# Household Labor Supply, Unemployment and Minimum Wage Legislation

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## Abstract

The supply behavior of labor frequently depends on the demand conditions that prevail on the labor market. If demand is inadequate, households may send additional household members, who otherwise would not have worked, to look for work, for fear that the main income earner may lose his job. This paper is a study of the theoretical consequences of this "added worker" affect. It is shown that this can give rise to multiple equilibria in the labor market. Surprisingly, a minimum wage law set below the prevailing market wage can now cause the market wage to fall and unemployment to rise. Unemployment benefits, by countering some of the risk of unemployment can neutralize the inefficiencies caused by the tendency of households to oversupply labor.

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# 1. INTRODUCTION

In economics textbooks one learns to derive supply curves and demand curves in separate chapters. Such compartmentalization, however, renders the textbook model of markets unusable in many domains of real life in which demand and supply turn out to be inter-dependent. As early as 1950, Harvey Leibenstein, motivated by Thorstein Veblen's classic, **The Theory of the Leisure Class**, had noted that, for many goods, a fall in supply may boost demand because there is "snob value" in being able to have what others cannot.

Nowhere is the interdependence between supply and demand more important than in labor markets. This happens because in labor markets each household takes decisions for several individuals, and within each household there occurs a certain amount of cooperation and consumption sharing. Suppose aggregate demand for labor falls. It is then quite natural to expect that a household which had thus far kept its women and children out of the labor force may now send them out in search of work to provide 'insurance' against the risk of the adult male members becoming unemployed. The aim of this paper is to theoretically model these kinds of supply effects and to demonstrate how in the presence of these effects standard labor market policies may give rise to paradoxical market response.

The fact that an increase in unemployment can cause an increase in labor supply, thereby exacerbating the unemployment problem, has long been known. It is called the "*added worker effect*". From the forties till recent times there have occurred several empirical investigations into this question. Yet some very natural implications of the added worker effect seem to have gone unnoticed in the literature. This is because of the lack of theoretical investigation into this subject. The need for a full-fledged theoretical analysis arises for three reasons. First, it is worth checking if the 'added worker effect' can be derived from the standard principles of consumer theory. Second, the added worker effect has some surprising implications which need to be understood if we are to devise effective policy interventions. Third, a theoretical model may allow us to devise more sophisticated tests for the added worker effect, which continues to be an area of much empirical dispute.

To give the reader a preview of this paper, we present here, in outline, one of the results that we obtain in this paper. Assume, as seems natural, that greater unemployment (for instance, among adult males) prompts women and children to join the labor force. Now start from a full-employment situation, with wage at some level, say $w$. It is shown in this paper that, if a legal minimum wage is announced at some wage rate $\bar{w}$, which is below $w$, then market wage can fall from $w$ to $\bar{w}$ and this can give rise to unemployment. Conversely, the abolition of a legal minimum wage can cause the market wage to rise. Moreover, a rise in the legal minimum wage can actually lead to a fall in unemployment despite the model being that of competition.

At first sight such results may seem academic, for we may wonder why government would ever impose a legal minimum wage below the prevailing market wage. In reality labor markets are often segmented, with different wages prevailing in different markets–for instance, agricultural wages may be lower than the wages that prevail in the manufacturing sector. Suppose in some fringe sector wage happens to be low. Now, minimum wage laws are typically used to boost wages in such "depressed" sectors. So a legal minimum wage below the wage that prevails in the main labor market but above the wage in the fringe market is not at all uncommon. In addition, our analysis also applies to models where the wage rigidity comes from an endogenous efficiency wage argument, instead of a legal minimum wage. For this reason we believe that the effect we are writing about is likely to be important in reality.

The plan of the paper is as follows. In section 2 we recapitulate some of the related literature and empirical findings. In section 3 an intuitive sketch of our model is developed and the paradoxical result concerning the effects of minimum wage legislation is established. Section 4 constructs a formal mathematical model. Section 5, draws out some of the other implications of our model, relates it to the literature on efficiency wage, demonstrates how giving unemployment benefits can increase efficiency and shows how our model could help reconcile some of the empirical controversies.

## 2. THE BACKGROUND

The effect of one person's employment status on the decision of others members of the household to look or not look for employment was recognized and attempted to be measured by Woytinsky

(1940a, see also 1940b). In the words of Humphrey (1940a, p. 412), what Woytinsky was getting at was "the familiar story of the head of the family losing his job whereupon his wife and children also start looking for work so that two or more persons appear to be unemployed and are reported to be unemployed by most censuses."

Starting with this exchange in the forties, this topic became a subject of considerable empirical investigation and debate (see, for instance, Mincer, 1962; Belton and Rhodes, 1976; Ashenfelter, 1980; Layard, Barton and Zabalza, 1980; Bardhan, 1984; Lundberg, 1985; Maloney, 1986, 1991; and Tano, 1993). This effect, of one person's (the 'primary' worker's) unemployment, or potential unemployment, prompting other family members (the 'secondary' worker's) to seek work, came to be known as the "added worker effect." Economists subsequently went on to argue about an opposing force, which has come to be called the "discouragement effect." This is the response of potential workers losing hope and ceasing to search for jobs, when they see a lot of unemployment around them. The strength of these two effects is a matter of debate. The empirical results are mixed. There seems to be some consensus, or at least a majority opinion among those involved in empirical research in this area, that the discouragement effect is very strong and frequently offsets entirely the added worker effect (see for instance Maloney, 1991; Humphrey, 1940; and the discussion in Layard et al., 1980). Most of these studies however focus on the effect of actual unemployment of husbands on the actual employment of women, whereas it is important to measure the effect of any employment constraints on the husband's labor supply on the *desired* hours of work of the wife, since the wife's actual employment may also be affected by the increase in unemployment. Once this is done, the results can look different. Maloney (1986), for instance, using reported data on underemployment finds a significant added worker effect. And, Tano (1993) finds that both effects are significant and coexist.

Much depends on properly defining what it means for a person to supply her labor. Consider two competing definitions: (1) that she actively searches for work, and (2) that she will accept a job if a job comes her way. During depressions people may cease to supply their labor, in the sense of (1), but it is highly unlikely that they would cease to supply labor *a la* (2). And, it seems to us, that (2) is the true meaning of labor supply. Of course, (2) is harder to measure, since it may not have an adequate behavioral manifestation. Flinn and Heckman (1983) discuss a closely-related classification of different kinds of unemployment and argue that, despite the vagueness,

such distinctions may be empirically meaningful.

Moreover, a major conceptual difference between our model and much of the empirical literature is that we assume that households and their secondary workers want to work in response to the worsening job *prospects* of the primary worker (instead of the actual loss of employment of the primary worker). It may be interesting to check the validity of this assumption. One way to do this would be to take two points of time where macro unemployment rates are significantly different. Then by focusing on households for which the primary worker's status is unchanged between these two time periods, we can check if there is a systematic change in the labor supply of the secondary workers of these households. Note that, in that spirit, Lundberg (1985) studies the effect of employment uncertainty and credit constraint in creating short-run participation and employment patterns. The estimates are based on employment transition probabilities rather than static measures of labor supply and the results show a small but significant added worker effect.

