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THE NATURAL RATE IN A SHARE ECONOMY

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Abstract

Will the natural rate of unemployment be lower in the share economy described by Martin Weitzman than in a wage economy? We examine this question for a search economy with an equilibrium unemployment rate, a version of Salop's (1979) quits model. Equilibrium unemployment is the same in both economies.

We also examine firms' short-run adjustment to shocks. Share-economy firms adjust output less than wage-economy firms for both demand shocks and labor-supply shocks. Depending on whether rapid output adjustment is stabilizing, a share economy may be more or less stable than a wage economy.

The Natural Rate in a Share Economy *

1. Introduction

One of the most interesting macroeconomic policy ideas in recent years is Martin Weitzman's "share economy." In this economy, firms pay workers not just wages, but also shares of their net revenues. Weitzman (1984, 1985) claims that such an economy has strong tendencies to stay at full employment, as firms act as employment "vacuum cleaners," hiring all of the unemployed they can find.

Some have interpreted Weitzman's claim to mean that the share economy has a lower natural rate of unemployment than the wage economy, but this has been controversial.[1] In part this was because in his formal work Weitzman used models where the labor market is at full employment in long-run equilibrium. In these models he showed that after a shock the share economy will return more quickly to full employment than would a wage economy.

More recently, Weitzman (1986) has shown that, for the Lindbeck and Snower (1984) model of the NAIRU, the long-run level of unemployment will be lower in a share economy; but he analyzes the stability properties of a share economy only for the case

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[1] At a conference on the share economy at Yale, Nordhaus described one claimed result of the share economy as

"The share economy will produce a lower natural rate of unemployment."

However, Tobin, at the same conference, asserted that the natural rate should not change (Nordhaus and John 1986).

where the long-run unemployment level is zero.[2]

Here we examine two questions for a share economy with a positive natural rate of unemployment. (1) Is the equilibrium natural rate lower in the share economy than in the wage economy? (2) If the equilibrium is disturbed by a shock how will the share economy adjust? We investigate these questions using a "search" economy model developed by Salop (1979). In Salop's model, workers queue to obtain jobs. Once on the job, they learn about the nonpecuniary aspects of the job, and some workers then decide to quit. The lower the firm's compensation level, the more likely workers are to decide that the negative nonpecuniary aspects outweigh the positive compensation. These workers quit to search for a better job. (Thus the model might be considered a "quits" model.)

This model is useful for exploring the questions raised here for two reasons. First, Salop has shown that the model will generate a positive natural rate of unemployment in a wage economy. Second, workers quitting is a reasonable response to lower compensation levels in both share and wage firms. For share firms, quits identify a cost firms must pay if they decide to hire more workers since increasing the number of workers causes compensation to fall. We find that the equilibrium unemployment rate in this model is the same in the share economy

[2] Just a few papers have previously analyzed the share economy in models other than Weitzman's. John (1986) examines the effects of shocks on firms that are wage-takers in both the short-run and the long-run. Cooper (1985) emphasises macroeconomic externalities caused by private contracts; with price-setting oligopolistic firms, share contracts sometimes reduce macroeconomic externalities and instability.

as in a wage economy. Furthermore, when faced with a shock, share-economy firms adjust output less than do wage-economy firms. Demand shocks do not push share firms as far away from the natural rate of output as wage firms would be driven, confirming one of Weitzman's claims. But share firms also adjust output less when the economy's labor supply changes, thus moving more slowly to the new equilibrium. Thus, share firms might be thought of as "vacuum cleaners without suction."

Salop's "quits" model is only one of a variety of search models that have an equilibrium unemployment rate. There are also "efficiency wage" models (e.g., Akerlof and Yellen 1986, Shapiro and Stiglitz 1984) and models with quits, hires, and vacancies (e.g., Pissarides 1985, 1986, Jackman and Layard 1986). In these latter models firms search for workers but before a firm can hire a worker, it must incur a fixed cost of first creating a vacancy. Workers are more likely to take the job and less likely to quit at higher compensation levels. For simple forms of these models, the same equilibrium results hold as for the quits model. These cases are examined in the Appendix.

The remainder of the paper is organized as follows. Section 2 briefly describes the quits model, modified to include the share economy. Section 3 shows that the equilibrium unemployment rate is the same in the share and wage economies. Section 4 shows that share firms adjust output less in response to shocks than do wage firms. Section 5 concludes the paper.

