Aggregate Demand, Idle Time, and Unemployment

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unemployment fluctuations remain insufficiently understood
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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 fairly complex
general-disequilibrium model

- vast literature after Barro & Grossman [1971]
  - revival after the Great Recession

- captures effect of aggregate demand on unemployment

- but limited role of supply-side factors in demand-determined regimes

- and difficult to analyze because of multiple regimes
the model in this paper

- Barro-Grossman architecture
- but matching structure on product + labor markets
  - instead of disequilibrium structure
  - advantage: markets can be too slack or too tight but remain in equilibrium
- aggregate demand, technology, mismatch, and labor supply (search / participation) affect unemployment
- simple: graphical representation of equilibrium
basic model:
only product market
structure

- 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 and tightness

$k$ services

$v$ visits
matching function and tightness

$\text{CRS matching function } h(k, v)$

$k$ services

sales

purchases

$\nu$ visits
matching function and 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: $x = v / k$

$k$ services

$v$ visits
low product market tightness
high product market tightness
evidence of unsold capacity

![Graph showing the percentage of idleness and unemployment from 1990 to 2010. The graph includes three lines: blue for idleness in non-manufacturing, black for idleness in manufacturing, and green for unemployment. The data shows fluctuations over the years, with peaks and troughs indicating changes in the economic conditions.]
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

\[
\begin{align*}
\begin{array}{c}
\text{output} \\
\text{consumption} \\
\text{matching services}
\end{array}
\end{align*}
\]

\[
y = c + \rho \cdot \frac{y}{q(x)}
\]

\[
\Rightarrow y = \left[ 1 + \frac{\rho}{q(x) - \rho} \right] \cdot c \equiv \left[ 1 + \tau(x) \right] \cdot c
\]
evidence of matching costs

workers devoted to purchasing (matching on product market)

workers devoted to recruiting (matching on the labor market)
consumption < output < capacity

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

- aggregate supply indicates the number of services consumed at tightness $x$, given the supply of services $k$ and the matching process

$$c^s(x) = \dfrac{f(x)}{1 + \tau(x)} \cdot k = [f(x) - \rho \cdot x] \cdot k$$

- it is equivalent to represent aggregate supply (and demand) in terms of output instead of consumption

- but consumption representation is linked to welfare
tightness and aggregate supply

\[
\text{product market tightness } x
\]

\[
\text{quantity of services}
\]

capacity: \( k \)
tightness and aggregate supply

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

idle time

capacity $k$

quantity of services

product market tightness $x$
tightness and aggregate supply

Aggregate supply:

$$c^s(x) = [f(x) - \rho x]k$$

output $y$

quantity of services

product market tightness $x$

capacity $k$

matching cost
tightness and aggregate supply

aggregate supply \( c^s(x) \)  
output \( y \)  
capacity \( k \)

product market tightness \( x \)

consumption

matching cost

idle time

quantity of services
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 $\tau$ as given
- choose $c, m$ to maximize utility

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

- subject to budget constraint

$$m_{\text{money}} + p \cdot (1 + \tau(x)) \cdot c = \mu_{\text{endowment}} + f(x) \cdot p \cdot k_{\text{labor income}}$$
aggregate demand

- optimal consumption decision:

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

- money market clears: \( m = \mu \)

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

\[
c^d(x, p) = \left( \frac{\chi}{1 + \tau(x)} \right)^{\varepsilon} \cdot \frac{\mu}{p}
\]
linking aggregate demand and visits

- 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

$$ \frac{(1 + \tau(x)) \cdot c^d(x, p)}{q(x)} $$
tightness and aggregate demand

$$c^d(x, p) = \left( \frac{\chi}{1 + \tau(x)} \right)^\epsilon \cdot \frac{\mu}{p}$$
equilibrium

- price $p$ + tightness $x$ equilibrate supply and demand: $c^s(x) = c^d(x, p)$
- the matching equilibrium is much richer than the Walrasian equilibrium—where only the 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 (slack) responds to shocks
price mechanism

- 1 condition but 2 variables \((x, p)\): 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 literature)
  - partially rigid price
comparative statics
increase in AD with fixed price ($\chi \uparrow$)

---

product market tightness

$\chi$

$xyk$

AS

AD

equilibrium

output

capacity

quantity

$k$
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 demand $\chi$</td>
<td>$y$: $+$</td>
<td>$x$: $+$</td>
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<tr>
<td>aggregate supply $k$</td>
<td>$y$: $+$</td>
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efficient equilibrium: consumption is maximum

efficient equilibrium: price is competitive
slack equilibrium: consumption is too low

slack equilibrium: price is too high
tight equilibrium: consumption is too low

紧缩均衡：消费过低
comparative statics with competitive price: price absorbs all shocks so tightness is constant

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complete model:

product + labor markets
labor market and unemployment

- labor supply $n^s(\theta)$
- employment $l$
- labor force $h$
- producers
- recruiters
- unemployment

labor market tightness $\theta$

workers
firms

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

\[
\underbrace{f(x) \cdot a \cdot n^\alpha}_{\text{selling probability}} - \underbrace{[1 + \hat{\tau}(\theta)] \cdot w \cdot n}_{\text{wage of producers + recruiters}}
\]
labor demand

■ optimal employment decision:

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

■ 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

\[ \theta \]

labor market tightness

labor supply

employment

labor force

partial equilibrium

labor demand

workers

\[ n \]

\[ l \]

\[ h \]
general equilibrium

- prices \((p, w)\) and tightnesses \((x, \theta)\) equilibrate supply and demand on product + labor markets:

\[
\begin{align*}
    c^s(x, \theta) &= c^d(x, p) \\
    n^s(\theta) &= n^d(\theta, x, w)
\end{align*}
\]

- 2 equations, 4 variables: need price + wage mechanisms
  - fixed price and fixed wage
  - competitive price and competitive wage
effect of AD on unemployment with fixed prices

AD increases so $x$ increases: it is easier for firms to sell

- product market tightness $x$
- output
- capacity

quantity
effect of AD on unemployment with fixed prices

\[ x \text{ increases so LD and } \theta \text{ increase: unemployment falls} \]

unemployment

employment

labor force

workers

labor market tightness \( \theta \)

\( x \)

\( LD \)

\( LS \)
effect of AD on unemployment with fixed prices

possible feedback: as employment changes, capacity and thus $x$ may adjust, dampening or amplifying the initial change in $x$
Keynesian, classical, and frictional unemployment

- equilibrium unemployment rate:

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

- 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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comparative statics with competitive prices: prices absorb all shocks so tightnesses are constant

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rigid or flexible prices?
we construct $x$ from capacity utilization in SPC

when utilization is low, it is hard to sell production, which indicates that product market tightness $x$ is low.
fluctuations in $x \implies$ rigid price

proxy for cyclical component of $x$
fluctuations in $\theta \iff$ rigid real wage

cyclical component of $\theta$

cyclical component of $\theta$
labor demand or labor supply shocks?
labor demand and 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 \((\theta)\)
positive correlation between $l$ and $\theta \implies$ labor demand
cross-correlogram: $\theta$ (leading) and $l$
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 \((x)\)
positive correlation between $y$ and $x \implies AD$
cross-correlogram: $x$ (leading) and $y$
conclusion
summary

- 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

- monetary business-cycle model, with liquidity trap
  - Michaillat & Saez [2014]
- optimal unemployment insurance
  - Landais, Michaillat, & Saez [2010]
- optimal public expenditure
  - Michaillat & Saez [2015]
- optimal monetary policy
  - Michaillat & Saez [2016]