Basic New Keynesian Model of Transmission

- Can be derived from primitives: household consumption decisions, firm pricing decisions. Assumes monopolistic competition, sticky prices. Only labor input, $C_t = Y_t$.

- Unlike old Keynesian literature, assumes rational expectations. When firms set prices, forecast future demand and policy. Households also forecast future conditions when choosing consumption.

- Basic model has 2 key equations: a Euler equation which gives an IS relation between output and interest rates, and a Phillips curve which results from price setting decisions. Gives a relation between output and inflation.

- Along with a specification of monetary policy, these determine the evolution of output, inflation, and interest rates.

Let $\pi_t$ be inflation, $E_t\pi_{t+1}$ expected inflation, $x_t = y_t - y^p_t$ the “output gap” (deviation of output from “potential”), $R_t$ the nominal interest rate.

First equation relates output gap to real interest rate:

$$x_t = -\phi(R_t - E_t\pi_{t+1}) + E_t x_{t+1} + g_t$$

Linearized consumption Euler equation/IS curve.

Second equation is the New Keynesian Phillips curve relating inflation and real activity:

$$\pi_t = \kappa x_t + \beta E_t\pi_{t+1} + u_t$$

Linearized pricing decisions of firms with staggered price setting.
Note that we assume

$$\pi_t = \kappa x_t + \beta E_t \pi_{t+1} + u_t$$

where $u_t$ represents an inflation or cost shock, which is serially correlated:

$$u_t = \rho_u u_{t-1} + \epsilon_t^u$$

Then

$$\pi_t = \kappa \sum_{i=0}^{\infty} \beta^i E_t x_{t+i} + \sum_{i=0}^{\infty} \beta^i E_t u_{t+i}$$

In the absence of cost shocks, can set both $x$ and $\pi$ to zero.

Now cannot keep both $x$ and $\pi$ equal to zero. Trade-offs must be made.


- Policy objective in general is to maximize welfare of agents. In this model, can derive approximation of welfare giving loss function:

$$L_t = \frac{1}{2} \left( \omega x_t^2 + \pi_t^2 \right)$$

- Penalizes deviations of output relative potential, deviation of inflation from target (zero): Price stability and Full Employment goals.

- In deriving this expression, weight on output $\omega$ can be related to underlying parameters.

- If there are distortions in the economy (such as monopoly power), optimal level of output gap is positive so loss is:

$$L_t = \frac{1}{2} \left( \omega (x_t - \bar{x})^2 + \pi_t^2 \right)$$
Policy Problem

- Suppose central bank targets positive output gap $\bar{x} > 0$. Chooses interest rate policy each period to minimize loss, taking as given private expectations.
- Easiest here to suppose central bank directly controls inflation and output gap, then use IS to back out optimal interest rate choice.
- Represent the central bank’s problem as a Lagrangian:

$$\mathcal{L} = \frac{1}{2} \left( \omega(x_t - \bar{x})^2 + \pi_t^2 \right) + \mu(\kappa x_t + \beta E_t \pi_{t+1} + u_t - \pi_t)$$

- The first order conditions are:

$$\omega(x_t - \bar{x}) + \mu \kappa = 0 \text{ and } \pi_t = \mu$$

or

$$x_t = -\frac{\kappa}{\omega} \pi_t + \bar{x}$$
\[ x_t = -\frac{\kappa}{\omega} \pi_t + \bar{x} \]

- Substitute back into Phillips:

\[ \pi_t = \kappa x_t + \beta E_t \pi_{t+1} + u_t \]

\[ (1 + \kappa^2 /\omega)\pi_t = \kappa \bar{x} + \beta E_t \pi_{t+1} + u_t \]

- Guess \( \pi_t = k_0 + k_1 u_t \). Then

\[ E_t \pi_{t+1} = k_0 + k_1 E_t u_{t+1} = k_0 + k_1 \rho_u u_t \]. Substitute and solve:

\[ \pi_t = \frac{\omega}{\kappa^2 + \omega(1 - \beta \rho)} u_t + \frac{\omega}{\kappa} \bar{x} \]

- Then from optimality get:

\[ x_t = -\frac{\kappa}{\omega} \pi_t + \bar{x} = \frac{-\kappa}{\kappa^2 + \omega(1 - \beta \rho)} u_t \]
Note $E\pi_t = \frac{\omega}{\kappa} \bar{x}$ but $Ex_t = 0$. Target gap $\bar{x}$ only affects mean inflation rate.

