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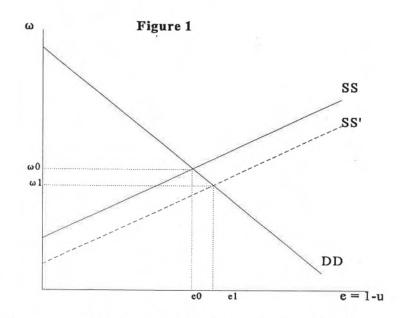|	
Date:	June 10, 1996
To:	Chairman Greenspan
From:	Janet Yellen
Subject:	Job Insecurity, the Natural Rate of Unemployment, and the Phillips Curve

Following our recent discussion concerning labor market issues, I thought I would try to codify my own thinking about the theoretical links among job insecurity, the behavior of wages, prices, and profit margins, and the natural rate of unemployment. The attached note outlines the theory that I consider relevant. It shows why an increase in job insecurity due to changing technology or other factors could induce a *permanent* decline in the natural rate of unemployment, along with a reduction in real wages and an increase in the markup of prices over unit labor costs. The note works out the technical details relating the labor supply/demand framework of efficiency wage models to the usual Phillips curve approach. Consistent with existing evidence, the theory predicts that an estimated wage-price Phillips curve equation will overpredict compensation by more than an estimated price-price Phillips curve overpredicts inflation during the transition to a "lower natural-rate" path.

Job Insecurity, Efficiency Wages and the Natural Rate of Unemployment.

The likely impact of heightened job insecurity on the natural rate of unemployment can only be studied in the context of an explicit model of the natural rate of unemployment. In my view, a group of theories--collectively dubbed the 'efficiency wage' model--offer an intuitively plausible and empirically relevant explanation of how the natural rate of unemployment and real wage rate are jointly determined. Although the details of particular models differ, the basic structure of all efficiency wage models is similar. Figure 1 depicts the structure of a typical efficiency wage model.

Figure 1

The vertical axis measures the real wage (compensation), denoted ω. The horizontal axis measures the employment rate, e, equal to 1-u, where u is the unemployment rate. The 'demand curve' DD represents the demand for labor as a function of the real wage. Alternatively, DD shows how the typical firm's markup of prices over wages varies as the level of employment and output change. There are two reasons why this curve will be downward sloping. First, as firms supply more output, they may encounter increasing

marginal cost as they operate closer to capacity, so that the marginal product of labor declines. Second, the elasticity of demand for the firm's products may decline as output and income rise, inducing a firm with pricing power to raise its markup over marginal cost. For both of these reasons firms may raise their prices relative to the wage as the level of employment increases.

The SS curve is akin to a labor supply curve and reflects the outcome of forces operative in the labor market. In contrast to competitive models of the labor market, almost all efficiency wage models view the wage paid to workers as a key decision variable for the firm, with a decision to pay higher wages conferring not just additional costs, in the form of higher compensation per manhour worked, but also producing potential offsetting benefits in the form of lower turnover, improved employee morale, or higher worker productivity. In arriving at a wage bargain with employees, firms consider the state of labor market slack and the wages paid by other firms. Of course, in simple models in which all firms are identical, all end up paying the same wage.

In virtually all variants of the efficiency wage model, the real wage paid by firms to workers rises as the employment rate rises, or the unemployment rate declines, resulting in an upward sloping SS curve. For example, according to the "turnover model" firms will choose to pay higher wages as the rate of unemployment declines in order to reduce costly turnover. At given wages, the cost to a worker of quitting one job to search for another declines as the unemployment rate falls and expected search time declines. Because increased turnover, in effect, lowers productivity, firms may attempt to mitigate the impact of lower unemployment on turnover by raising wages to combat quits as unemployment declines. A second theory--the

cheat-threat or (Shapiro-Stiglitz) shirking model--posits that with lower unemployment, the cost to workers of slacking off on the job declines, since alternative jobs are more easily obtainable and the current job therefore offers the typical worker lower "rents." In this theory, firms offer higher real wages as unemployment declines to combat the increased tendency of workers to "shirk"--behavior which can be only imperfectly monitored and controlled by management. A higher real wage raises the perceived value of the current job and the willingness of the employee to work hard to keep it. Finally, bargaining versions of the efficiency wage model posit that real wage bargains depend on the size of the 'surplus' available to be split between workers and shareholders. The bargaining power of each side determines the share of the surplus that it can extract. Bargaining power, in turn, depends on each side's outside opportunities. As unemployment declines, other things equal, labor's bargaining power rises, resulting in higher real wage settlements. These various hypotheses provide complementary rationales for the upward sloping supply curve, SS, in figure 1. The figure shows that, in equilibrium, the real wage and the "natural rate of unemployment", which is just 1 - e, are determined by the "supply" and "demand" factors depicted in the DD and SS curves.