2. Share Firms in a Quits Model

In this model firms are monopolistic competitors. They face an unlimited supply of labor at the going wage, so long as the equilibrium rate of unemployment is positive. (This and other assumptions of the model are discussed in more detail in Salop 1979). Firms use labor and some form of "capital" to produce output, but capital is not explicitly modeled.

The probability that workers quit firms is described by the function $Q = Q(W/\bar{W}(1-U))$, with $Q'(\cdot) < 0$ and $Q''(.) > 0$. Workers compare their own compensation, W, with the compensation received at the representative firm, $\bar{W}$, and are less likely to quit when their own compensation is high. They are also less likely to quit when the unemployment rate, U, is high. Some workers quit even when $W = \bar{W}$, since they may dislike nonpecuniary aspects of the job.

When workers quit, firms incur a cost γ per worker, where γ represents the opportunity cost of training a new worker to take the place of the worker who has quit. (Firms pay all workers alike, so they cannot charge workers the cost of training).[3]

The firm's profit function is

$$\pi = PY - WL - \gamma Q(\cdot)L. \quad (1)$$

PY is total revenue. The wage firm is differentiated from the share firm by the components of compensation, W. For the wage firm, all compensation is in the form of a wage, w. For the

[3] Alternatively, workers who quit could leave a vacancy in the production process. The cost of a quit would then be related to the value of output, P. The results are not affected by this alternative assumption.

share firm, compensation has two components, a wage component w and a share, λ, of net revenues to be shared, R_s. Each worker thus receives $W = w + \lambda R_s/L$. R_s equals the firm's revenues minus costs, excluding the share compensation:

$$R_s = PY - wL - \gamma Q(\cdot)L. \qquad (2)$$

So $\Pi - R_s = -\lambda R_s$, and $R_s = \frac{1}{1-\lambda}\Pi$. The share firm's profit function can therefore be rewritten as $\Pi = (1 - \lambda)R_s$, or

$$\Pi = (1 - \lambda)[PY - wL - \gamma Q(\cdot)L].[4] \qquad (3)$$

The firm maximizes profits by finding the optimal employment size, L, and an optimal share rate, λ. As Weitzman has discussed, for reasons not in the model, firms and workers would agree on an all-wage compensation structure if given a choice.[5] Thus, some restraint must be placed upon compensation--either a ceiling upon w or a floor upon λ. Weitzman (1985) chose to set w = 0, which is closer to setting (a maximum) w, with firms then choosing λ.

The first-order condition for L is

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[4] This profit function already reveals many of our later results. The share relationship does not directly modify any of the terms in the wage firm's profit function (although w should be lower for a share firm with positive profits). Rather, the share firm essentially maximizes wage-firm profits times a constant factor. Alternative definitions of the "share" change the function, but do not change our main results.

[5] This does not hold in more complete models of firm and worker behavior. "Optimal contracts" generally do not have fixed wages (Stiglitz 1986), and might be like share contracts. Firm and worker risk and risk preferences must be modeled to determine "optimal" contracts. See also Cooper's remarks in Nordhaus and John (1986).

Cooper (1985) also raises an important question when he asks why the wage system has evolved. Are there important reasons for a wage system that have not as yet been identified? Does changing it have costs that have not as yet been discerned?

$$\Pi_L = (1 - \lambda)[MRP_L - w - \gamma Q(\cdot) - \frac{\gamma Q'(\cdot)L}{\bar{W}(1 - U)} w] \qquad (4)$$

MRP_L is the marginal revenue product of labor, a function of L.

Now, $W_L = \frac{\lambda}{1-\lambda}(\Pi_L \frac{1}{L} - \frac{\Pi}{L^2})$.

Substituting into (4) and collecting terms,

$$\Pi_L[1 + \frac{\lambda\gamma Q'(\cdot)}{\bar{W}(1-U)}] = (1 - \lambda)[MRP_L - w - \gamma Q(.) + \frac{\lambda}{1-\lambda}\frac{\gamma Q'(\cdot)}{\bar{W}(1-U)}\frac{\Pi}{L}].$$

The first order condition, $\Pi_L = 0$, holds if the term in brackets on the right-hand side of this expression equals zero or:

$$w = MRP_L - \gamma Q(\cdot) + \frac{\gamma Q'(\cdot)}{\bar{W}(1-U)}\frac{\lambda}{1-\lambda}\frac{\Pi}{L}. \qquad (5)$$

(5) can be interpreted as the wage rate equals the marginal revenue product of labor (as it would in neoclassical models) plus two quit factors. First, there are additional costs because any new worker will quit with some probability. Second, hiring an additional worker in a share firm will lower the compensation of all current workers, increasing the probability of quits and imposing an additional cost on the firm.