We shall show in section 4.5 that once a theoretical model of household supply response is constructed, we could add plausible features to it which can explain why the added worker effect can create an empirical illusion of there being a discouragement effect (which may in actuality be non-existent). In reality we would expect both effects (added worker and discouragement) to be present. Our analysis could then be taken to explain why the discouragement effect may appear larger than it actually is.

There have been some earlier attempts to theoretically model inter-dependence in the household. Ashenfelter (1980) analyzed the effect of one person's labor supply being constrained on another household member's supply. In Basu and Van (1998) and Basu, (1998) the effect of adult labor market conditions on the incidence of child labor is analyzed, using a model of household-based decision making.

The present paper builds a theoretical model which explicitly allows for the added worker effect, highlights some paradoxical results, shows why the discouragement effect may be, in part, illusory, and relates these ideas to other areas of research such as efficiency wage and inflation, unemployment benefits and race and gender issues.

# 3. BASIC MODEL: MINIMUM WAGE AND UNEMPLOYMENT

Since the novelty of our results arise from the labor supply decision, let us suppose that the aggregate demand for labor is the usual downward-sloping function of wage, $w$, denoted by $D(w)$, and keep this aside for later reference.

What we have to model carefully is the 'supply curve.' Let us consider an economy with many households, each household $i$ consisting of $n$ workers. When we want to be explicit about the sex and age of the workers we will think of person 1 in each household as the adult male, person 2 as the adult female, and the rest as the children. In case this is a society where children do not work, we may think of a household's members $3; 4; :::; n$ as the children who are above 16 years of age.

Recall how the textbook supply curve of labor is derived. We take the market wage, $w$, to be arbitrarily given and make the household do a maximization exercise and work out the household's labor supply. There is an implicit assumption in such an exercise. The assumption is that a person who supplies his or her labor gets to work. This assumption becomes unrealistic if there is unemployment in the economy. It is for this reason that some economists have worked out the household's supply, taking as given the fact that some members may be supply-constrained (one early such exercise was that of Ashenfelter, 1980).

We shall proceed in the same spirit but conceive of a different model. We shall assume that the level of unemployment in the economy is public knowledge. If the unemployment rate (expressed as a fraction) is $u$, then we shall take $1 ¡ u = p$ to be the probability of each worker finding a job. Let us assume that this is the same for those who are currently employed and those who are currently unemployed. This assumption is used in the well-known Harris-Todaro model (Harris and Todaro, 1970). If we think of this as a casual labor market with large turnover then this is not an unrealistic assumption. If a fraction $p$ of all those supplying their labor currently find jobs, it seems reasonable to suppose that each worker treats $p$ as the probability of being employed in the next period. We shall assume that just as each household is a wage-taker, each household is a $p$-taker (that is, it ignores the effect of its own decision on the aggregate unemployment rate in the economy).

This being so it is quite reasonable to suppose that individual labor supply decision will depend on $w$ and $p$ (and not only on $w$). This is especially so when decision-making occurs at the level

of the household. For ease of thinking, let us suppose each person sees $w$ and $p$ and then has to decide (even if this is a household-based decision) whether to supply his or her labor or not. If the person does supply labor, then if he (or she) is picked for a job, he is committed to taking it. Later we introduce a sunk cost associated with supplying labor in order to 'endogenize' this assumption.

It seems reasonable to suppose that if $p$ is very low, the household faces a genuine risk of the adult male not finding a job. It is then reasonable for the other members of the household to supply their labor as well (so as to minimize the risk of the household being left with no one employed).[1] This "added worker effect" not seems to have been modeled theoretically and its full implications not to have been studied.[2] So let us proceed to take explicit account of this.

Leaving formal mathematical modeling to later, we may assert that the above consideration will mean that household $i$'s total labor supply, $S_i$, will depend on $w$ and $p$ and as $p$ falls $S_i$ will rise. By aggregating the labor supply of all households we may write

$$S = S(w; p); \quad \frac{@S}{@p} \cdot 0 \tag{1}$$

where $S$ is the aggregate supply. At this stage $\frac{@S}{@p} \cdot 0$ is simply an assumption. Since this added worker effect assertion (that a worsening in job prospects results in an increased labor supply) is so central to our paper, it would be unfortunate if this remained at the level of an axiom. In the next section we show that under standard neo-classical assumptions, with no transaction or sunk cost, $\frac{@S}{@p} \cdot 0$ is a property that can be deduced. This is our Theorem 1 and is the technical result on which much of our subsequent analysis is based. But for now let us continue to treat this as an assumption. We shall later show that once transactions or sunk costs are allowed $\frac{@S}{@p}$ can be positive, thereby creating a general model which can explain both the added worker effect and the discouragement effect.

The textbook supply curve of labor is the relation between $w$ and $p$ when $p = 1$. Figure 1 shows this curve as $OA$. We do not insist on any particular shape for this. If we want to think of this as

[1] Note that an additional factor, beyond the income effect, in favor of the added worker effect lies in the fact that an increase in the primary worker's leisure time tends to reduce the relative value of the secondary worker's non-market time, thereby inducing them to participate to the labor force. We will not consider this factor here. It is also worth noting that increase the labor supply is only one way to reduce the fluctuations in income due to unemployment, borrowing or dissaving constituting other options. Hence the added worker effect is likely to be stronger for households which are credit constrained or whose credit or dissaving opportunities are more costly.

[2] An early attempt of doing so is Ashenfelter (1980).

perfectly inelastic (with only adult males working) it will be a vertical straight line. If we believe supply curves bend backwards at high wages, we could build that into our model.

Next note that, for each $p \in [0;1]$, we can draw a supply curve $S = S(w;p)$. We shall call each such curve a 'quasi-supply curve' or '$p$-supply curve.' Figure 1 illustrates a family of $p$-supply curves. If we wanted to model the "discouragement effect" of unemployment, we would take $\frac{\partial S}{\partial p} > 0$ and so, as $p$ fell, the $p$-supply curves would move left. If we believed that for low wages the added worker effect is dominant and for high wages the discouragement effect dominates, we would have the $p$-supply curves intersecting one another. Let us however, for now, go along with the assumption $\frac{\partial S}{\partial p} \leq 0$.

Our aim now is to construct the "actual (aggregate) supply curve" from the $p$-supply curves. This will, interestingly, depend on the nature of the demand curve, thereby illustrating our initial observation regarding the inter-dependence of demand and supply.

Let the demand curve, $D(w)$, be as shown in Figure 2. Now, given any point on any $p$-supply curve, we can easily work out the rate of employment that will actually come to prevail. Suppose, for instance, we are at point $b$. Then labor supply is $\overline{wb}$ and (given the wage implicit at $b$) labor demand is $\overline{wk}$. Hence the rate of employment or probability of finding a job is given by $\frac{\overline{wk}}{\overline{wb}}$. Note that $b$ is a point on $p^0$-supply curve. Hence if $\frac{\overline{wk}}{\overline{wb}}$ is not equal to $p^0$, labor supply can never occur at $b$.

