Technological change, productivity growth, and unemployment

Olivier Blanchard *

April 1998

The fourth factor often mentioned in discussions of European unemployment is the slowdown in productivity growth that has affected nearly all OECD countries since the mid-1970s.

Constructing total factor productivity growth numbers free of the effects of business cycle variations is, as the large recent literature on the topic has shown, a difficult exercise. But the trend evolutions are clear. In most countries, TFP growth has been lower—often much lower—than it was before the mid-1970s. And the decrease in the underlying TFP growth rate appears to have been quite abrupt, taking place largely during the second half of the 1970s. Given that this period also corresponds to the start of the rise in unemployment, it is tempting to see a causal link from productivity growth to unemployment. Furthermore, the decline has typically been larger in Europe than in the United States; this may help explain why the increase in unemployment has been larger in Europe.

The purpose of this note is to explore this argument, and more generally explore the relation between productivity growth and unemployment. I focus on two issues.

(1) The relation between technological change and unemployment.
To the extent that behind productivity growth is a process of technological change, a process of creation and destruction, the type of model we have developed suggests that productivity growth is likely to affect unemployment. Different rates of productivity growth are likely to be associated with different rates of job flows, different paths of profit for firms, different bargaining outcomes between workers and firms as existing jobs become economically obsolete.

Can this line of argument help explain the rise in European unemployment? Not easily:

Theoretically, the sign is typically wrong: to the extent that a decline in productivity growth comes with a lower rate of technological change, lower job creation/destruction, and to decrease unemployment than to increase it.

Empirically, while the models lead us to think about the links between productivity growth, technological change, job flows, worker flows, and unemployment, all these links appear much more complex and tenuous in reality than in the models. To take an example, transition in Eastern Europe has been characterized by very high reallocation across sectors, but very low flows of workers in the labor market.

(2) The relation between the reservation wage and the level of productivity, for different rates of underlying productivity growth.

The following story has often been told and sounds plausible: Based on high productivity growth until the mid 70s, workers' reservation wages continued to rise rapidly in the second half of the 1970s, faster than the now lower rate of productivity growth. This increase in labor costs led in turn to an increase in unemployment. While this mechanism may no longer fully explain high unemployment today, it is part of the answer as to why unemployment rose in the first place.  

1. See Bruno Sachs for example. Recall also that, in the “Medium Run”, I argue that the initial increase in unemployment was indeed due to such an increase in wages in efficiency units. I then argue that other shifts are needed to explain the persistence of high unemployment from the mid
This argument forces us to return to the determinants of the reservation wage, and to ask: in response to a slowdown in productivity growth, should we expect the reservation wage to adjust instantaneously and one for one to changes in productivity—in which case a slowdown in productivity growth will have no effect on unemployment— or to adjust only over time—in which case a slowdown in productivity growth will lead to higher unemployment for some time, or may be never to adjust fully, leading to a permanent effect of productivity growth on unemployment?

This line raises a lot of theoretical and empirical issues, few of them settled. But the tentative answer is that a slowdown in productivity growth can indeed potentially lead to an increase in unemployment for some time. The cross-country evidence on the relation between the slowdown in TFP growth and the initial rise in unemployment is mildly supportive. There is much more work to do on this issue.

Before moving on, let me mention one more issue I shall not deal with (because of the focus on equilibrium unemployment), that of the short-run effects of a slowdown in productivity growth in the presence of nominal rigidities. We had a pass at it in the basic model (lecture 2). See also the paper by Gali on this topic.

1 Technological change and unemployment

Think of technological change as a process in which new jobs are steadily more productive. As new jobs are created, and average productivity increases over time, so do wages that firms must pay. As a result, old jobs—jobs embodying old technologies—eventually become unprofitable, and must be closed. Technological change thus triggers job and worker flows, and thus is likely to affect unemployment.

---

1980s on.
There exists a number of models that embody these basic mechanisms (Mortensen-Pissarides, Aghion-Howitt). The model below is a close cousin to Mortensen-Pissarides.

The model is a straight extension of our benchmark flow model (lecture 4). The main difference is that state-of-the-arts productivity increases over time. Jobs reflect the state-of-the-arts productivity when they are created; but thereafter, the productivity of a given job remains constant until the job is closed.

