The economic theory, developed in the early 1970s, of the physicist Henri Rathgeber is examined. The seminar paper present the more technical issues and the seminar presentation will work on more conceptual issues. On a physical level, associated with every transaction is a minimum required transmission of information. Claude Shannon's information theory determines the minimum level of redundant, or extra information required to correct noisy messages. If information transmission in economic systems is noisy, and the transaction of a unit of currency is on average associated with a given amount of information, then extra currency added to the system is required to compensate for noise. Noise causes a shortfall in actual goods and services transacted over what buyers and sellers wish to transact, therefore the received error rate results in unemployment. The result is an linear inverse relationship between the rate of change in the money flow and the unemployment rate. Holding the growth rate constant results in a linear inverse relationship between inflation and unemployment. We call this simple tradeoff a Fisher line. Changes in the growth rate cause horizontal shifts in the Fisher line. In addition, we find that there is a positive feedback between increases in the inflation rate and the interest rate, which pushes the Fisher Line to the right under high inflation conditions, explaining post-1970 stagflation conditions. Post-stagflation low inflation targeting causes capital equilibriation and left-shifts of the Fisher line, explaining the widespread decrease in unemployment rates with the introduction of inflation-targeting policy. The theory raises the question of how to reach full employment. High inflation selections temporarily reduce the unemployment rate but cause right-shifts of the Fisher
line resulting in both high inflation and high unemployment. The introduction of a unit of account
indexation breaks the inflation feedback process and allows us to make stable selections anywhere
along the Fisher line, allowing stable full-employment selections to be made.

Figure 1 shows the results of information theory. Given a message with an error rate of $e$, a
redundancy rate of $h$ is required to result in the correct message being received.

**Figure 1**

*Received Error Rate as a Function of Redundancy Rate*

We assume that the law of supply and demand holds, and that money is neutral. We add one extra
assumption, that there is noise in the transmission of the information required for all transactions,
that both buyers and seller agree to, to occur. Since, on average, there is a certain average amount
of currency per unit of information, we need to correct errors by adding redundant information, and
therefore extra currency, to our system. Assuming money-neutrality, this means that we require a
certain rate of increase in the flow of currency. Noise causes a shortfall in actual goods and
services transacted over what buyers and sellers wish to transact, therefore the received error rate in
this transmission results in unemployment. Figure 2 shows the consequences of noise.

**Figure 2**

**Unemployment as a Function of Rate of Change in Money Flow**

We can divide currency flow into a price index and quantity. Let $F$ be the flow of currency. Note that this includes all transactions, including intermediate goods.

\[
\begin{align*}
MV &= PQ \\
F &= PQ \\
\frac{1}{F} \frac{dF}{dt} &= \frac{1}{P} \frac{dP}{dt} + \frac{1}{Q} \frac{dQ}{dt} \\
\frac{1}{F} \frac{dF}{dt} &= i + G
\end{align*}
\]

The rate of change of the flow of currency is equal to the inflation rate, $I$, plus, $G$, the growth rate (of $Q$). In Figure 3 we call the relationship between the inflation rate of unemployment rate when $G$ is held constant a Fisher line, after Irving Fisher who first published empirical results on this
relationship in 1926. For a constant inflation rate, a decrease in the growth rate $G$, results in a decrease in $F$, causing an increase in the unemployment rate. Therefore, changing the growth rate shifts the Fisher line horizontally as shown in Figure 3.

**Figure 3**

**Fisher Line Dynamics**

[Diagram of Fisher Line Dynamics]

We now examine a positive feedback relationship between inflation and the interest rate.

\[ C = W + iK \]