Government tries to push output above potential, in equilibrium only leads to higher inflation.

This is just as in the earlier model, but more direct/explicit.

Policymakers have an incentive to announce they will be tough on inflation to affect people’s expectations, then actually to pursue loose policy.

In equilibrium, people will come to expect this. With rational expectations (as we’ve used), this only leads to higher inflation.
Optimal Discretionary Policy

- With $\bar{x} = 0$:

$$\pi_t = \frac{\omega}{\kappa^2 + \omega(1 - \beta \rho)} u_t, \quad -\frac{\kappa}{\kappa^2 + \omega(1 - \beta \rho)} u_t$$

- Can then get optimal interest rate response from IS:

$$x_t = -\phi(R_t - E_t \pi_{t+1}) + E_t x_{t+1} + g_t$$
$$R_t = E_t \pi_{t+1} + (1/\phi) (E_t x_{t+1} - x_t + g_t)$$
$$= \gamma E_t \pi_{t+1} + (1/\phi) g_t, \text{ where } \gamma > 1.$$ 

- (i) Cost push shocks $u_t$ imply inflation/output tradeoff.
- (ii) If expected inflation rises, nominal interest rates should rise by more ($\gamma > 1$) so real rates increase.
- (iii) Policy should offset demand shocks $g_t$, accommodate movements in potential output (say productivity shocks).
Basic Facts About the Labor Market

- US working age population in 2012: 243.4 million people
- Labor force participation rate of about 63.6%. Employment-population ratio of 58.7%
- Between 1967 and 1993 the average job loss rate was 2.7% per month, average job finding rate was 43%, and average unemployment rate 6.2%.
- In September 2012 job loss rate was 1.3% per month (with 2.5% going out of labor force), finding rate was 19%, and unemployment rate was 9.1%.
- Large differences in employment, unemployment, and their evolution in US and Europe.
Separations and Hires

Total Separations: Total Nonfarm (JTSTSR), Hires: Total Nonfarm (JTSHIR), Quits: Total Nonfarm (JTSQUR), Layoffs and Discharges: Total Nonfarm (JTSLDR), UNRATE/2

Shaded areas indicate US recessions. 2012 research.stlouisfed.org
Figure 4. Separation Rate Measured in the CPS, 1994-2004
Figure 5. Flows out of Employment in the CPS, 1967-2004
<table>
<thead>
<tr>
<th></th>
<th>Not in labor force</th>
<th>Unemployed</th>
<th>Working</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not in labor force</td>
<td>92.8</td>
<td>22.7</td>
<td>3.2</td>
</tr>
<tr>
<td>Unemployed</td>
<td>2.5</td>
<td>49.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Working</td>
<td>4.7</td>
<td>27.6</td>
<td>95.4</td>
</tr>
</tbody>
</table>

Table 2. Transition Matrix for the CPS, 1967-2004, Percent per Month

Source: Robert Shimer’s tabulations of raw data from the CPS
**Perpetual Motion**

Behind the monthly jobs numbers are millions of individual movements as people find jobs and lose them, retire and graduate. Together, those movements help reveal the underlying state of the labor market.

### HISTORICAL FLOWS, OR PATTERNS OF CHANGE, IN LABOR-FORCE STATUS

**What happened to the unemployed**

- **Remained unemployed**
- **Dropped out of the labor force**
- **Found a job**

### SEPTEMBER 2012 SNAPSHOT

**OF THOSE EMPLOYED IN SEPTEMBER:**
- 136.7 million were employed in August
- 2.4M were unemployed in August
- 3.8M weren't in labor force in August

**OF THOSE UNEMPLOYED:**
- 82.1M weren't in labor force in August
- 2.8M were unemployed in August
- 7.3M were unemployed in August
- 1.9M were employed in August
- 2.9M were new entrants to the labor force

### OF THOSE NOT IN LABOR FORCE:

- 3.5M had jobs in August

Notes: Three-month moving averages are used in flow calculations; data are seasonally adjusted.