By this reasoning, note that the probability of finding work at point $a$ is $1$ and at point $c$ it is $0$ (since demand for labor at $c$ is zero). It follows that when we move from a to $c$ along the $p^0$-supply curve there must occur (given the continuity of the demand and $p^0$-supply curve) some point where the probability of finding work is exactly equal to $p^0$. If the demand curve is downward sloping and the quasi-supply curve upward sloping (and one of these strictly so), then this happens at a unique point of each $p$-supply curve where $p < 1$. Let us assume that for the $p^0$-supply curve this happens at $b$. That is, $\overline{wk}/\overline{wb} = p^0$: We could then think of $b$ as a point on the actual supply curve. It is a point that satisfies rational expectations. Suppose the wage happens to be $\overline{w}$. If all workers expect the rate of employment to be $p^0$, then their supply would be such that the expectation is confirmed.

If on each quasi-supply curve we pick the point that satisfies rational expectation and join up such points what we get is the *actual aggregate supply curve* of labor. Let the thick line going

through $0$ and $b$ be such a curve.

It may be worthwhile explaining why the aggregate supply curve coincides with the $1$-supply curve (that is the $p$-supply curve corresponding to full employment) to the left of the demand curve. This is because at any such point, for example, $e$, demand for labor exceeds supply and so the rate of employment is $1$.

Let us now demonstrate some of the paradoxical results that this model gives rise to. Suppose $DD^0$ in Figure 2 does represent the demand for labor. Then $E$ represents a point of equilibrium. The wage is $w^*$ and demand equals supply. Now suppose government enacts a new minimum wage law and sets the legal minimum wage at $w_0$. Since $w_0 < w^*$, standard economics would lead us to expect that this cannot possibly have any impact (Mincer, 1976; Ashenfelter and Blum, 1976). But in this model, where there are "added worker effects," this legal intervention can have significant consequences.

Observe that if wage were at $w_0$, there are three levels of supply that would satisfy rational expectations. These are $w_0e$, $w_0b$ and $w_0z$. Suppose $w_0b$ is the supply. Then supply exceeds demand and so wages have a tendency to fall, but the law will not allow it to fall. So the wage persists at $w_0$ and there is open unemployment. So point $b$ depicts an equilibrium. Point $e$ does not depict an equilibrium because , though it satisfies rational expectations, at $e$ there is excess demand for labor and so wage would rise. By this same logic point $z$ depicts an equilibrium. Of course the earlier equilibrium at $E$ is still available. In other words, the minimum wage law gives rise to multiple equilibria and, in particular, a legal minimum wage, imposed at a level below the prevailing market wage, can result in a fall in the wage. This is however unlikely since $b$ is an unstable equilibrium. A small rise in unemployment at $b$ will result in more unemployment and the equilibrium would finally settle at $z$ which is a stable equilibrium.

Another interesting result arises if this model is combined with an efficiency wage model. Consider either a labor turnover model or a Leibensteinian model (Leibenstein, 1957; Mirrlees, 1975; Stiglitz, 1974, 1976; or Fehr, 1986) in which a worker's productivity happens to depend on his wage, ignoring for now the fact that a part of this wage may go to feed other members of the household. The latter is discussed in Genicot (1998). Let us suppose that the efficiency wage is at $w_0$, and the aggregate demand for labor is $w_0k$: For wages above $w_0$, aggregate labor demand is given by the line $Dk$.

Let us suppose the supply conditions are as shown in Figure 2. Thus the standard textbook supply curve is given by $OA$. Our first expectation may be that, since at the efficiency wage labor demand exceeds $w_e$, wage will rise above $w_0$, the efficiency wage, and there will be no involuntary unemployment. However, in our model, wage may persist at $w_0$ with unemployment equal to $kb$ or, more likely, $kz$. Of course at this wage, workers will be willing to work for a lower wage, but employees will not accept such offers.

It should also be transparent that the aggregate supply curve of labor depends on the nature of the demand curve. To see this, suppose the wage is fixed at $w_0$ (Figure 3) and the economy is at the equilibrium $A$: Consider a drop in the labor demand from $D_1$ to $D_2$. To $w_0$ corresponds a labor demand $l$ smaller than $k$: Hence $A$ does no longer belongs to the actual aggregate supply curve since $\frac{w_0 l}{w_0 A} < \frac{w_0 k}{w_0 A} = p$: The point on $S(w; p)$ which will translate in an actual probability of finding work of $p$ is now $A^0$: It is easy to check that a fall in demand will result in the supply curve moving down (everywhere to the right of the demand curve). Starting from $A$; a decrease in the demand worsen people's expectations about the likelihood of finding a job. In response they will increase their labor supply causing the unemployment to rise by more than the fall of demand and the economy will settle in a new equilibrium $B$.

## 4. FORMAL MODEL

Let a household have $m$ members with desutility of labor $c_1; c_2; :::; c_m$. Without loss of generality, assume $c_1 \cdot c_2 \cdot ::: \cdot c_m$: These costs could include norms. If it is the case that the adult male is the first to go out to work, we could suppose that person 1 in each household is the adult male and so $c_1 \cdot c_i$; for all $i = 1; 2; :::; m$. It is assumed that the household is sufficiently small in comparison to the aggregate labor force that it takes the wage rate, $w$, and the probability of each person finding a job, $p$, to be given. If the total income of the household is $Y$ and the total effort expended by the household is $C$, then the household's utility, we will assume, is given by $u = u(Y; C)$, where $u_1 > 0$, $u_{11} < 0$, $u_2 < 0$, $u_{22} \cdot 0$. Hence, if $S$ is the set of household members who find employment, the household's welfare is given by $u((\#S)w; \sum_{i2S} c_i)$, where $\#S$ denotes the number of elements in $S$.

Note that, since everybody fetches the same wage, if a household chooses to send $n$ members

to the labor force (that is, in search for a job), it will be the first $n$ persons in the household, that is persons $1; 2; :::n$. Keeping this in mind, it is evident that if $w$ is the market wage and $p$ the probability of each person to find work, then the household's problem is to choose $n \in \{1; 2; :::; m\}$ so as to:

$$\max W(n; p; w) \equiv \sum_{S \subseteq \{1;2;:::m\}} p^{\#S}(1 - p)^{n - \#S} u((\#S)w; \sum_{i \in S} c_i) \tag{2}$$

If $n^*$ solves (1), it means that the household will send its first $n^*$ members to the labor market. This formulation, that is (1), will be called the '*general problem or formulation*'. Most of the time we shall work with what we will call the '*special problem or formulation*' which assumes $c_1 = c_2 = ::: = c_m$ and $u(Y; C) = V(Y) - C$.