The first-order condition for λ is

$$\Pi_\lambda = (-1)[PY - wL - \gamma Q(\cdot)L] + (1 - \lambda)[-\frac{\gamma Q'(\cdot)L}{\bar{W}(1 - U)}]W_\lambda. \qquad (6)$$

W_λ in turn is

$$W_\lambda = (\frac{1}{1-\lambda} + \frac{\lambda}{(1-\lambda)^2})\frac{\Pi}{L} + \frac{\lambda}{(1-\lambda)L}\Pi_\lambda = \frac{1}{(1-\lambda)^2}\frac{\Pi}{L} + \frac{\lambda}{(1-\lambda)L}\Pi_\lambda$$

Substituting into (6) we obtain

$$\Pi_\lambda = (-1)[\cdot] - \frac{\gamma Q'(\cdot)}{\bar{W}(1-U)}(\frac{\Pi}{1-\lambda} + \lambda\Pi_\lambda).$$

But the term in brackets is just $\Pi/(1-\lambda)$; collecting terms,

$$\Pi_\lambda [1 + \frac{\lambda\gamma Q'(\cdot)}{\bar{W}(1 - U)}] = - \frac{\Pi}{1 - \lambda} - \frac{\gamma Q'(\cdot)}{\bar{W}(1 - U)} \frac{\Pi}{1 - \lambda} .$$

$\Pi_\lambda = 0$ if the right-hand side of this equation equals zero. So the first-order condition holds when

$$Q'(\cdot) = - \frac{\bar{W}(1 - U)}{\gamma} \qquad (7)$$

Finally, there is the constant-profit condition, which includes the firms's implicit cost of capital k.

$$\Pi = (1 - \lambda)[PY - wL - \gamma Q(\cdot)L] = k. \qquad (8)$$

(8) represents long-run free entry and exit of firms under monopolistic competition.

3. Equilibrium Unemployment with Share and Wage Firms

The equilibrium unemployment for share and wage firms can be compared in several ways. The most direct is to observe the share firm's first-order conditions. With some manipulation, they take the same form that Salop found for wage firms. Substituting $Q'(\cdot)$ from (7) into (5), we obtain

$$w + \frac{\lambda}{1 - \lambda} \frac{\Pi}{L} = MRP_L - \gamma Q(\cdot). \qquad (9)$$

(9) can be interpreted as the firm's choice of overall compensation; it can be rewritten as

$$W = MRP_L - \gamma Q(\cdot) \qquad (10).$$

Total compensation equals the marginal revenue product of labor minus the marginal cost of replacing workers who quit. So long as both w and λ are positive, the firm is not constrained at all by the requirement to pay a "share." It looks purely at total compensation W.

(10) is identical to Salop's equation for a wage firm (see

his equation (9), 1979) except that in Salop's paper W is the wage. In both cases this equation represents an internal equilibrium for the firm. Unemployment exists in the models because there is a queue of workers who want jobs but firms are unwilling to hire them. If the equilibrium compensation in both share and wage firms is the same, then the length of the queue and therefore the unemployment rate should be the same in both systems. In other words, <u>the natural rate of unemployment is the same in both economies</u>.

This system has no excess demand for labor at the long-run equilibrium point. This differs from the Weitzman models where excess demand for labor exists at the long-run full employment equilibrium point.[6] Unemployed workers are not being hired because it is not profitable for firms to expand their employment beyond existing levels.

Still this result is consistent with Weitzman's argument that the two systems are isomorphic and with Tobin's view that the natural rate should be the same in both systems (Nordhaus and John 1986).