Source: Labor Department

The Wall Street Journal
Figure 1
Annual Hours Worked Over Time

OECD data. Annual hours per employed person. Annual hours are equivalent to 52*usual weekly hours minus holidays, vacations, sick leave.
Figure 3

Men's Labor Force Participation Over Time

OECD data. Men ages 15-64.
Figure 4
Women's Labor Force Participation Over Time

OECD data. Men ages 15-64.
Figure 5
Labor Force Participation People 55-64

OECD Data. Lines from top to bottom in 2003 are US (blue), Germany (red), France (green), Italy (Orange)
### Length of Unemployment Spells

<table>
<thead>
<tr>
<th>Unemployment Spell</th>
<th>8/89</th>
<th>10/92</th>
<th>10/06</th>
<th>3/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 weeks</td>
<td>48%</td>
<td>35%</td>
<td>38%</td>
<td>18%</td>
</tr>
<tr>
<td>5 - 14 weeks</td>
<td>31%</td>
<td>28%</td>
<td>31%</td>
<td>22%</td>
</tr>
<tr>
<td>15 - 26 weeks</td>
<td>11%</td>
<td>14%</td>
<td>14%</td>
<td>15%</td>
</tr>
<tr>
<td>&gt; 26 weeks</td>
<td>9%</td>
<td>23%</td>
<td>16%</td>
<td>46%</td>
</tr>
</tbody>
</table>

Other countries: in Germany, France or the Netherlands about two thirds of all unemployed workers in 1989 were unemployed for longer than six months.
Table 1: Unemployment and long-term unemployment in OECD

<table>
<thead>
<tr>
<th></th>
<th>Unemployment (Per cent)</th>
<th>Long-term unemployment of six months and over (Per cent of total unemployment)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1974-79&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1980-89&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Belgium</td>
<td>6.3</td>
<td>10.8</td>
</tr>
<tr>
<td>France</td>
<td>4.5</td>
<td>9.0</td>
</tr>
<tr>
<td>Germany&lt;sup&gt;g&lt;/sup&gt;</td>
<td>3.2</td>
<td>5.9</td>
</tr>
<tr>
<td>Netherlands</td>
<td>4.9</td>
<td>9.7</td>
</tr>
<tr>
<td>Spain</td>
<td>5.2</td>
<td>17.5</td>
</tr>
<tr>
<td>Sweden</td>
<td>1.9</td>
<td>2.5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>5.0</td>
<td>10.0</td>
</tr>
<tr>
<td>United States</td>
<td>6.7</td>
<td>7.2</td>
</tr>
<tr>
<td>OECD Europe</td>
<td>4.7</td>
<td>9.2</td>
</tr>
<tr>
<td>Total OECD</td>
<td>4.9</td>
<td>7.3</td>
</tr>
</tbody>
</table>
Median Duration of Unemployment

Median Duration of Unemployment (UEMPMED)

Shaded areas indicate US recessions.
2012 research.stlouisfed.org
Distribution of Unemployment Duration

Of Total Unemployed, Percent Unemployed Less than 5 Weeks (LNS13008397)
Of Total Unemployed, Percent Unemployed 5 to 14 Weeks (LNS13025701)
Of Total Unemployed, Percent Unemployed 15 to 26 Weeks (LNS13025702)
Of Total Unemployed, Percent Unemployed 27 Weeks and Over (LNS13025703)

Shaded areas indicate US recessions.
2012 research.stlouisfed.org
Now some simple accounting, assuming constant job finding rate $e$, separation rate $s$.

Assume that $N_t = (1 + n)N_{t-1}$, and that participation rate is also constant.

Then we have:

$$U_t = (1 - e)U_{t-1} + sL_{t-1}$$

$$= (1 - e)U_{t-1} + s(N_{t-1} - U_{t-1})$$

Dividing both sides by $N_t = (1 + n)N_{t-1}$ yields

$$u_t = \frac{U_t}{N_t} = \frac{(1 - e)U_{t-1}}{(1 + n)N_{t-1}} + \frac{s(N_{t-1} - U_{t-1})}{(1 + n)N_{t-1}}$$

$$= \frac{1 - e}{1 + n}u_{t-1} + \frac{s(1 - u_{t-1})}{1 + n}$$

$$= \frac{1 - e - s}{1 + n}u_{t-1} + \frac{s}{1 + n}$$
In theory: steady state unemployment rate, absent changes in \( n, s, e \)

Equivalent to Friedman’s (1968) “natural rate” discussed earlier.