Hence, in the special formulation, the household's problem is to choose the number of household members, $n$, to supply to the labor market, $n \in \{0; 1; 2; :::; m\}$, so as to:[3]

$$\max W(n; p; w) = \sum_{k=0}^{n} \pi(k|n; p)(V(kw) - kc) \tag{3}$$

where $\pi(k|n; p)$ is the probability that $k$ household members find jobs conditional on $n$ members looking for work (or, in other words, supplying labor). Clearly, $\pi(k|n; p) = \frac{n!}{k!(n-k)!} p^k (1 - p)^{n-k}$: It should be evident that it is being assumed that, a person who looks for work and then gets it, cannot turn it down. This is a simplifying assumption, which keeps the algebra tractable. As discussed at the end of this section and again in section 5.3, this is not an essential assumption in the sense that our conceptual results would remain valid in a more sophisticated framework, which allowed people to change their minds.

Barring one or two special times, when this will be explicitly stated, from here on we will work with the special case, (3). No matter which formulation is adopted we will use $s(w; p)$ to denote

[3] Our use of the indirect household utility function $V(:)$ places no restriction on how consumtpion is distributed within the household. We could, for instance, begin by assuming that the household utility from its $m$ members consuming $x_1; :::; x_m$ is given by $\acute{A}(x_1; :::; x_m)$. In that case $V(Y)$ is the solution to the following problem:

$$\max_{\{x_i\}_{i=1}^{m}} \acute{A}(x_1; :::; x_m) \text{ subject to } \sum_{i=1}^{m} x_i \leq Y$$

The restriction that we place on the form of $V(Y)$ can easily be derived from the standard restrictions on $\acute{A}(:)$. It is in particular easy to see that if $\acute{A}_i > 0$ and $\acute{A}_{ii} < 0$ for all $i$; then $V' > 0$ and $V'' < 0$:

the number of household members who supply labor, given $w$ and $p$. In other words,

$$s(w;p) \equiv \arg\max_{n} W(n;p;w)$$

Assuming that the economy has $h$ identical households, let us use $S(w;p) \equiv hs(w;p)$ to denote the aggregate labor supply. This is of course the same quasi-supply curve of the previous section. Let the demand for labor be given by $D = D(w)$; $D'(w) < 0$: To now derive the 'actual aggregate supply curve', we will proceed by a rational expectations arguments in section 3. Suppose the wage is given by $w$. Let all households have an expectation of $p$ given by $p^e$: This expectation is rational if and only if

$$\min\left\{\frac{D(w)}{S(w;p^e)};1\right\} = p^e \tag{4}$$

Let $P(w)$ be the correspondence such that for all $p^e \in P(w)$, $p^e$ satisfies (4): Then $P(w)$ is the '*actual (aggregate) supply curve.*' In other words, if the wage is $w$; the actual supply of labor is any value $z$ such that for some $p \in P(w)$, $z = S(w;p)$.

An important technical result which then allows us to do our economic analysis concerns the behavior of $S(w;p)$ with respect to changes in $p$. The theorem below sums this up.

**Theorem 1 :** If $\hat{p} < \check{p}$; then $S(w;\hat{p}) > S(w;\check{p})$; for all $w \geq 0$:

**Proof.** Note that we would have proved this Theorem if we can show the following:

If

$$W(n;\check{p};w) < W(n+1;\check{p};w) \tag{5}$$

then

$$W(n;\hat{p};w) < W(n+1;\hat{p};w), \text{ for all } \hat{p} < \check{p} \tag{6}$$

So in the remainder of the proof, we show that (5) implies (6). The proof is developed in four steps.

**Step 1:** If $n+1$ persons from a household apply for jobs, we could think of the household's expected welfare to be a weighted average of two possible events; one where person 1 does not find a job (probability $1-p$) and one where he does find a job (probability $p$). Hence, we may write

$$W(n+1;p;w) = (1-p)W(n;p;w) + p\left[\sum_{k=0}^{n}(\pi(k|n;p)V((k+1)w)) - npc - c\right] \tag{7}$$

Hence,

$$\begin{aligned} W(n+1;p;w) - W(n;p;w) &= p\left[\sum_{k=0}^{n}(\pi(k|n;p)V((k+1)w)) - npc - c - W(n;p;w)\right] \\ &= p\left[\sum_{k=0}^{n}\pi(k|n;p)\,(V((k+1)w) - V(kw)) - c\right], \end{aligned}$$

by the definition of $W(n;p;w)$:

Hence, by defining $Z(k) \equiv V((k+1)w) - V(kw)$; we have

$$W(n+1;p;w) - W(n;p;w) = p\left[\sum_{k=0}^{n}\pi(k|n;p)Z(k) - c\right] \tag{8}$$

**Step 2:** It will now be shown that as $p$ drops from $\check{p}$ to $\hat{p}$, there exists $k^{*}$; such that , for all $k \leq k^{*}$, $\pi(k|n;\hat{p}) \geq \pi(k|n;\check{p})$ and, for all $k > k^{*}$, $\pi(k|n;\hat{p}) < \pi(k|n;\check{p})$:

To see this, recall that

$$\pi(k|n;p) = \left[\frac{n!}{(n-k)!k!}\right] p^{k}(1-p)^{n-k}:$$

Hence, $\pi(k|n;\hat{p}) \geq \pi(k|n;\check{p})$, if and only if

$$\hat{p}^{k}(1-\hat{p})^{n-k} \geq \check{p}^{k}(1-\check{p})^{n-k};$$

or

$$\left[\frac{\hat{p}}{\check{p}}\right]^{k}\left[\frac{1-\check{p}}{1-\hat{p}}\right] \geq \left[\frac{1-\check{p}}{1-\hat{p}}\right]^{n}: \tag{9}$$

Given that $\hat{p} < \check{p}$; then if the above inequality, (9), holds for some $k^{0}$; then it must hold for all $k \leq k^{0}$; and if the above inequality is invalid for some $k^{0}$, then it must be invalid for all $k > k^{0}$. This completes the proof of the claim made at the start of step 2.

**Step 3:** This step consists of showing that as $p$ falls from $\check{p}$ to $\hat{p}$, $\sum_{k=0}^{n}\pi(k|n;p)Z(k)$ must rise.

Note that, concavity of the household utility from consumption implies that

$$Z(0) > Z(1) > \cdots > Z(n) \tag{10}$$

Intuitively, the proof of the claim being made in this step is immediate. Note that $\sum_{k=0}^{n} \varphi(k|n;p)Z(k)$ is simply a weighted average of $Z(0), Z(1), \ldots, Z(n)$. As $p$ falls, we know from step 2 that the weights shift towards the higher valued elements, so the value of the sum must rise.