This result should not be surprising. Workers and firms both know the value of compensation, they can correctly value its two components, and they value the components in the same way. The results would be different if firms and workers had different

6 It does not differ, however, from Weitzman's results with a positive natural rate of unemployment. Weitzman (1986) explores two cases; in one the economy is at full employment in long-run equilibrium; in the other the economy is at less than full employment in long-run equilibrium. He shows how the excess demand process will work for the full employment case but not for the less than full employment case.

expectations about future profits. If workers were more "optimistic" about their own firm's future profits per worker than the firm was, they would quit less at any level of compensation and that would lead to a lower equilibrium level of unemployment. This could occur if the firm intended to increase the number of workers but did not inform the workers.[7]

There is another way to show that the share economy does not affect equilibrium unemployment. Assume a pure wage economy. Then reduce wages, allowing firms to substitute share compensation. This problem is equivalent to the problem where w changes and the effects upon U, L and λ are determined by differentiating the three equations of the equilibrium model, using the implicit-function rule. These equations are the representative firm's first-order conditions and the zero-profit constraint, (4), (7), and (8). The effects of changing w can be found by solving the matrix equation

$$\begin{bmatrix} (4)_L & (4)_\lambda & (4)_U \\ (7)_L & (7)_\lambda & (7)_U \\ (8)_L & (8)_\lambda & (8)_U \end{bmatrix} \begin{bmatrix} \frac{dL}{dw} \\ \frac{d\lambda}{dw} \\ \frac{dU}{dw} \end{bmatrix} = \begin{bmatrix} -(4)_w \\ -(7)_w \\ -(8)_w \end{bmatrix} \qquad (11)$$

with partial derivatives with respect to the equations written $(\cdot)_L$ and so on. Solving for the full effects of w,

$$\frac{dL}{dw} = 0 \qquad \frac{d\lambda}{dw} = -(1-\lambda)^2 \frac{L}{\pi} < 0 \qquad \frac{dU}{dw} = 0. \qquad (12)$$

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[7] Weitzman's view that firms would hire more workers that would 'dilute' each worker's share is consistent with this interpretation. So are the hostile criticisms of labor union leaders. See Epstein 1986.

dλ/dw has the value that keeps W constant. Thus, directly considering a change in the external constraint gives the same conclusions.

While the introduction of sharing itself may not affect the natural rate of unemployment, its actual implementation could. To overcome resistance to the acceptance of share arrangements, Weitzman has proposed a subsidy (or lower tax) on share compensation (Weitzman 1985, p. 946). Several authors, working with similar search models, have found policies that reduce the natural rate of unemployment. These policies change firms' marginal cost of labor, while remaining revenue-neutral. For example, Jackman and Layard (1986) propose a wage tax that is offset (for firms as a whole) by a per-worker subsidy. The firm's profit function under their tax-subsidy system looks like

$$\pi = PY - W\,(1 + t)L + SL - \gamma Q(.)L$$

with t the tax rate and S the subsidy. Jackman and Layard (1986) prove that this tax-subsidy scheme <u>reduces</u> the natural rate of unemployment.

For Weitzman's subsidy to be revenue-neutral, a tax must be imposed--perhaps on wage compensation. Such a tax-subsidy arrangement would affect firm behavior and the natural rate of unemployment, much as Jackman and Layard have argued, but it can be shown that the direction of the effect depends on the specific form of taxes and subsidies chosen and in some cases parameter values. Thus such arrangements should be carefully designed; but a combination of tax-subsidy arrangements and sharing could lead to a lower natural rate and (see below) less adjustment to shocks.

The British government is adopting a subsidy on share compensation (<u>Economist</u> 1986), but this represents an attempt to reduce workers' compensation to its equilibrium level.

4. Share Firms' Response to Shocks

How do share firms react to macroeconomic shocks?[8] Weitzman shows in his models that the share economy has lower unemployment rates during the period of adjustment to a shock. This section examines adjustment to two shocks: (1) a sudden increase in the supply of workers, who "parachute" uniformly into the economy, and (2) a sudden fall in the marginal revenue product of labor.

(1) <u>Increased supply of labor</u>. We examine the response of a share firm and a wage firm to this shock. Both firms are at equilibrium when the shock occurs; thus, they are paying the same level of compensation and have the same output.

When the workers suddenly "parachute" into the economy, unemployment is instantly increased. In both economies, workers respond by reducing their quit rate, so firms in both economies will adjust output.[9] In Weitzman's analysis of shocks neither wage rates, w, nor share rates, λ, can be instantly changed,

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[8] In interpreting the firm's response to shocks we assume the firm reacts only to the <u>initial</u> change in the unemployment rate or demand for the product. (The optimal full reaction path of the firms is very difficult to calculate (Barro 1972).) Firms' decisions to <u>hire</u> will clearly affect unemployment, and in the share economy $\bar{W}$ as well. We ignore these effects, and so analyze only the initial response to the shock.