More formally, let $y(t)$ be the state-of-the-arts productivity at time $t$. Assume that $y(t)$ grows at rate $g$ over time. Let $y(s, t)$ be the productivity at time $t$ of a job created at time $s$, and thus of age $t - s \geq 0$. Then:

$$y(s, t) = y(s) = y(t)e^{g(s-t)}$$

Thus, as time passes, a job falls further and further behind the technological frontier. At some time, call it $T$ (to be determined endogenously later), the job is no longer worth operating and the job closes.

Assume that there is no physical depreciation. Assume also that firms can pay the capital cost and choose the level of technology when the worker shows up for the new job (rather than when they create the vacancy), so that all filled jobs start initially at the state-of-the-arts level of productivity. It follows from these assumptions that, in steady state, with a constant rate of job creation, the distribution of filled jobs is uniform over ages $[0, T]$.

1.1 Value functions and wage determination

Think about wage determination between a worker and a firm in an existing job. The productivity of that job is constant over time. But, as the wage paid by new jobs increases steadily over time, so do the options open to workers. Thus, despite that the job has constant productivity, the wage must increase over time. At some
point, the wage exceeds the job’s productivity and the job closes.

Thus wage determination is central to the behavior of the economy. To think about it, one must start with the value functions both for the worker and the firm:

Start with the worker. Let \( V_E(s, t) \) and \( V_U(t) \) be the value of being employed at time \( t \) in a job created at time \( s \), and the value of being unemployed at time \( t \) respectively. For \( t \leq s + T \), these two values satisfy the following arbitrage equations:

\[
\begin{align*}
 rV_E(s, t) &= w(s, t) + dV_E(s, t)/dt \\
 rV_U(t) &= y(t)b + (h/u)(V_E(t, t) - V_U(t)) + dV_U(s, t)/dt
\end{align*}
\]

When employed at time \( t \) in a job created at \( s \), the worker receives a wage \( w(s, t) \). (There is a boundary condition at time \( s + T \), when the job ends and the worker becomes unemployed. At that point, \( V_E(s, s + T) = V_U(s + T) \)).

When unemployed, the worker receives unemployment benefits. The assumption is that unemployment benefits are a constant fraction, \( b \), of state-of-the-arts productivity, \( y(t) \). This assumption evacuates the issue that we shall focus on in the second part of this note, that of whether and how the reservation wage adjusts to changes in productivity: the assumption here is that it adjusts one-for-one and instantaneously. Hirings here are only for new jobs: thus being hired at time \( t \) has value \( V_E(t, t) \).

Turn to the firm. Let \( V_F(s, t) \) and \( V_V(s, t) \) be the values at time \( t \) of a filled and a vacant job created at \( s \) respectively. Then, for \( t \leq T \):

\[
\begin{align*}
 rV_F(s, t) &= (y(s) - w(s, t)) + dV_F(s, t)/dt \\
 rV_V(s, t) &= (h/v)(V_F(s, t) - V_V(s, t)) + dV_V(s, t)/dt
\end{align*}
\]

As long as the job is open and filled, it produces a constant output \( y(s) \) and pays a wage \( w(s, t) \). Because there is no physical depreciation, the probability that the job is closed before \( T \) is zero. There is again a boundary condition at time \( s + T \),
namely that $V_F(s, s + T) = 0$.

If the job is vacant, then it is filled with instantaneous probability $(h/v)$. If so, the value jumps from $V_V$ to $V_F$. (In equilibrium, jobs are never vacant except when first created. But we need to know the value of a vacancy to determine the outcome under Nash bargaining).

Nash bargaining implies that, for $t$ between $s$ and $s + T$:

$$V_E(s, t) - V_U(t) = V_F(s, t) - V_V(s, t)$$ (1.1)

The general nature of the solution for the wage is clear. Productivity in the current job is constant. But outside opportunities steadily increase. Thus, it is clear that, for a given job, the wage will increase over time, more so than output of the job—which is constant—and less so than outside options—which grow at rate $g$. How much it depends on each will depend on labor market conditions. But the exact solution for $w(s, t)$ is however difficult to derive. I do not believe that there exists a closed form solution.²

One can however get a closed form solution under the assumption of static expectations (so that all the time derivatives of the values in the equations above are put equal to zero.) Note that this is not right, even in steady state: given decreasing profits, the value of a job to the firm decreases systematically through time. In contrast, given productivity growth, the value of being unemployed increases.