To see this formally, as $p$ falls from $\check{p}$ to $\hat{p}$, let $k^*$ be the critical integer identified in step 2. Clearly,

$$\sum_{k=0}^{n} \varphi(k|n;\hat{p})Z(k) - \sum_{k=0}^{n} \varphi(k|n;\check{p})Z(k)$$

$$= \sum_{k=0}^{k^*} \left[\varphi(k|n;\hat{p}) - \varphi(k|n;\check{p})\right] Z(k) - \sum_{k=k^*+1}^{n} \left[\varphi(k|n;\check{p}) - \varphi(k|n;\hat{p})\right] Z(k)$$

$$> \sum_{k=0}^{k^*} \left[\varphi(k|n;\hat{p}) - \varphi(k|n;\check{p})\right] Z(k^*) - \sum_{k=k^*+1}^{n} \left[\varphi(k|n;\check{p}) - \varphi(k|n;\hat{p})\right] Z(k^*),$$

by the definition of $k^*$ and (10),

$$= \left\{\sum_{k=0}^{k^*} \left[\varphi(k|n;\hat{p}) - \varphi(k|n;\check{p})\right] - \sum_{k=k^*+1}^{n} \left[\varphi(k|n;\check{p}) - \varphi(k|n;\hat{p})\right]\right\} Z(k^*) = 0,$$

since the probabilities must add up to 1.

**Step 4:** An immediate implication of step 3 is that if $\check{p} \cdot \left[\sum_{k=0}^{n} \varphi(k|n;\check{p})Z(k) - c\right] > 0$ and $\hat{p} < \check{p}$, then $\hat{p} \cdot \left[\sum_{k=0}^{n} \varphi(k|n;\hat{p})Z(k) - c\right] > 0$. In the light of (8) this completes the proof. ■

What this Theorem asserts is that as the labor market worsens, in the sense of a decrease in the probability $p$ of finding a job, households will respond by supplying more labor. This justifies our Figures 1 and 2 where $p'' < p' < 1$. Note that in drawing these figures we ignore the fact that our mathematical model labor supply takes only integer values.

Observe that in Figure 2 the actual aggregate supply curve is multi-valued for some wages, for instance $\hat{w}$. This happens because the actual supply curve rises up to point $E$, drops down and then rises again. Since much of the interesting analysis arises because of the multi-valuedness of the supply curve, the question must arise whether this can actually happen or whether Figure 2 is a figment of pure geometric imagination. The answer is that this can not only happen but is eminently plausible. We first explain this intuitively and then construct an example to formally illustrate the point. In Figure 2 let us use $E'$ to label the point (not shown in the figure) horizontally to the right of $E$ and on the quasi-supply curve $S(w;p')$. It is easy to conceive of a model where households respond with increased labor supply to a small fall in $p$ from 1. So let us suppose that, in Figure 2, $p - p'$ is very small. In particular, let $p'$ be greater than $w^*E/w^*E'$. Then, given that the demand curve is downward sloping and assuming that the quasi-supply curve is upward sloping, it follows

that the only point satisfying rational expectations on the quasi-supply curve $S(w; p^0)$ must be below $E^0$. Hence the actual supply curve turns downwards at $E$, thereby assuring multi-valuedness.

We now demonstrate this more concretely by constructing an example. We do this for the general problem, where effort costs may vary across household members.

### Example:

As before, there are $h$ identical households, each having two members. Assume $c_1 = 0; c_2 \geq c > 0$ and $V(0) = 0$: It is easy to verify that:

$$W(1; p; w) = pV(w)$$

$$W(2; p; w) = p^2[V(2w) - c] + p(1 - p)V(w) + p(1 - p)[V(w) - c].$$

Hence, $W(2; p; w) \geq W(1; p; w)$ if and only if

$$p \leq \frac{V(w) - c}{2V(w) - V(2w)} \tag{11}$$

Purely for expositional ease, let us consider an extreme case (which violates some of our technical assumptions, such as continuity), where $V(w) = A > 0$, for all $w > 0$. Then (11) becomes (for $w > 0$)

$$p \leq 1 - \frac{c}{A} \tag{12}$$

If $p = 1$, then this is violated. So both persons will not supply labor. Since $c_1 = 0$, person 1 always supplies labor. Hence, the quasi supply curve with $p = 1$ is as shown in Figure 4.

Now let the demand curve be the straight line $D^0D$, such that $\frac{OD}{OH} < 1 - \frac{c}{A}$, where $OD$ and $OH$ refer to the line segments shown in Figure 4. It follows that, for all $p \leq \frac{OD}{OH}$, the quasi-supply curve is the vertical line $SH$, and the actual aggregate supply curve is the thick line $GF$ and $SH$. So for all wage below point $F$, the supply is multi-valued. **[End of example]**

In closing this section, let us state more formally the concept of a labor market 'equilibrium' that we have already used intuitively in section 3.

Given a model as just described, we shall say that a wage $w$ and labor supply $z$ constitute an '*equilibrium*' if $D(w) = S(w; 1)$ and $z = S(w; 1)$.

Given a model as just described plus a minimum wage law, the idea of an equilibrium becomes more complicated. If the minimum wage is set at $\bar{w}$, we shall say that a wage $w$ and labor supply $z$

constitute an '*equilibrium*' if (i) $w > \bar{w}$ and $D(w) = S(w;1) = z$; or (ii) $w = \bar{w}$ and there exists $p$ such that $D(w) \cdot S(w;p) = z$, and $\frac{D(w)}{S(w;p)} = p$.

In brief, if the equilibrium wage is above the legal minimum wage, the demand for labor must be equal to the supply of labor, and if the equilibrium wage is equal to the legal minimum wage, then supply of labor can exceed demand. In each case, we also have to make sure that the rational expectations properties are fulfilled.

The paradoxical result discussed in section 3 about how the imposition of a legal minimum wage *below* the free market wage can create a new equilibrium wage below the free market wage is now evident.

Before moving on, note that in our model if a person supplies her labor and finds a job, she is committed to taking it–let us call this the 'commitment assumption.' In other words, she cannot decide to reject a job on the ground that when she applied for the job she was unsure whether her husband would find work, and now that she knows that he has found work,she does not want it. This commitment assumption is used because it keeps the mathematical analysis simple and also because it is a reasonable approximation for certain kinds of markets, for instance the casual labor market (see, for instance, Dreze and Mukherjee, 1989). If the assumption were dropped, it would no longer be the case that $S(w;p)$ would always rise as $p$ fell, as Theorem 1 claims, but there would nevertheless be classes of parameters within which this would be true. Hence, the possibility of pathological response to certain policies, such as minimum wage legislation, would continue to be valid even in the absence of the commitment assumption. This can be seen by adding to our model the realistic possibility of there being sunk costs associated with searching for work. Suppose that to supply one's labor one has to incur some search costs, such as registering at an agency or subscribing to newspapers and employment gazettes, or acquiring basic skills, word-processing for instance. These are sunk costs because if one does not find the job one is looking for, the costs cannot be recovered. If such costs are present, then even if people are allowed not to take the job they searched for, people may oversupply their labor, resulting in the kind of pathologies that we have described. We show this with an example in section 5.3, after the concept of a sunk cost has been formally introduced.

The remainder of this paper explores different extensions of this basic model.

# 5. EXTENSIONS

## 5.1 Note on Efficiency Wage and Inflation

The above model has an interesting implication when combined with standard theories of efficiency wage (for instance Leibenstein, 1957; Stiglitz, 1976; Schlicht, 1978). Suppose the labor market in an economy looks as in Figure 2 and there are no laws restricting wage movement and so the economy rests at point $E$; where wage is $w^{\alpha}$ and demand for labor is equal to supply. Now suppose that we build in an efficiency wage feature and the efficiency wage turns out to be $\overline{w}$. Two implications of this are worth noting.