[9] Workers observe the change in unemployment, but can<u>not</u> immediately observe other firms' changes in wage rates, so $\bar{W}$ in the quits term remains constant.

but employment levels can adjust. However, the share firm affects compensation when it changes L. Thus, while the wage firm faces a constant W in adjusting its output, the share firm finds its compensation changing--falling, as we shall show.

The effect of increased labor supply on wage firms can be found from equation (10) with W interpreted as the wage rate:

$$\frac{dL}{d\bar{U}} = \frac{\gamma Q'(\cdot)\bar{W}/W(1-U)^2}{MRP_{LL}} > 0 \qquad (16)$$

MRP_{LL} is the second derivative of the revenue function with respect to L and is negative. The entire expression is thus positive. In other words, an increase in labor supply that initially increases the unemployment rate causes firms to hire additional workers.

This result is different from Weitzman's. In his model there is no quit function and entry of new labor into the labor force does not affect the wage firm's short-run optimum--i.e., employment remains at its original level.

The effect of increased labor supply on share firms comes from equation (5):

$$\frac{dL}{d\bar{U}} = \frac{\gamma Q'(\cdot)w/\bar{W}(1-U)^2 - \lambda(R_s/L)\gamma Q''(\cdot)W/\bar{W}(1-U)^3}{MRP_{LL} + W_L\lambda(R_s/L)\gamma Q''(\cdot)/\bar{W}(1-U)} > 0 \qquad (17)$$

Since share compensation falls as L rises, $W_L < 0$. Also, $Q''(\cdot) > 0$. The full expression is positive. A larger labor force causes employment to expand.

Which economy responds better to this shock? Employment expands in both. Unemployment will be lower in the economy where employment increases more. Comparing equations (16) and (17), it is not clear in which economy the expansion will be greater. If the second-order terms containing $Q''(\cdot)$ are very small,[10] then (17) becomes

$$\frac{dL}{dU} \approx \frac{\gamma Q'(\cdot)w/\bar{W}(1-U)^2}{MRP_{LL}} > 0. \qquad (17')$$

With this simplification the wage economy does better. The only difference between (16) and (17') is that W appears in the numerator of (16) and w in the numerator of (17'). Since compensation in both systems is initially the same and w is only the fixed part of share compensation, $w < W$. The wage system, therefore, reacts more strongly than does the share system. In the short run, unemployment will be lower in a wage system.

This is the opposite of Weitzman's conclusion. In his model the share economy's greater flexibility in compensation encourages the firm to hire more workers. In this model share compensation also falls as employment goes up, but as the share firm's compensation falls, quit rates rise. These two effects offset each other. Furthermore, the higher unemployment rate raises the cost of increasing the probability of quits - the last term in equation (5). The wage firm does not change its compensation level, so when it hires more workers the probability of quits is not changed. The expansionary effects are therefore greater (if the second-order terms are ignored as in (17')).

(2) Demand Shock. The demand shock changes the marginal revenue product of labor. We model that by assuming that the

[10] The terms containing $Q''(.)$ are second-order terms describing how lower compensation affects the rate of change of the probability of quits. The first-order terms which describe the direct effect of lower compensation and the adjustment of the quit rate to lower compensation levels cancel each other and do not appear in equation (17).

shock affects the first-order condition for choice of L, (5), by a fixed amount δ, and calculating $dL/d\delta$ for the two systems.[11] Since the share firm's compensation adjusts automatically with the change in revenue due to the shock, it changes output less. Equation (10), for the wage firm, is now $W = MRP_L - \gamma Q(\cdot) - \delta$.

$$\frac{dL}{d\delta} = \frac{1}{MRP_{LL}} < 0. \qquad (18)$$

Adding the same $-\delta$ term to (5), the share firm's adjustment is

$$\frac{dL}{d\delta} = \frac{1}{MRP_{LL} + W_L \lambda(R_s/L)\gamma Q''(\cdot)/\bar{W}(1-U)} < 0. \qquad (19)$$

Both of the terms in the denominator are negative, so for this shock the share firm adjusts labor less than the wage firm. If the $Q''(\cdot)$ term is very small, then the two reactions will be about the same. Since the share firm's adjustment in labor supply is less than or equal to the wage firm's, fluctuations in output should be smaller in the share economy.