---

2. Technical remark 1: Mortensen-Pissarides derive a solution, but I do not believe their solution to be right. They in effect assume, in my notation, that $V_V(s, t) = V_V(t, t)$. This can be given two interpretations. First, if a worker leaves, the firm can shift costlessly to state-of-the-arts technology. Or, second, the firm can costlessly sell its capital to a firm using state-of-the-arts technology. Neither assumption seems consistent with the notion that technology is embodied in capital. I shall check with them whether I have misunderstood their argument.
systematically through time. But it gives (I guess) a good sense of the general solution.\(^3\)

Given the nature of the equations above, it makes sense to guess that the wage \(w(s, t)\) satisfies:

\[
w(s, t) = x(s) \left( \alpha + \beta e^{g(t-s)} \right)
\]

with parameters \(\alpha\) and \(\beta\) to be determined. As you can check, this guess is indeed correct (under static expectations) and the parameters \(\alpha\) and \(\beta\) are given by:\(^4\)

\[
\alpha \equiv \frac{r}{2r + (h/v)} \tag{1.3}
\]

And:

\[
\beta = \frac{(r + (h/v))[b + (h/u)/(2r + (h/v))]}{2r + (h/u) + (h/v)} \tag{1.4}
\]

Note first that:

\[(h/u) \to 0, \quad (h/v) \to \infty \Rightarrow (\alpha \to 0, \quad \beta \to b)\]

In words, in a depressed labor market, the wage is driven down to the level of unemployment benefits (which here are assumed to increase at rate \(g\) over time).

---

3. Technical remark 2: One way of avoiding this problem is to assume that firms, rather than choosing a terminal date \(T\) choose a constant probability \(\lambda\) of job closing. This avoids the differential nature of the dynamic system, but is not a tremendously appealing characterization of the choice of firms.

4. Technical remark 3: This sentence hides a bit of algebra, and the results may not be error-free. The way to solve for the two parameters is to solve for the value equations for the worker and the firm, use the division of surplus relation, and find out what values of \(\alpha\) and \(\beta\) satisfy this relation identically.
Note also that:

\[((h/u) \to \infty, (h/v) \to 0) \Rightarrow (\alpha \to 1/2, \beta \to 1/2)\]

The tighter the labor market, the closer \(\alpha\) and \(\beta\) are to 1/2. This implies that, when the job starts, the initial wage is just equal to output. As the wage increases from then on, the job closes right away. In a tight labor market, workers extract all the rents.

Recalling from the benchmark model that \((h/v)\) can be expressed as a function of \((h/u)\), both \(\alpha\) and \(\beta\) can be expressed as functions of \(r\) and \((h/u)\) only. I suspect, but have not proven, that, once the condition determining \(T\) is taken into account, the wage profile on a job is strictly higher the tighter the labor market, i.e. the higher \((h/u)\). I shall assume this in what follows.

To summarize, the wage in a given job grows over time, but more slowly than productivity. Its level and its slope depend on labor market conditions. The tighter the labor market, the higher the wage profile.

1.2 Equilibrium job flows and unemployment

Labor market conditions determine the wage schedule. Given the wage schedule, firms decide how long to keep jobs open. This determines \(T\), and in turn the value of a new job.

In steady state, the value of a new job must be equal to the cost of capital needed to run it. Working backwards, this determines the wage consistent with free entry, and in turn, labor market conditions—more specifically, the exit rate from unemployment, or equivalently, its inverse, unemployment duration. Finally, the flow of job destruction and the duration of unemployment determine jointly the unemployment rate.

Consider the first step, the determination of \(T\). Given the wage schedule \((\alpha, \beta)\),
consider the value at time $t$ of a filled job created at time $s$:

$$V_F(s, t) = \int_t^{s+T} y(s)(1 - \alpha - \beta e^{g(u-s)})e^{-r(v-t)} dv$$ (1.5)

Maximimization with respect to $T$ yields:

$$1 - \alpha - \beta e^{gT} = 0$$ (1.6)

In words, the job will be closed when the wage has increased to the point where it is equal to the productivity of the job.

Given this optimal value of $T$, the value of a new job is equal to (recall that firms can choose the technology when a worker shows up, so that a job filled at time $t$ has level of technology $y(t)$:

$$V_F(t, t) = \int_t^{t+T} y(t)(1 - \alpha - \beta e^{g(v-t)})e^{-r(v-t)} dv$$ (1.7)

Assume that it takes $y(t)k$ units of capital to create a job at time $t$ (The reason for having capital costs increase with productivity is the usual: this is needed to get a steady state, with constant unemployment). The free entry condition implies that $V_F(t, t) = k$, or equivalently:

$$k = y(t)[(1-\alpha)\frac{1-e^{-rt}}{r} - \beta \frac{1-e^{-(r-g)T}}{r-g}]$$ (1.8)

In words, the wage schedule $(\alpha, \beta)$ must be such that profits on new jobs cover the capital cost (more formally that that (1.8), with $T$ given by (1.6) holds). Returning to equations (1.3) and (1.4), this in turn determines the labor market conditions—the value of $(h/u)$—needed to make workers accept the wage.