First, if $\overline{w}$ exceeds $w^{\alpha}$, the unemployment that will occur may be much larger than the standard theory would lead us to expect. Thus if $\overline{w}$ is as shown in Figure 2, unemployment will not be $fg$ but $fh$. By Theorem 1, $fh$ has to be larger than $fg$.

Next, suppose that $\overline{w}$ is below the market clearing wage $w^{\alpha}$. The standard theory of efficiency wage would lead us to believe that the efficiency wage cannot have any impact on the wage that prevails on the market. However, in our model, for reasons very similar to the one involved in our minimum wage argument, the wage could actually settle below $w^{\alpha}$ and be accompanied by open unemployment.[4]

There is an interesting insight that our model sheds on the relation between unemployment and inflation. Suppose an economy has a legal minimum wage at $\mathbf{w}$ as shown in Figure 2 and suppose that the labor market equilibrates exactly at that wage with labor supply equal to $\mathbf{w}z$ and unemployment $kz$. It is usually the case that minimum wages are specified in nominal rather than real terms, and so let us assume that this is the case. Now, suppose that there is gentle inflation in the economy. This means that the minimum wage, in real terms, will slowly erode downwards. It seems reasonable to suppose that the equilibrium supply will move along the segment $zr$ on the actual supply

[4] In the efficiency wage theories in which the value of the efficiency wage depends on the level of unemployment (Stiglitz, 1974; Shapiro and Stiglitz, 1984; Fehr, 1986) the story can be a bit different. When a larger unemployment rate acts as a disciplining device, the efficiency wage paid to the workers is a decreasing function of the unemployment rate. If this effect is very strong there will be a single equilibrium. Multiple equilibria will arise if the efficiency wage curve corresponding at the different levels of unemployment intersects more than once with the aggregate supply curve. We thank Aaron Edlin for drawing our attention to this.

curve.[5] Note now that, as we go from $z$ to $r$, we move from $S(w; p^{000})$ to $S(w; p^{00})$. From Theorem 1, we know that $p^{000} < p^{00}$. Hence $1 - p^{000} > 1 - p^{00}$: So as inflation occurs, unemployment will tend to fall. In other words, a minimum wage legislation, in the absence of automatic indexation, provides an explanation for a Phillips curve type relation, though inflation in our model results not just in lower unemployment but a falling *rate* of unemployment.

## 5.2 Unemployment Benefits

Suppose in Figure 2 the wage has a floor at $\bar{w}$. This can be because there is a minimum wage law or because $\bar{w}$ happens to be the efficiency wage. The exact explanation does not matter for our purpose here. There are then three possible equilibria–at points $E$, $b$ and $z$. Let us check on the welfare properties of these equilibria. Clearly, given that this is a competitive market, the equilibrium at $E$ is the most efficient. At $b$ and $z$ there is greater output but this is caused by workers working excessively for fear of unemployment. The household's welfare is the highest at $E$, since there is full employment and the wage is higher. Between the two other equilibria, our conjecture is that $b$ dominates $z$.[6] Output and employment is the same at $b$ and $z$, but there is more unemployment at $z$. As we switch to the general formulation, where costs of effort vary across individuals, $z$ becomes even more welfare dominated by $b$. The reason is that more people supply labor at $z$ than at $b$. This means that, at $z$, workers whose effort is more costly supply labor. So a random selection of workers at $z$ will contain more of these inefficient (in the sense of high cost) workers than a random selection at $b$. So the expected effort cost at $z$ is more and so this accentuates the welfare difference between both equilibria. Since $z$ is the stable equilibrium and $b$ is unstable, this is a worrying consequence of the added worker effect. In the absence of the added worker effect the equilibrium would move to $E$. This raises the question whether we can devise policy which counteracts the tendency of workers to oversupply labor.

Since the oversupply is a consequence of the workers fearing that their household will be left without adequate employed members, any policy that combats this risk should make improve mat-

[5] In other words, though the labor supply correspondence is multi-valued around $\bar{w}$; we are assuming that, as $\bar{w}$ changes a little, supply will vary continuously as long as that were possible.

[6] For reasons similar to the argument in Rothschild and Stiglitz (1970).

ters.[7] An obvious candidate is a safety net for the unemployment. We shall here study a safety net at the level of the household, since it is the *household-level decision making* which is the source of the problem. If this is properly designed the safety net may seldom have to be used. It is its mere presence that can change household behavior favorably. So it need not cause any fiscal strain.

To see formally how this works, suppose that the government guarantees an income of $G$ for each household. So any household whose income drops below $G$ is given enough unemployment benefit for the household to consume $G$. If we use $\hat{V}$ to denote a household's expected welfare, then following a notation similar to that used in section 4, and staying for simplicity with the special case, we may write

$$\hat{V}(n;p;w;G) = \sum_{k=0} \pi(k|n;p)V(\max\{kw;G\}) - npc$$

Given $p;w;G$; the household's total supply of labor $\hat{e}$ is defined as follows:

$$\hat{e}(p;w;G) = \arg\max_{n} \hat{V}(n;p;w;G)$$

The question that we want to investigate is the effect of $G$ on the supply of labor. The next theorem sums this up.

$\boxed{\textbf{Theorem 2 :}}$ As $G$ increases, $\hat{e}(p;w;G)$ (weakly) decreases.

**Proof.** Following a strategy similar to the one used to prove Theorem 1, note that

$$\hat{V}(n+1;p;w;G) = (1-p)\hat{V}(n;p;w;G) + p\left[\sum_{k=0} \pi(k|n;p)V(\max\{G;(k+1)w\}) - npc - c\right]$$

Hence,

$$\hat{V}(n+1;p;w;G) - \hat{V}(n;p;w;G) = p\left[\sum_{k=0} \pi(k|n;p)\left(V(\max\{G;(k+1)w\}) - V(\max\{G;kw\}\right) - c\right]$$

Define $k(G)$ such that

$$(k(G)+1)w > G \geq k(G)w$$

If $w > 0$; then $k(G)$ is well-defined. Using this definition, we have

[7] It should be stressed that this is currently a conjecture since we have not been successful yet at formally proving that $b$ dominates $z$.

$$\hat{W}(n+1;p;w;G) - \hat{W}(n;p;w;G) =$$
$$p[\pi(k(G)|n;p)(V((k(G)+1)w) - V(G)) + \sum_{k=k(G)+1}^{n} \pi(k|n;p)[V((k+1)w) - V(kw)] - c]$$

Suppose, first, that households supply positive amounts of labor. It is now easy to see that, if $\hat{W}(n+1;p;w;G) - \hat{W}(n;p;w;G) \geq 0$ and $G' \leq G$; then $\hat{W}(n+1;p;w;G') - \hat{W}(n;p;w;G') \geq 0$:

To see this consider two cases:

(i) $G' \geq k(G)w$, and

(ii) $G' < k(G)w$

If (i), a fall in $G$ to $G'$, leaves $k(G)$ unchanged and increases $V((k(G)+1)w) - V(G)$: It follows that $\hat{W}(n+1;p;w;G) - \hat{W}(n;p;w;G)$ will rise; and so $\hat{W}(n+1;p;w;G') - \hat{W}(n;p;w;G') > 0$:

If (ii), a fall in $G$ to $G'$ causes $k(G')$ to fall under $k(G)$, which again causes $\hat{W}(n+1;p;w;G) - \hat{W}(n;p;w;G)$ to rise.