If $C$ are firm's nominal costs, $W$ is nominal wage costs, $i$ the interest rate, and $K$ nominal capital costs, then if the interest rate $i$ is constant, an increase in the inflation rate, will cause $C$, $W$ and $K$ to rise proportionally so that there is no change in real costs. However, because a component of the interest rate compensates for increases in the inflation rate, $i$ will not remain constant but increase in response to increases in the inflation rate. Therefore, if there is an increase in the inflation rate, capital costs will increase faster than the inflation rate, causing real costs to increase. Profits will
create a constraint on this condition and at some point Q must decrease, causing a right-shift in the Fisher line. If central banks respond with an expansionary policy as shown in Figure 5, this will cause further increases in the inflation rate which then feeds back into the interest rate, causing positive feedback. Expansionary economic policy results in rapid increases in both the inflation and unemployment rate, as experienced in the 1970s, as shown in the 'inflation feedback' shift in Figure 5. If central banks shift to low inflation-targeting monetary policy then we see a shift along the Fisher line resulting in decreased inflation rates but further increases in the unemployment rate as seen in the 'shift to low inflation' in Figure 5. Firms are now subject to fixed contracts at high interest rates, and growth rates will be restricted until these contracts are paid off. Thus we see a slow increase in growth rates and decrease in the unemployment rate, at low inflation rates until economies return to capital equilibrium in the sense that payments on contracts are close to present interest rates.

**Figure 4**

**Monetary Response to Inflation Feedback**
Figure 5
Inflation Feedback Cycle

Inflation Feedback
Shift to Low Inflation

Capital Equilibration
We examine whether the theory is consistent with evidence. Lucas, in his Nobel prize lecture in 1996 suggests that there are short-run inverse relationships between unemployment and inflation in the periods 1960-1969, 1970-1973, 1974-1979 and 1980-1983 in the United States, but that this relationship shifts. Plotting the periods Lucas selects in Figure 6, we find three Fisher lines with remarkably similar slopes. As the inflation rate increases from 1972 to 1973, inflation feedback develops and the Fisher Line shifts to the right between 1973 and 1974. The Federal Reserve reacts to increases in inflation with contractionary policy, ending the inflation feedback, however the period 1976 to 1979 sees a reversion to expansionary policy and feedback sets in again until 1980. A clockwise loop can be observed between 1974 and 1979 which can be observed across many countries. A decrease in the inflation rate is associated with the Fisher line and capital equilibration keeping the Fisher line constant or shifting to the left. An increase in the inflation rate is associated with inflation feedback shifting the Fisher line to the right. This results in
clockwise loops. From 1980, the Federal Reserve adopts a strong contractionary policy and inflation targeting, resulting in a shift along the Fisher line between 1980 and 1983. Post 1983 shows decreasing unemployment under inflation targeting, resulting from capital equilibriation. This shift continues to 2000, where the United States economy returns to a stable position of low inflation and unemployment resulting from noise at that low inflation rate.

Figure 7
Unemployment and Inflation, Australia 1970-2005

A similar picture can be observed in Australia, with inflation feedback between 1970 and 1975, decreases along the Fisher Line between 1975 and 1995, including a intermediate change in central bank policy between 1978 and 1986 until low inflation was reached in 1992. Capital equilibriation causes decreases in unemployment until the present. Australia now remains in a relatively stable state, with unemployment and inflation similar to the United States.
In Norway the central bank introduced strong contractionary policy in 1981, before Norway could experience unemployment resulting from inflation feedback. Between 1981 and 1993 a Fisher line is observed, resulting in 1992 in an unemployment rate that was still relatively low compared to the United States and Australia. From this time a slow shift to an unemployment rate similar to United States and Australia of around 4 or 5 percent is observed. On the other hand, Ireland experienced strong inflation feedback so that in 1986, after inflation targeting is introduced, the unemployment rate was above 17 percent. However until 1999, capital equilibration was strong leading to an a similar position of low inflation and an unemployment rate of around 4 or 5 percent from 1999. Such consistent capital equilibration behaviour across countries, towards a similar unemployment rate, is difficult to explain using market failure or natural rate of unemployment theories.
Figure 9
Unemployment and Inflation, Ireland 1983-2006

![Graph showing unemployment and inflation trends from 1983 to 2006, with slopes indicated for different periods.]