A graphical representation may be useful here and is given in Figure 1. Plot the log of the state-of-the-arts level of productivity $y(t)$ against time—a straight line
$\log y$
$\log w$

Figure 1
with slope $g$. Now consider a job created at time $s$. This job will have constant productivity $y(s)$ until it is closed. This is drawn as the horizontal line, starting at time $s$. For given labor market conditions, the wage on this job will increase over time, initially at rate less than $g$, and with rate tending to $g$ asymptotically. The job will however be closed when the wage reaches $x(s)$. This determines $T$. Profits from the job are given by the shaded area. The free entry condition implies that their present value must be equal to $ky(s)$. This in turn determines the labor market conditions, parametrized by $(h/u)$ that deliver the required wage schedule.

1.3 Productivity growth and unemployment

We are now able to derive the basic results from this model. Consider an increase in productivity growth, an increase in $g$. At given labor market conditions, the wage now increases faster in existing jobs, leading to faster economic obsolescence. This in turn has two effects.

First, the duration of a job, $T$, goes down. Put another way, the rate of job destruction, $1/T$, and by implication the rate of job creation, both go up: faster technological change leads to larger flows.

Second, at initial labor market conditions, the value of a new job goes down, thus becomes insufficient to cover capital costs. Wage costs must therefore decrease. This is achieved through a lower exit rate $(h/u)$, equivalently through longer unemployment duration.

Putting things together, an increase in productivity growth leads to both an increase in flows into unemployment and an increase in unemployment duration, thus to an unambiguous increase in the unemployment rate. Conversely, a decrease in productivity growth leads unambiguously to a decrease in the unemployment rate; definitely not good news for the hypothesis that lower productivity growth may be one of the causes of the increase in European unemployment.
How robust is the result? Mortensen and Pissarides have pointed out the importance of the assumption, in the above model, that technological change can only be achieved through destruction of old jobs and creation of new ones. Suppose instead that firms can upgrade at no cost. Then, there will be no need for destruction. And the larger profits from productivity growth will allow firms to pay higher wages, leading to a decline in equilibrium duration. This case is extreme, but shows the importance of the question: what is the relation between productivity growth and reallocation?

What evidence is there on the various links suggested by the model? I have not systematically looked at the empirical evidence, but my perception is the following:

- There is no evidence of a robust link between sectoral reallocation, measured say by the Lilien index (the standard deviation of employment growth rates across sectors), and TFP growth.
- Series for gross job flows are too short to tell us much, but there appears to be little relation between gross job flows and the rate of TFP growth.
- Flows of workers in the labor market show no clear relation to reallocation. The example of Central Europe since the beginning of transition is striking in this respect. Transition has been characterized by very high reallocation, as measured by the Lilien index. Yet the flows of workers in the labor market have been very small by OECD standards. In 1994 for example, the monthly flow from unemployment to employment, as a ratio of the labor force, was equal to .6% in the Czech Republic, to .3% in Bulgaria (compared to about 1.6% in the United States). The most likely explanation is that, while job flows have been high, a very depressed labor market and a very high duration of unemployment has basically eliminated quits, and thus reduced worker flows.

---

5. See for example Table 8, Chapter 3, in my “Economics of Post-Communist Transition”.
2 Changes in productivity growth, the reservation wage, and unemployment

The model we just saw simply assumes that the reservation wage of workers moves one for one with productivity. Thus, by construction, productivity growth has no effect, permanent or transitory, on the ratio of the reservation wage to average output in that economy.

Could it be instead that, after a slowdown in productivity growth, the reservation wage keeps increasing faster for some time than productivity? Researchers who refer to the reservation wage as the "aspiration wage", and to aspirations sometimes increasing faster than productivity, clearly have something like this in mind. To make progress here, we need to go back and look at the determination of the reservation wage a bit more closely.

2.1 Restrictions from neutrality of the productivity level

First, let us go back to the standard problem of a consumer with instantaneous utility function $U(c, l)$, where $c$ is consumption, $l$ is leisure ($1 - l$ being work). For simplicity, assume that leisure is continuous rather than zero-one as we have implicitly assumed in the models above; this will simplify the algebra but is inconsequential.