Hence, in either case a fall in $G$ causes quasi-supply to fall.

This proof was under the assumption that the households supply positive amounts of labor. Note that a household will cease to supply positive amounts of labor, if $\max_n \hat{W}(n;p;w;G) \leq V(G)$: Clearly, if $G$ falls, the cut-off wage at which the household ceases to supply labor will fall. ■

Theorem 2 shows how an unemployment benefit can dampen the added worker effect. It may be checked that an implication of this theorem is that as $G$ increases, the aggregate supply curve moves (weakly) upwards. Hence, for each wage, $w$, the largest supply of labor satisfying rational expectations must fall. Hence, for a given minimum wage, a rise in $G$ can cause unemployment to fall (with total employment remaining unchanged) . Further it is easy to see that if $G$ is kept at a small level, the quasi supply, when $p$ is 1, remains unaffected by the $G$. That is, $\hat{s}(1;w;G) = s(1;w)$: In other words there is no shirking of labor. So, interestingly, what this demonstrates is that unemployment benefits may be justified without having to invoke equity reasons, but purely on grounds of efficiency.

## 5.3 Discouragement Effect

We have worked thus far under the assumption that labor supply consists of a willingness to work, even if this does not translate into active search for work. In other words, a dispirited labor force that has ceased to look for work should not be reason for government to declare that unemployment

has declined. Nevertheless, it is interesting to ask what happens to labor supply of the other kind, where a worker is described as supplying his labor if he actively searches for employment. To model this realistically it is essential to recognize that job search can be costly.[8] In the light of the model developed above this feature is easy to incorporate.

Let labor supply involve a lump-sum cost of $\mu$ dollars per person, where $\mu \geq 0$. So $\mu$ can be the cost of neglected house-work or the transactions cost of getting oneself registered at the employment exchange. If we now use $\Phi(n; p; w)$ to denote a household's expected welfare where $n$ is the number of persons who supply labor, $p$ is the probability of each person finding employment and $w$ is the market wage, then

$$\Phi(n; p; w) = W(n; p; w) - n\mu; \tag{13}$$

where $W(n; p; w)$ is defined as before by (3).

Define $S_\mu(p; w) \equiv \arg\max_n \Phi(n; p; w)$:

It is now easy to show that for some parameters the discouragement effect dominates. In particular, for sufficiently small $p$, labor supply will decline and in fact go to zero.

$\boxed{\textbf{Theorem 3 :}}$ For all $w$, there exists $\varepsilon > 0$; such that, for all $p \leq \varepsilon$, $S_\mu(p; w) = 0$:

**Proof.** It is easy to see from (3) that as $p \to 0$, $W(n; p; w) \to V(0)$. Hence, as $p \to 0$, $\Phi(n; p; w) \to V(0) - n\mu$.

Next note that $\Phi(n; p; w) = V(0)$: Therefore, for all $w$; there exists $\varepsilon > 0$, such that, for all $p \leq \varepsilon$, $\Phi(0; p; w) > \Phi(n; p; w)$, for all $n \in \{1; \ldots; m\}$: ■

This theorem implies that, as wage rises, the actual (aggregate) supply curve must eventually turn back towards $D$. In fact, if the demand curve touches the vertical axis, the actual supply curve must meet up with the demand curve where the demand curve touches the vertical axis. However, when $p$ is large, that is, unemployment is low, the added worker effect may dominate. If $\mu$ is small, in fact this must be so. In other words, in Figure 2, the actual supply curve may continue to dip down at $E$, before rising and turning back towards $D$ eventually. Therefore, though adding search

[8] Note that in our model, zero search cost does not mean that everybody will supply their labor. This is because of the desutility associated with labor and because of the assumption that a worker who supplies labor and finds a job has to take it.

costs will make a difference to our analysis, the possibility of multiple equilibria and the 'peculiar' analytic of minimum wage legislation may continue to work the way it did in the model developed sections 3 and 4.

Let us now turn to the question raised at the end of section 4, namely, what happens if workers are free to reject jobs, which they themselves had sought. We will here construct an example which shows that, within certain classes of parameters, households will respond to a drop in $p$ by sending more members to the labor market.

Example:

Assume $c = 0$; $m = 2$; $V(0) = 0$ and

$$\frac{V(2w)}{4} > \mu > V(2w) - V(w) \tag{14}$$

It is easy to see by choosing actual numbers for $V(w)$ and $V(2w)$ that (14) can be true, given a sufficient amount of risk aversion.

Now note that

$$\Phi(0; p; w) = 0$$

$$\Phi(1; p; w) = pV(w) - \mu$$

$$\Phi(2; p; w) = p^2V(2w) + 2p(1 - p)V(w) - 2\mu$$

Suppose $p = 1$. It follows immediately from (14), that $\Phi(1; 1; w) > \Phi(2; 1; w)$: Next note that $\Phi(1; 1; w) > \Phi(0; 1; w)$ if and only if

$$V(w) > \mu : \tag{15}$$

From the strict concavity of $V(:)$, and the normalization assumption that $V(0) = 0$, it follows that $V(w) > \frac{V(2w)}{2}$: Hence, by (14), $V(w) > \mu$, thereby establishing (15). Hence, if $p = 1$, the household sends only one member to work. Next, if $p = \frac{1}{2}$, it is easy to check, using (14), that the household will send both members to work. Since $c = 0$, a person who sought work and found it will never turn the offer down. Therefore a fall in $p$ can result in a greater labor supply. **[End of example]**

## 5.4 Formation of Expectations and Price Rigidities

It is interesting to explore the dynamics of wages and unemployment that our model would predict.

In this section we give an informal sketch of this argument.

As a first step let us consider the way expectations on the employment rate $p^e$ influence the actual employment rate $p$, *assuming that wage is completely rigid*. Let us for simplicity suppose that the demand curve is a straight line $DD_0$ as shown in Figure 5, and that wage is rigid at $w^{\text{¤}}$. To study the dynamics of expectations, assume that because of some minor disturbance the labor market is out of equilibrium and currently at point $1$ in Figure 5. This could be for instance because the demand curve has recently moved left to $DD_0$. This will mean that people will revise their expectation of $p$. To see what the revised expectation will be, draw a ray from $D$ through point $1$. Let $1^{\text{¤}}$ be the point where it intersects the actual aggregate supply curve and let $S(w; p^1)$ be the quasi supply through this point. Clearly at point $1$ the revised expectation of the employment rate will be $p^1$. Hence, (with rigid wage) the labor supply will increase up to point $2$. But at point $2$ the employment rate will need to be revised again. And, by similar reasoning, the revised rate will be $p^2$ and there will again be an additional supply response moving the labor market towards point $3$. And the process continues, like Achilles and the tortoise, coming to a halt only at $B$. In brief, if the economy started at point $A$ in Figure 6, wages were fully fixed, and there was a slight shock causing a small unemployment to appear, the market would end up at point $B$.