5. Conclusion

This paper has shown for standard models that the share and wage economies have the same natural rate of unemployment. Furthermore, in such models with a positive natural rate of unemployment share firms adjust output less in response to both demand and labor supply shocks; their demand adjustment keeps the economy closer to the natural rate, but their labor supply

[11] If the demand curve is linear and the production function has a constant marginal product of labor, a demand shift can be interpreted as the δ shift.

adjustment slows movement to the natural rate.

These results are different from those obtained by Weitzman (1986) who uses a different approach to defining the natural rate of unemployment. As Weitzman states, his model may be more applicable to a European environment where unions are stronger.

These results suggest that reaching any firm conclusions about the superiority of a share economy may be difficult. Furthermore, these models of equilibrium unemployment may be leaving out important factors. For example, current models do not include adjustments to shocks. Perhaps the natural rate of unemployment should be defined over a range of shocks and adjustment to them. If, in that case, the share economy has superior adjustment properties equilibrium unemployment would be smaller.

Appendix

This appendix sketches the efficiency-wage and quits-hires-vacancies models for share firms. The models follow Jackman and Layard (1986), except that the firms are monopolistic competitors and so choose price and labor. These models have natural rates of employment similar to the "quits" economy. For these models, the share economy does not affect the natural rate of unemployment.

Efficiency-wage models (Akerlof and Yellen 1986, Shapiro and Stiglitz 1984) have a function that affects productivity: workers work harder at higher wages. Output per worker is

$$\gamma e(\cdot), \text{ with } e(\cdot) = e\left(\frac{W}{\bar{W}(1 - U)}\right).$$

The firm's revenues are $P\gamma e(\cdot)L$ and the firm's profits are

$$\Pi = P\gamma e(\cdot)L - WL. \tag{A1}$$

A wage firm would maximize (A1) by choice of L and W:

$$\Pi_W = \frac{P\gamma e'(\cdot)L}{\bar{W}(1 - U)} - L = 0, \text{ so}$$

$$e'(\cdot) = \frac{\bar{W}(1 - U)}{P\gamma} \tag{A2}$$

$$\Pi_L = P\gamma e(\cdot) + P_L L\gamma e(\cdot) - W = 0,$$

or, defining the elasticity of price with respect to labor as ϵ,

$$W = P\gamma(1 + 1/\epsilon)e(\cdot).$$

Substituting for $P\gamma$,

$$W = \bar{W}(1 - U)(1 + 1/\epsilon)\frac{e(\cdot)}{e'(\cdot)}. \tag{A3}$$

With the share rule, profits are (just as in the quits economy),

$$\Pi = (1 - \lambda)[P\gamma e(\cdot)L - wL].$$

$$\pi_L = (1 - \lambda)[P(1 + 1/\epsilon)\gamma e(\cdot) + \frac{P\gamma e'(\cdot)L}{\bar{W}(1 - U)} w_L - w] = 0. \qquad (A4)$$

$$\pi_\lambda = -[\cdot] + (1 - \lambda)\frac{P\gamma e'(\cdot)L}{\bar{W}(1 - U)} w_\lambda = 0,$$

$$-\frac{\pi}{1 - \lambda} + (1 - \lambda)\frac{P\gamma e'(\cdot)}{\bar{W}(1 - U)}\frac{1}{(1 - \lambda)^2}\frac{\pi}{L} = 0, \quad \text{so again}$$

$$e'(\cdot) = \frac{\bar{W}(1 - U)}{P\gamma} \qquad (A5)$$

Substituting into (A3) for $P\gamma$,

$$w = \bar{W}(1 - U)(1 + 1/\epsilon)\frac{e(\cdot)}{e'(\cdot)} + \frac{\bar{W}(1 - U)e'(\cdot)}{e'(\cdot)\bar{W}(1 - U)} L_L W$$

$$W = w + \frac{\lambda}{(1 - \lambda)}\frac{\pi}{L} = \bar{W}(1 - U)(1 + 1/\epsilon)\frac{e(\cdot)}{e'(\cdot)}. \qquad (A6)$$

(A4) and (A7) are the same. The same equivalence exists here as in the quits model.