Increasing Job Insecurity. An important feature of all efficiency wage models is that unemployment is at least partly involuntary, even when the economy is operating at its natural rate. Not even the marginal worker is indifferent between working and being unemployed. Jobs offer their occupants a 'rent' in the sense that a spell of unemployment is costly and the typical worker is better off working at his current job than experiencing unemployment and searching for a new one. In this sense, the prospect of unemployment *normally* engenders

some sense of job insecurity. Other things equal, the degree of job insecurity depends on the expected cost of job loss, which increases with the unemployment rate. (Recall that the one reason for the SS curve to be upward sloping in the first place is because reduced job insecurity associated with lower unemployment produces greater turnover and other productivity-reducing worker behavior which needs to be countered with higher wages.)

The unemployment rate is only one factor influencing the degree of job insecurity. Any factor that increases either the perceived odds of a layoff or the likely cost of a layoff also likely heightens job insecurity. For example, the degree of insecurity could rise due to trends in technology that threaten to make the worker's skills outmoded or diminish the odds of finding comparably paid work in the event of a layoff. Similarly, an increase in the perceived chances of displacement due to corporate reorganization, with an associated loss of potential future earnings due to the destruction of firm-specific human capital would likely enhance job insecurity. An increase in job insecurity likely shifts the SS curve downward, as depicted in Figure 1. Presumably, increased insecurity makes workers more fearful of unemployment, more desirous of pleasing their employers through improved performance and higher effort, and less apt to quit in search of alternative work. Firms would accordingly find it possible to offer lower real wages (or smaller pay increases) at any unemployment rate.

In bargaining versions of the efficiency model, any factor that shifts bargaining power away from workers and toward firms shifts the SS curve downward, as in Figure 1. In this framework increased job insecurity and the fear that workers have more to lose should they suffer unemployment, translate into a decline in workers' bargaining power. Additionally, improvements in the ability of firms to outsource production--domestically or internationally--

would likely improve the bargaining power of firms relative to employees. Increased availability of alternatives to existing work arrangements--whether due to new labor-saving technology or declining transportation and communication costs that lower the barriers to domestic or foreign outsourcing--improves management's options and serves as a threat to workers. Even if management does not actually use these options, their availability lowers workers' bargaining power. An increase in profits at the expense of compensation would be the expected result. Lower unemployment benefits or decreased unionization could similarly result in a decline in workers' bargaining power, shifting the SS curve downward. George Borjas and Valery Ramey in the November 1995 *Quarterly Journal of Economics* use such a bargaining model to show how an increase in imports in highly concentrated, high rent industries, particularly durable goods, could have depressed the relative wages of less skilled workers.

Figure 1 shows that a downward shift of the SS curve, due to increased job insecurity, or any other cause results in a permanent reduction in the natural rate of unemployment, along with a reduction in the real wage. The shift causes a rise in the equilibrium employment rate from e0 to e1, and a corresponding reduction in the natural rate of unemployment. And real wages decline from ω0 to ω1. This outcome is consistent with a statement you have made in various speeches--that increased job insecurity should result in a willingness on the part of workers to accept a cut in real wages *for a time, but not indefinitely*. The diagram shows that a one-time increase in job insecurity (to a new, higher level) results in a permanent, but finite, decline in the real wage. With positive trend growth in real wages due to productivity growth, say at rate θ, an increase in job insecurity causes a decline in real

wage growth below rate θ for a period, after which time, real wage growth returns to the original rate--θ.

It is easy to explain why an increase in job insecurity translates into a permanent decline in the natural rate of unemployment, although each version of the efficiency wage model offers a slightly different rationale. In essence, unemployment serves as a worker-discipline device because the prospect of a costly unemployment spell produces sufficient fear of job loss to motivate workers to perform well without constant, costly supervision. In the turnover model, equilibrium unemployment limits voluntary quits and costly turnover to 'manageable levels.' In the bargaining model, the prospect of a costly unemployment spell places limits on workers' ability to extract the firm's surplus. In each of these models, an 'autonomous' increase in job insecurity at given unemployment rates permits a new equilibrium with lower unemployment and lower wage premia. In essence, an 'exogenous' increase in job insecurity produces productivity-enhancing changes in workers' behavior, mitigating the need for alternative controls on worker behavior through the channels of higher unemployment and efficiency wage premia. Alternatively stated, increased job insecurity makes it possible for firms to lower the wage premia they pay without suffering productivity-reducing worker backlash; with lower wage premia, firms hire more labor and produce more output.

From the Efficiency Wage Model to the Phillips Curve

The demand and supply model depicted in Figure 1 translates in a straightforward way into the accelerationist Phillips curve model that is typically estimated by our staff. This section represents the efficiency wage model mathematically, translates it into the wage-price

Phillips curve form, and analyzes the consequences of an increase in job insecurity in that framework.

