Aggregate Demand, Idle Time, and Unemployment

Pascal Michaillat
Emmanuel Saez

Quarterly Journal of Economics, 2015
unemployment fluctuations remain insufficiently understood
unemployment fluctuations remain insufficiently understood

Unemployment rate

1980 1990 2000 2010
3%
5%
7%
9%
11%
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 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

- 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
matching function and tightness

\[ k \text{ services} \]

\[ \text{sales} \]

CRS matching function \( h(k, v) \)

\[ \nu \text{ visits} \]

\[ \text{purchases} \]
matching function and tightness

\[ \text{sales} = k \cdot h \left(1, x\right) = k \cdot f(x) \]

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

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

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

\( k \) services

\( v \) visits
low product market tightness
high product market tightness
evidence of unsold capacity
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:

$$y = \underbrace{c}_{\text{output}} + \underbrace{\rho \cdot v}_{\text{matching services}} = c + \rho \cdot \frac{y}{q(x)}$$

$$\Rightarrow y = \left[ 1 + \frac{\rho}{q(x) - \rho} \right] \cdot c \equiv \left[ 1 + \tau(x) \right] \cdot c$$
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 $y < \text{capacity } k$ because the matching function prevents all services from being sold
  - formally: selling probability $f(x) < 1$

- consumption $c < \text{output } y$ 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

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

- 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

product market tightness \( x \)

quantity of services

capacity: \( k \)
tightness and aggregate supply

\[ y = f(x) \cdot k \]

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

quantity of services

product market tightness \( x \)

capacity \( k \)

idle time
tightness and aggregate supply

\[ c^s(x) = [f(x) - \rho x]k \]
tightness and aggregate supply
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

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

- services
- real money balances

subject to budget constraint

$$\mu + f(x) \cdot p \cdot k = \mu + f(x) \cdot p \cdot k$$

money expenditure on services endowment labor income
aggregate demand

- optimal consumption decision:

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

- 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 ($\chi \uparrow$)
increase in AD with fixed price ($\chi \uparrow$)
increase in AS with fixed price ($k \uparrow$)
comparative statics with fixed price

<table>
<thead>
<tr>
<th>increase in:</th>
<th>effect on:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>output</td>
</tr>
<tr>
<td>aggregate demand $\chi$</td>
<td>$y$</td>
</tr>
<tr>
<td>aggregate supply $k$</td>
<td>$+$</td>
</tr>
<tr>
<td></td>
<td>$+$</td>
</tr>
</tbody>
</table>
efficient equilibrium: consumption is maximum

Efficient equilibrium: price is competitive

Product market tightness
consumption
slack equilibrium: consumption is too low

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

product market tightness

consumption

$C^*$

$\chi^*$

$\text{tight equilibrium: price is too low}$
comparative statics with competitive price: price absorbs all shocks so tightness is constant

<table>
<thead>
<tr>
<th>increase in:</th>
<th>effect on:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>output</td>
</tr>
<tr>
<td>aggregate demand $\chi$</td>
<td>0</td>
</tr>
<tr>
<td>aggregate supply $k$</td>
<td>$+$</td>
</tr>
</tbody>
</table>
complete model: product + labor markets
labor market and unemployment
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

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

selling probability \hspace{1cm} production \hspace{1cm} 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

![Graph showing labor supply, employment, and labor force with labor market tightness and workers on the axes.](image-url)
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

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

<table>
<thead>
<tr>
<th>increase in:</th>
<th>output</th>
<th>product tightness</th>
<th>employment</th>
<th>labor tightness</th>
</tr>
</thead>
<tbody>
<tr>
<td>aggregate demand $\chi$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
<td>$+$</td>
</tr>
<tr>
<td>technology $a$</td>
<td>$+$</td>
<td>$-$</td>
<td>$+$</td>
<td>$+$</td>
</tr>
<tr>
<td>labor supply $h$</td>
<td>$+$</td>
<td>$-$</td>
<td>$+$</td>
<td>$-$</td>
</tr>
</tbody>
</table>
comparative statics with fixed prices

<table>
<thead>
<tr>
<th>increase in:</th>
<th>effect on:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>output y</td>
</tr>
<tr>
<td>aggregate demand χ</td>
<td>+</td>
</tr>
<tr>
<td>technology a</td>
<td>+</td>
</tr>
<tr>
<td>labor supply k</td>
<td>+</td>
</tr>
</tbody>
</table>
comparative statics with competitive prices: prices absorb all shocks so tightnesses are constant

<table>
<thead>
<tr>
<th>increase in:</th>
<th>output $y$</th>
<th>product tightness $x$</th>
<th>employment $l$</th>
<th>labor tightness $\theta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>aggregate demand $\chi$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>technology $a$</td>
<td>$+$</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>labor supply $k$</td>
<td>$+$</td>
<td>0</td>
<td>$+$</td>
<td>0</td>
</tr>
</tbody>
</table>
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 $x \Rightarrow$ rigid price

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

cyclical component of $\theta$

1980 1990 2000 2010

− 0.75
− 0.5
− 0.25
0
0.25
0.5
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

cyclical component of $\theta$

cyclical component of $l$
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]