The quits-hires-vacancies model modifies the "quits" function by including the ratio of vacancies to unemployment. In this model, firms require capital or incur some fixed cost per worker to produce. Only with that cost incurred can they attempt to fill a vacancy. Thus the firm incurs a cost if the position is not filled, just as with the quits model. That cost is $\gamma\Phi(1 + V/N)$, where γ is the worker's marginal product and Φ is the cost of having the position, while V is the number of vacancies and N is the number of positions available to be filled. At equilibrium, the firm maintains a constant labor force, so that defining H as the probability of firing a worker for a vacancy and Q as the probability that a worker will quit, VH = QN. Substituting, the firm's profits are

$$\pi = PY - WL - \gamma\Phi(1 + \frac{Q}{H})L \qquad (A7)$$

The basic behavioral relationships are that

$$Q = Q(\frac{W}{\bar{W}}, \frac{U}{V/N}) \qquad H = H(\frac{W}{\bar{W}}, \frac{U}{V/N}).$$

For a wage firm, the first-order conditions are

$$\pi_L = MRP_L - W - \gamma\Phi(1 + \frac{Q}{H}) = 0$$

$$W = MRP_L - \gamma\Phi(1 + \frac{Q}{H}) \qquad (A8)$$

$$\pi_W = -L - \gamma\Phi\,\frac{\frac{Q_W}{\bar{W}}H - \frac{H_W}{\bar{W}}Q}{H^2}L = 0.$$

$$-\gamma\Phi\,\frac{\frac{Q_W}{\bar{W}}H - \frac{H_W}{\bar{W}}Q}{H^2} = 1 \qquad (A9)$$

(This model reaches equilibrium unemployment by the U/V ratio in $Q(\cdot)$ and $H(\cdot)$; while firms choose W, they cannot affect $W/\bar{W}$; rather, the U/V ratio has to change for overall equilibrium.) Substituting for $\gamma\Phi$ in (A8),

$$W = MRP_L + (1 + \frac{Q}{H})\frac{\bar{W}H^2}{Q_W H - H_W Q}. \qquad (A10)$$

For a share firm,

$$\pi = (1 - \lambda)[PY - wL - \gamma \quad + \frac{Q}{H})L]. \qquad (A11)$$

In a share economy, a change in L changes W, so

$$\pi_L = (1 - \lambda)[MRP_L - w - \gamma\Phi(1 + \frac{Q}{H}) - \gamma\Phi\,\frac{\frac{Q_W}{\bar{W}}H - \frac{H_W}{\bar{W}}Q}{H^2}LW_L] = 0,$$

$$w = MRP_L - \gamma\Phi(1 + \frac{Q}{H}) + \gamma\Phi\,\frac{\frac{Q_W}{\bar{W}}H - \frac{H_W}{\bar{W}}Q}{H^2}\,\frac{\lambda}{1 - \lambda}\,\frac{\pi}{L}. \qquad (A12)$$

$$\pi_\lambda = -[\cdot] - (1 - \lambda)\gamma\Phi\,\frac{\frac{Q_W}{\bar{W}}H - \frac{H_W}{\bar{W}}Q}{H^2}LW_\lambda = 0$$

$$\frac{\pi}{1-\lambda} = -\gamma\Phi \frac{Q_w H - H_w Q}{\bar{w} \quad H^2} \frac{\pi}{1-\lambda}$$

$$-\gamma\Phi \frac{Q_w H - H_w Q}{\bar{w} \quad H^2} = 1 \tag{A13}$$

Again substituting for $\gamma\Phi$,

$$w = MRP_L + (1 + \frac{Q}{H}) \frac{\bar{w} \quad H^2}{Q_w H - H_w Q} - \frac{Q_w H - H_w Q}{Q_w H - H_w Q} \frac{\lambda}{1-\lambda} \frac{\pi}{L};$$

$$w + \frac{\lambda}{1-\lambda} \frac{\pi}{L} = MRP_L + (1 + \frac{Q}{H}) \frac{\bar{w} \quad H^2}{Q_w H - H_w Q}. \tag{A14}$$

(A10) and (A14) are the same.

This appendix has shown in several standard models that the equilibrium rate of unemployment is the same in share and wage economies. These models have been used to show that such policies as TIP, MAP, and wage arbitration will reduce the equilibrium unemployment rate. The explanation is the same as in the main text: firms and workers care about overall compensation and in these models they can accurately observe overall compensation.

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