We begin the derivation of the Phillips curve by mathematically representing the SS and DD curves in figure 1. For simplicity, we ignore benefits, treating the real wage and real compensation as identical.

The SS Curve. The SS curve gives the notional or 'expected' real wage, ω^n, determined in the labor market as a function of the level of the employment (or output) and other factors, denoted I, influencing the level of job insecurity. The notional wage, ω^n, rises as e rises and falls as I, the level of job insecurity increases.

(1)
$$\omega^n = \omega^n(e, I).$$

This labor supply curve in terms of the level of output or employment can be easily converted into a function of the unemployment rate by noting that with a fixed supply of labor the unemployment rate is simply 1-e.

We thus obtain the expected real wage that comes from wage settlements as a function of the *unemployment* rate, rather than the *employment* rate:

(2)
$$\omega^n = g(u, I).$$

The DD Curve. It is now necessary to represent the DD curve. Assuming that the typical firm faces a demand curve for its product that has a constant elasticity of demand, β,

the firm will optimally set its price as a markup, $\beta/(\beta - 1)$, over marginal cost.[1] If the marginal product of labor, denoted MPL, depends on the level of output, we can write:

(3)
$$MPL = MPL(u).$$

Marginal cost, in turn, is the product of the wage and the amount of labor required to produce an additional unit of output, which is the inverse of the marginal product of labor. So the price charged by the firms will be

(4)
$$p = \left(\frac{\beta}{\beta - 1}\right) \frac{1}{MPL(u)} w,$$

where w is the nominal wage.

The ratio of w to p implied by equation (4) gives the DD curve in figure 1. It shows how an increase in the level of employment (or, correspondingly, a decrease in unemployment) results in a rise in the markup of price over wage costs, and thus a decrease in the real wage.

Derivation of the Price-Price Phillips Curve from the SS and DD curves. The price-price Phillips curve is derived as follows. We assume that nominal wage settlements are made to reach the real expected wage given by the settlement function g(u, I), but with price expectations formed from past information. The expected current price level is denoted p_t^e. As a result, the nominal actual wage is the product of the expected price level and the notional

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[1] In a more general framework the elasticity of demand, β, facing a given firm would depend on the level of aggregate demand, probably becoming less elastic as other firms are also approaching capacity. This generalization leaves the subsequent analysis qualitatively unchanged but would yield an additional reason why the DD curve slopes downward.

real wage. Introducing time subscripts, the wage at time t is:

(5)
$$w_t = p_t^e \, \omega_t^n = p_t^e \, g(u,I).$$

Combining price formation, equation (4), with wage formation, equation (5), yields the price

level in period t:

(6)
$$p_t = p_t^e \, \frac{\beta}{\beta - 1} \, \frac{1}{MPL \, (u_t)} \, g \, (u_t, \, I_t).$$

The price-price Phillips curve is now derived by taking the natural logarithms of (6),

subtracting $\ln p_{t-1}$ from both sides of (6), and approximating $\ln$ MPL (u) and $\ln$ g(u, I) as linear

functions of u, and of u and I, respectively.

Taking the natural logs of the LHS and the RHS of (6) yields:

(7)
$$\ln p_t = \ln p_t^e + \ln [\beta/(\beta - 1)] - \ln MPL \, (u_t) + \ln g(u_t, \, I_t).$$

Subtracting $\ln p_{t-1}$ from both the RHS and LHS of (7) yields:

(8) $\ln p_t - \ln p_{t-1} = \ln p_t^e - \ln p_{t-1} + \ln[\beta/(\beta - 1)] - \ln MPL \, (u_t) + \ln g(u_t, \, I_t).$

Noting that $\ln p_t - \ln p_{t-1}$ is the rate of inflation, π_t, and that $\ln p_t^e - \ln p_{t-1}$ is approximately

expected price inflation, π_t^e, we obtain the usual accelerationist price-price Phillips curve.

This function will be linear if the functions $\ln$ MPL(u) and $\ln$ g(u, I) are approximated as

linear functions of u, and u and I, respectively. Approximating $\ln MPL(u_t)$ as a + bu and

ln g(u, I) as c - du - hI and rearranging, we obtain:

$$(9) \qquad \pi_t = \pi_t^e + \ln \frac{\beta}{\beta - 1} - (a - c) - (b + d)u_t - h\, I_t,$$

The natural rate of unemployment, u^n, is the rate of unemployment at which actual and expected inflation are equal. Namely,

$$(10) \qquad u^n = \frac{[\ln(\frac{\beta}{\beta - 1}) - (a - c) - hI]}{b + d}$$

Equation 10 shows that if I, the level of job insecurity, rises the natural rate of unemployment will decline. In addition, there should be a shift in the price-price Phillips curve. But, as we now show, the shift in the wage-price Phillips curve will be more pronounced.