Let $w$ be the wage per hour, $b$ be the payment per hour not worked—call it unemployment benefits. Let $\lambda$ the marginal utility of wealth. Then, the first order conditions for the consumer-worker are given by:

\[
U_c(c, l) = \lambda \\
U_l(c, l) = \lambda(w - b)
\]

In standard competitive labor market models, we think of the second equation as
determining \( l \) given \( \lambda, c, w \) and \( b \). In the class of models we have developed, think of the equation as determining the reservation wage, i.e. the value of \( w \) such that, given \( c, \lambda \) and \( b \), the worker is willing to work a given amount of work \( l \).

To a first approximation, the steady rise in productivity over the last 100 years has not led to a systematic increase or decrease in the unemployment rate. Thus, the first question we want to ask is:

Suppose that \( c, b \) and \( w \) grow at rate \( g \). Under what conditions will these two equations yield a constant value of \( l \) over time? Or, equivalently, suppose that \( c \) and \( b \) grow at rate \( g \) and that \( l \) is constant. Under what conditions will the reservation wage \( w \) implied by the two equations grow at rate \( g \) as well.

The answer is that there are three sets of conditions that deliver such an answer:

(1) The first is the condition we have implicitly assumed so far, that instantaneous utility is of the form:

\[
U(c, I) = c + ae^{gt}l
\]  

(2.1)

Utility is linear in consumption and leisure, and furthermore the utility of leisure increases at the rate of productivity growth. One interpretation is that home production has the same rate of productivity growth as market production. Under this condition, then the second first order condition becomes:

\[
ae^{gt} = (w - b)
\]

Or else, \( l \) is at a corner, zero or one. As both sides are growing at the same rate, the condition is unaffected by the level of productivity, or the rate of productivity growth. Equivalently, for a given value of \( l \), the reservation wage, the wage that satisfies equation (2.1) increases at rate \( g \).

(2) The second is that leisure does not yield utility. In that case, the condition involves a trivial a-temporal choice, that of choosing work if \( w > b \), leisure oth-
erwise, and be indifferent if $w = b$. Again, both sides of this condition grow over time at the same rate. Thus, the condition is invariant to the level of productivity. The reservation wage grows at the same rate as $b$.

(3) The third is that instantaneous utility is separable in consumption and leisure, and logarithmic in consumption:

$$U(c, l) = \log(c) + V(l)$$  \hspace{1cm} (2.2)

This is the standard assumption of real business cycle models. Under this assumption, $\lambda = 1/c$, and thus:

$$V'(l) = (w - b)/c$$

As the denominator and numerator on the right grow at the same rate, this condition yields a constant value of $l$ over time. Equivalently, for a given value of $l$, if both $c$ and $b$ grow at rate $g$, so does the reservation wage $w$.

### 2.2 The effects of a decrease in productivity growth

Suppose now that, at time $t$, the rate of productivity growth decreases, unexpectedly and permanently, from, say, $g$ to $g'$. We can ask what will happen to the reservation wage in each case.

In both the linear case and the no-utility of leisure case, the answer is: nothing exciting. In either case, if $b$ now increases at $g'$, the reservation wage will also increase at $g'$, in line with the new lower rate of output. If unemployment benefits are proportional to the wage, then the same result holds: both unemployment benefits and the reservation wage—and by implication the wage itself when we close the model—will now grow at rate $g'$. (If unemployment benefits depend on the last wage paid to the currently unemployed workers, $b$ will increase a bit faster than $w$ for a while, but this seems too short and small an effect to take seriously).
The story is a bit more complex in the third case. But the effect goes the wrong way, at least for our purposes. A decrease in productivity growth is likely to lead initially to a decrease in $c$, as expectations of future income are now lower. This in turn decreases the reservation wage, and in the models we have worked with, leads to lower, not higher unemployment. The effect is familiar from RBC models: in effect, the decrease in productivity growth increases productivity today relative to future productivity; it thus leads to a lower reservation wage today, and thus higher not lower employment.

Where does this leave us? Working through the effects of productivity growth on the reservation wage does not appear promising. There is nevertheless an extension of the model that can deliver and seems plausible. It is that wages are set based on expected rather than on current output.

