{1 + \hat{\tau}(\theta)} \right)^{\frac{\alpha}{1-\alpha}} \]

- if \( f(x) = 1, w = a\alpha h^{\alpha-1} \), and \( \hat{\tau}(\theta) = 0 \), then \( u = 0 \)

- the factors of unemployment therefore are
  - Keynesian factor: \( f(x) < 1 \)
  - classical factor: \( w > a \cdot \alpha \cdot h^{\alpha-1} \)
  - frictional factor: \( \hat{\tau}(\theta) > 0 \)
# COMPARATIVE STATICS WITH FIXED PRICES

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<th>employment $l$</th>
<th>labor tightness $\theta$</th>
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<tr>
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RIGID OR FLEXIBLE PRICES?
When utilization is low, it is hard to sell production, which indicates that product market tightness $x$ is low.
FLUCTUATIONS IN $x \Rightarrow$ RIGID PRICE

proxy for cyclical component of $x$
FLUCTUATIONS IN $\theta \Rightarrow$ RIGID REAL WAGE

The cyclical component of $\theta$ is shown in the graph from 1980 to 2010.
LABOR DEMAND

OR LABOR SUPPLY SHOCKS?
LABOR DEMAND & LABOR SUPPLY SHOCKS

- source of labor demand shocks:
  - aggregate demand $\chi$
  - technology $a$

- source of labor supply shocks:
  - labor-force participation $h$
  - $h$ can also be interpreted as job-search effort
PREDICTED EFFECTS OF SHOCKS

- labor supply shocks:
  - negative correlation between employment \((l)\) and labor market tightness \((\theta)\)

- labor demand shocks:
  - positive correlation between employment \((l)\) and labor market tightness \((\theta)\)
$\text{corr}(l, \theta) > 0 \Rightarrow \text{LABOR DEMAND}$
CROSS-CORRELOGRAM: $\theta$ (LEADING) & $l$
AGGREGATE DEMAND
OR TECHNOLOGY SHOCKS?
PREDICTED EFFECTS OF SHOCKS

• aggregate demand shocks:
  – **positive** correlation between output \( y \) and product market tightness \( x \)
• technology shocks:
  – **negative** correlation between output \( y \) and product market tightness \( x \)
$\text{corr}(y, x) > 0 \Rightarrow \text{AD}$

- cyclical component of $y$
- cyclical component of $x$
CROSS-CORRELOGRAM: $x$ (LEADING) & $y$
CONCLUSION
we develop a tractable, general-equilibrium model of unemployment fluctuations
we construct empirical series for
  - product market tightness
  - labor market tightness
we find that unemployment fluctuations stem from
  - price rigidity and real-wage rigidity
  - aggregate demand shocks
APPLICATIONS OF THE MODEL TO POLICY

- optimal unemployment insurance
  - Landais, Michaillat, & Saez [2018]
- optimal public expenditure
  - Michaillat & Saez [2019]
- optimal monetary policy
  - Michaillat & Saez [2021]