The wage-price Phillips Curve. Equation (9) is the price-price Phillips curve. Similar methodology can be used to derive the wage-price Phillips curve. Taking the natural log of both the RHS and the LHS of the wage equation (5) yields:

$$(11) \qquad \ln w_t = \ln p_t^e + \ln g(u_t, I_t).$$

The price equation (4) in natural logs, lagged one period, and rearranged with $\ln w_{t-1}$ on the LHS is:

$$(12) \qquad \ln w_{t-1} = \ln p_{t-1} - \ln \frac{\beta}{\beta - 1} + \ln MPL\, (u_{t-1})\, .$$

Subtracting (12) from (11) yields the accelerationist wage-price Phillips curve.

$$(13) \qquad \ln w_t - \ln w_{t-1} = \ln p_t^e - \ln p_{t-1} + \ln \frac{\beta}{\beta - 1} - \ln MPL\,(u_{t-1}) + \ln g(u_t, I_t).$$

Approximating ln MPL(u) and ln g(u,I) as linear functions, as above, and simultaneously adding and subtracting bu_t, we obtain the linear form of the wage-price Phillips curve:

$$(14) \qquad \frac{w_t - w_{t-1}}{w_{t-1}} = \pi_t^e + \ln \frac{\beta}{\beta - 1} + b(u_t - u_{t-1}) - (a - c) - (b + d)u_t - h\,I_t.$$

Contrasting the wage-price and price-price Phillips curves. The wage-price Phillips curve, equation (14), is very similar to the price-price Phillips curve, equation (9), with one significant difference: the wage price Phillips curve contains one additional term: $b(u_t - u_{t-1})$. This extra term has implications for wage-price dynamics during periods in which the unemployment rate is changing due, say, to an increase in job insecurity. During a transition period with declining unemployment, the additional term in (14) is negative, so that wages will rise less quickly than prices. During such a transition to a new, lower natural rate of unemployment, prices will rise by more than wages *for a time*. This reflects the decrease in the real wage, or the increase in the markup of prices over wages, depicted in Figure 1. In all other respects (9) and (14) are identical. Both equations yield the identical natural rate of unemployment. After a transition period, a shift in I_t should affect both equations identically.

Theory and evidence. Do these equations fit the facts? According to the theory, a downward shift in the wage setting equation, for technological or other reasons, will produce

an initial shift in the wage-price Phillips curve that is more pronounced than the shift in the price-price Phillips curve. This prediction is consistent with observed Phillips curve errors over the last six quarters: errors in the wage-price Phillips curve have been persistent and cumulatively statistically significant. Errors in the price-price Phillips curve are smaller and often statistically insignificant. However, econometric methods relying on time-varying parameters do detect a decline in the natural rate in price-price Phillips curve formulations. Implicit in this scenario is an increase in the markup of prices over wages. Indeed, it appears that profit margins are also higher. In this sense, the theory fits the facts.

Curiously, although markups and profit rates have recently increased, firms insist that the business environment has become more competitive. Such perceptions of the marketplace are consistent with the preceding model if the recent strength in profits has been at least partly generated by the declining bargaining power of labor. Firms with high profits (large Marshallian quasi-rents) have strong incentives to poach on each other's markets. This may explain the common perception that competition for business is intense and each firm's pricing power very limited. As firms succeed in invading each other's markets, markups may fall and real wages could eventually rise. But such an outward shift of the DD curve would result in a further decline in the natural rate of unemployment.

Conclusion.

The job insecurity hypothesis is consistent with the aggregate time series evidence (thus far) on wages, prices and unemployment. But it is not the *only* hypothesis consistent with the evidence. For example, the growth rate of benefits costs may simply have declined for a time, resulting in a transitory, but not a permanent decline in the natural rate of unemployment.

Indeed, the hypothesis that *nothing* fundamental has changed cannot be rejected out of hand. More detailed, disaggregate evidence could be helpful in evaluating the legitimacy of the job insecurity hypothesis. The little data that is available from the Survey of Displaced Workers suggest that permanent layoff rates have risen significantly for older, more educated, white-collar workers, in accord with the hypothesis. But they have not risen discernibly for less educated, blue collar workers, who have always suffered higher layoff odds and continue to experience a higher chance of displacement. In aggregate, permanent layoff unemployment appears to be at expected levels correcting for the stage of the business cycle. But survey evidence points to a more broad-based sense of job insecurity. Turnover data would be extremely helpful in evaluating the job-insecurity hypothesis. Are voluntary quits currently high or low given the aggregate unemployment rate? Unfortunately, the Labor Department ceased collecting such data in 1981. I have been struck, however, by the paucity of reports by our Directors and in the Beige book over the last year or so concerning turnover problems. The absence of any barking from this particular dog strikes me as mild evidence that something has changed.