Suppose that the process for productivity growth is one in which there are both transitory and permanent shocks (an even more relevant extension may be one with three types of shocks, transitory to level, permanent to level, permanent to the rate of growth. This extension allows for the difference between actual and expected productivity to increase for some time after a decrease in the underlying rate of productivity growth). Assume that workers and firms adjust expectations in Bayesian fashion. In this case, if permanent shocks to the growth rate are infrequent, a decrease in productivity growth will lead to higher wages relative to actual output for some time. The effect works however through expectations of $x$ rather than through the dynamics of $b$.

Let me end with a brief return to facts. Beyond the basic coincidence of the productivity slowdown and the increase in unemployment, what evidence is there that the increase in wages relative to tfp growth from the mid-70s on was due to the slowdown in productivity growth?

A first pass at the answer is to look at the cross-country evidence on the decline
in tfp growth, the decrease in the share of capital (recall from our second basic model, if the short-run elasticity of substitution is less than one, or if there are costs of adjusting factor proportions, an increase in wages relative to tfp will initially decrease the share of capital) and the initial increase in unemployment, from 1973 to 1980. Table 1 shows the constructed numbers for each country. Figures 2 and 3 give the corresponding scatterplots.

Tfp growth is computed as the Solow residual divided by the labor share—without adjustment for cyclical fluctuations, a potentially serious shortcoming for countries in the middle of a disinflation program, such as the United Kingdom in the late 1980s. The decline in tfp growth is computed as average tfp growth for 1968 to 1973 minus tfp growth for 1974 to 1980. The change in the share is defined as the share of capital in the business sector in 1980 minus its value in 1973. The change in the unemployment rate is defined as the unemployment rate in 1980 minus the unemployment in 1973. Again here, I have made no attempt to estimate the equilibrium as opposed to the actual rate; this is probably of some importance: viz the United Kingdom again.

The table and the associated figures suggest three conclusions.

- The decrease in productivity growth is nearly universal. So is the decrease in the share, and the increase in unemployment.
- The change in the share and the change in productivity growth appear to be positively correlated. The regression coefficient is 2.0 (t = 2.6) when all countries are included, 2.2 (t = 2.1) when the main outlier, Portugal (where the decrease in the share surely comes mostly from the 1975 revolution) is excluded.
- There appears to be little relation however between the change in the unemployment rate and the change in productivity growth. The regression coefficient is -0.5 (t = -1.0) when all countries are included.
Table 1. Change in tfp growth, the share of capital and unemployment, 1980 versus 1973.

<table>
<thead>
<tr>
<th>Country</th>
<th>G74-80 minus G68-73</th>
<th>S80 minus S73</th>
<th>U80 minus U73</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>-1.5</td>
<td>-2.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Austria</td>
<td>-3.3</td>
<td>-2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Belgium</td>
<td>-3.0</td>
<td>-7.0</td>
<td>5.6</td>
</tr>
<tr>
<td>Canada</td>
<td>-3.7</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Denmark</td>
<td>-2.5</td>
<td>-6.0</td>
<td>5.9</td>
</tr>
<tr>
<td>Finland</td>
<td>-3.7</td>
<td>-1.0</td>
<td>2.4</td>
</tr>
<tr>
<td>France</td>
<td>-3.1</td>
<td>-5.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Germany</td>
<td>-2.6</td>
<td>-3.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Ireland</td>
<td>-2.8</td>
<td>-7.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Italy</td>
<td>-2.6</td>
<td>-1.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Japan</td>
<td>-4.4</td>
<td>-5.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Netherlands</td>
<td>-3.0</td>
<td>-1.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Norway</td>
<td>-0.1</td>
<td>2.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Portugal</td>
<td>-5.5</td>
<td>-16.0</td>
<td>5.8</td>
</tr>
<tr>
<td>Spain</td>
<td>-3.1</td>
<td>1.0</td>
<td>8.6</td>
</tr>
<tr>
<td>Sweden</td>
<td>-2.8</td>
<td>-6.0</td>
<td>-0.5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>-3.8</td>
<td>-2.0</td>
<td>3.2</td>
</tr>
<tr>
<td>United States</td>
<td>-2.3</td>
<td>0.0</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Source: OECD business sector data base, and transformations.
Change inshore eondchangei nt fp

Change in shore 73-81

change in tfp growth, 74-80 over 68-73

Canada

Norway
Change in unemployment and change in TFP

![Graph showing the relationship between change in unemployment and change in TFP growth from 1974-1980 compared to 1968-1973. The graph includes points for several countries, including Spain and Portugal, with Norway also marked on the right side.]