Table 1

<table>
<thead>
<tr>
<th>Country</th>
<th>Unemployment rate 1995</th>
<th>Unemployment rate 2000</th>
<th>Change in unemployment rate from 1995 to 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>5.9</td>
<td>5.8</td>
<td>-0.1</td>
</tr>
<tr>
<td>Belgium</td>
<td>12.9</td>
<td>10.6</td>
<td>-2.3</td>
</tr>
<tr>
<td>Denmark</td>
<td>10.2</td>
<td>5.8</td>
<td>-4.4</td>
</tr>
<tr>
<td>Finland</td>
<td>15.4</td>
<td>9.1</td>
<td>-6.3</td>
</tr>
<tr>
<td>France</td>
<td>11.6</td>
<td>10.3</td>
<td>-1.3</td>
</tr>
<tr>
<td>Germany</td>
<td>8.1</td>
<td>8.7</td>
<td>+0.6</td>
</tr>
<tr>
<td>Country</td>
<td>1995</td>
<td>2000</td>
<td>Change</td>
</tr>
<tr>
<td>-------------</td>
<td>------</td>
<td>------</td>
<td>--------</td>
</tr>
<tr>
<td>Greece</td>
<td>10.0</td>
<td>10.9</td>
<td>+0.9</td>
</tr>
<tr>
<td>Ireland</td>
<td>12.2</td>
<td>5.0</td>
<td>-7.2</td>
</tr>
<tr>
<td>Italy</td>
<td>11.7</td>
<td>11.2</td>
<td>-0.5</td>
</tr>
<tr>
<td>Netherlands</td>
<td>7.1</td>
<td>3.2</td>
<td>-3.9</td>
</tr>
<tr>
<td>Norway</td>
<td>4.9</td>
<td>3.8</td>
<td>-1.1</td>
</tr>
<tr>
<td>Portugal</td>
<td>7.2</td>
<td>4.3</td>
<td>-2.9</td>
</tr>
<tr>
<td>Spain</td>
<td>22.7</td>
<td>14.0</td>
<td>-8.7</td>
</tr>
<tr>
<td>Sweden</td>
<td>7.7</td>
<td>4.5</td>
<td>-3.2</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>8.6</td>
<td>6.0</td>
<td>-2.6</td>
</tr>
</tbody>
</table>


Table 1 shows a similar situation for other European nations. Only Germany and Greece experienced increases in the unemployment rate between 1995 and 2000, and both of these increases were less than 1 percent compared to more significant unemployment decreases in other European nations.

**Figure 10**

Three Components of Phillips Curve
In 1956 A.W. Phillips published empirical evidence that the relationship between unemployment and inflation is a curve. We show how a Phillips curve can be constructed from three components as shown in Figure 10. First we examine the full employment component.

**Figure 13**

Unemployment and Inflation, All Countries
From Figure 13, there appears to be a lower bound on unemployment between 1 and 2 percent. This can be accounted for by frictional unemployment or 'between jobs' unemployment. At high rates of increase in flow of money, sufficient currency is added to the system to prevent unemployment resulting from noise. The vertical line on Figure 12 is the full employment rate, taking into account frictional unemployment. Component 2 is determined by the position of the Fisher line.
Figure 14
Unemployment and Inflation, United Kingdom 1913-1948
Figure 15
Unemployment and Inflation, Japan 1971-2006

Figure 14 shows the empirical data that Phillips presented in his 1956 paper. Figure 15 shows recent Japan data. In both plots, we can observe a strong curvilinear relationship between unemployment and inflation. Between 1921 and 1936 in the United Kingdom and in Japan from 1987 to the present, both countries experience liquidity trap conditions. This suggests that liquidity trap conditions result in a horizontal relationship between inflation and unemployment. We show this on Figure 10 as a horizontal line. Taking these three components together explains a curvilinear relationship for those countries which have produced a clear Phillips curve.
The theory illuminates the problem in achieving full employment. We are able to select points along the Fisher line through central bank open-market-operations. At low inflations, the selection is stable, even if the Fisher line shifts from left to right depending on variations in the growth rate. At full employment selections, however, the Fisher line consistently shifts to the right, resulting in high inflation and unemployment. A full-employment selection, if adhered to, would result in hyperinflation. Economists such as Jevons, Marshall, Irving Fisher and more recently Robert Shiller have investigated what is called an indexed unit of account. Currency is written into contracts in a unit of account so that when payments are due, the value in contracts is converted using a measure such as the CPI into a currency value. In this way, the real value of payments is
determined regardless of any changes in the price level. Such a arrangement is used in Chile and is called the Unidad de Fomento. If all contracts are written in an indexed unit of account, then the inflation component in the interest rate is eliminated, the inflation feedback process becomes non-existent, and it is now possible to select any points as shown in Figure 17. The black point shows a full-employment selection. The introduction of an indexed unit of account results in the possibility of central banks controlling for stable full employment.

**Figure 17**

**Full Employment Policy**
References