Solve for \( u^* = u_{t-1} = u_t \)

\[
\begin{align*}
    u^* &= \frac{1 - e - s}{1 + n} u^* + \frac{s}{1 + n} \\
    \frac{n + e + s}{1 + n} u^* &= \frac{s}{1 + n} \\
    u^* &= \frac{s}{n + e + s}
\end{align*}
\]

From data \( s = 2.7\% \), \( e = 43\% \) and \( n = 0.09\% \) ⇒ \( u^* = 5.9\% \)
CBO Natural Rate of Unemployment

Natural Rate of Unemployment (Long-Term) (NROU)
Source: U.S. Congress: Congressional Budget Office

Shaded areas indicate US recessions.
2012 research.stlouisfed.org
We just presented an accounting exercise. No theory. Now develop model to explain variations in unemployment.

Unlike Keynesian models, unemployment here will be in a market clearing setting.

Basic premise: Search and matching are costly. Both for workers looking for job, firms looking to hire.

2010 Nobel citation: Why are so many people unemployed at the same time that there are a large number of job openings? How can economic policy affect unemployment? This year’s Laureates have developed a theory which can be used to answer these questions.

High costs are often associated with buyers’ difficulties in finding sellers, and vice versa. Even after they have located one another, the goods in question might not correspond to the buyers’ requirements. A buyer might regard a seller’s price as too high, or a seller might consider a buyer’s bid to be too low. Then no transaction will take place and both parties will continue to search elsewhere. In other words, the process of finding the right outcome is not without frictions.

Diamond, Mortensen, and Pissarides have developed a model of joint search of firms posting vacancies looking for workers and workers looking for jobs. Leads to a the Beveridge curve: a stable relationship between job vacancies and unemployment.

We will focus on the workers’ side, taking the distribution of wage offers as given.
The Beveridge Curve in the U.S., 2000-2011

United States, December 2000–September 2011

2008-2011 data in red

vacancy rate (percent)

unemployment rate (percent)
An infinitely-lived worker would like to maximize

$$\sum_{t=0}^{\infty} \beta^t U(C_t) = U(C_0) + \beta U(C_1) + \beta^2 U(C_2) + \cdots$$

She has two uses for her time: Work or search for a job. For simplicity, she does not enjoy leisure.

If she is unemployed, she must search to find a job.

- Probability $p$ of finding a job in any period.
- The job pays some wage $w_1 < w_2 < \cdots < w_N$.
- The probability it pays $w_i$ is $\pi_i$.
- She may reject the job if the wage is too low.
There is no borrowing or lending:
  - When unemployed, she consumes an unemployment benefit $b$.
  - When employed she consumes her wage $w$.

An employed worker loses her job with probability $s$.

The key to solving this problem is expressing it recursively.

- $V_e(w)$ is the expected lifetime utility of an employed worker.
- $V_u$ is the expected lifetime utility of an unemployed worker.
An employed worker earns and consumes $w$.

Next period, she is unemployed with probability $s$, otherwise she is still employed.

This can be expressed recursively as

$$V_e(w) = U(w) + \beta [sV_u + (1 - s)V_e(w)]$$

Solving this for $V_e(w)$ gives

$$V_e(w) = \frac{U(w) + \beta sV_u}{1 - \beta (1 - s)}$$

So $V_e(w)$ is increasing, assuming $U$ is.
An unemployed worker earns and consumes $b$.

Next period she finds a job with probability $p$.

- The job pays a wage $w_i$ with probability $\pi_i$.
- She may accept the wage (continuation value $V_e(w)$), or she may reject the wage (continuation value $V_u$).

She fails to find a job with probability $1 - p$.

This can be expressed recursively as

$$V_u = U(b) + \beta \left[ p \left( \sum_{i=1}^{N} \pi_i \max\{ V_e(w_i), V_u \} \right) + (1 - p) V_u \right]$$