Now we are in position to investigate the movement in wage and employment when wage are *partially* rigid. Suppose $DD_0$ in Figure 6 does represent the demand for labor and that the economy is at the full employment equilibrium $A$: The wage is $w^{\text{¤}}$ and demand equals supply. Now suppose there is a small drop in the demand that decreases $p$: This drop is likely to have two types of effect. On the one hand, if it results in a decrease in the expected employment rate $p^e$, households will respond by increasing their labor supply. This in turn causes the actual employment rate to decrease even more. On the other hand, an excess supply of labor puts a downwards pressure on wage, which in turn results in an increase in the labor demand and a decrease in the labor supply, pushing up the actual employment rate. The net effect is likely to depend on the speed of adaptation of both the wage and the expectations. At the extreme, if there is no rigidity in the wage and expectations are slow to adapt, the drop in the wage will instantaneously correct for the small drop in the labor demand and the added worker effect will not occur. At the other extreme, if wages are perfectly rigid downwards, the cumulative effect of worsening expectations and increasing unemployment will result in the economy shifting from $A$ to point $B$ on Figure 5 and 6. The most likely effect being

in between. The small shock in the demand first increases the unemployment and this even more as expectation worsen, but at some point, the wage will fall reversing the effect, the employment rate increases improving the expectations, and the economy comes back to its initial equilibrium $A$, all described by the loop in Figure 6.

## 5.5 Race, Gender and Unemployment

A well-known fact for most economies is that unemployment rates vary across different categories of labor more than can be dismissed as natural stochastic variations. Thus, we often hear how Black unemployment exceeds White unemployment by a wide margin, or how unemployment for one caste groups in India is markedly larger[9].

At first blush, it may appear that our model with its penchant for multiple equilibria may have an explanation for this. Indeed, it does offer an explanation but for reasons more roundabout than one may expect at first blush.

To see this, suppose first that employers are race-blind and caste-blind, that is, they select their workers randomly from among the unemployed without showing preference for any race or caste. Evidently, then the expected unemployment rates of Hispanics, Blacks and Whites, and any sub-category for that matter, must be the same. This fact remains unchanged even if it were the case that more Blacks supplied labor. In brief, this fact is independent of the supply responses of the different groups. If on the other hand, employers set themselves, or are given, quotas for different races and other sub-categories, or have diversity norms for the work-force, the unemployment rate can vary across different sub-groups. What is interesting is that this can happen even if employers follow diversity norms which are 'fair'.

To understand this, assume that a fraction $\bar{}$ of an economy's (working-age) population happens to be Black and $1 ¡ \bar{}$ non-Black or, for simplicity, White. Let us suppose that the wage has a floor at $\mathbf{w}$ below which it will not go. This can be because of a minimum wage law or because of efficiency wage arguments. Let us also suppose that $\mathbf{w}$ is below the aggregate market-clearing wage $w^{¤}$: So the situation is akin to the one shown in Figure 2. Now assume that Blacks and Whites

[9] In Third World countries, child unemployment rates often differ markedly from adult unemployment rates. This can however have causes very different from the ones discussed here (see Basu, 1998) and so lies beyond the ambit of this paper.

take their household labor decision not based on the aggregate employment rate $p$ but race-specific employment rates, $p_b$ and $p_w$: Now it is entirely possible to have different racial unemployment rates despite the fact of the employer following the norm of employing workers so that a fraction $\bar{}$ of the workers are Blacks. The argument is easy to see. Suppose Blacks conjecture that $p_b$ is low, while Whites conjecture $p_w$ is high. Then this can create a relatively larger supply of black labor by bringing all black women into the labor force while white women stay at home, thereby fulfilling the initial conjectures.

Note finally that we assumed that the employers use a fair norm not because they actually do so, nor because that is necessary for our argument, but because that is the assumption under which our result is least expected. If employers use a biased norm, variations in race-specific unemployment rates are only to be expected.

It is interesting to note that the logic of sex-specific unemployment rates will have to be very different since most households consist of males and females, and so female labor supply will depend not just on $p_f$ (the employment rate of female) but also on $p_m$ (the male employment rate). And typically a larger male unemployment will cause a positive female labor supply response resulting in a larger female unemployment rate as well. Our model suggests that at a macro level male-female unemployment rates will tend to move together, though unemployment rates can vary markedly across races.

This leads us to an interesting micro question. How do unemployment rates within households and across gender vary? That is the subject matter of the next sub-section.

## 5.6 Reconciling Some Empirical Paradoxes

A number of empirical studies of labor supply in the US have remarked that the added worker effect in reality is feeble[10]. Other studies have pointed out that this effect may not be feeble but it's net effect is weak because it is offset by comparable discouragement effect pushing in the opposite direction[11]. Naturally, the presence of search costs might explain a certain discouragement effect in the sense of a less active search, but in the light of our Theorem 1, we are inclined to believe that the discouragement effect *appears* to be larger than it really is. We shall show his by assuming that

[10] See e.g. Mincer, 1966; Maloney, 1991.
[11] Cain, 1966; Lundberg, 1985; Taro, 1993,

there are no search costs and therefore, as in our Theorem 1, there is no discouragement effect. We will then show how with a small realistic modification of our model we can explain why it may be the case that the discouragement effect is overestimated.

The modification in question consists in allowing for the possibility that there are household-level factors which can influence a person's job prospect. This possibility is hinted at in a study by Layard, Barton and Zabalza (1980) and discussed more explicitly by Lundberg (1985). It seems quite reasonable to suppose that there are many influences which occur at the level of the households. The empirical evidence of "assortative mating" provide support for this assumption. In the U.S., in a typical household, both husband and wife are Black or both are White. Now if employers discriminate against Blacks, then either both will stand better chances on the market, or both will stand worse chances respectively. Likewise, if some locations provides better job opportunities, then again each member of one household may have better job prospects than each member of another household. The same is true if ones network matters and if husbands and wives belong, or do not belong, to networks together.

To model this, let us assume that there are two types of households, $1$ and $2$. There are $h_1$ and $h_2$ households of each of these types and $h_1 + h_2 = h$: These two kinds of households are identical in every other way except that type $1$ households are more likely to find jobs when there is unemployment. Let us model this by assuming that, when a type $1$ individual (i.e. a person belonging to a household of type $1$) applies for a job, he is $1 + \mu$ times as likely to get a job as a type $2$ individual, where $\mu > 0$. It then follows that if $K_1$ and $K_2$ persons of types $1$ and $2$ supply their labor and there are $J$ jobs going, then the probability of each type $2$ person finding a job is given by (for simplicity, we assume that $K_1 + K_2 \geq J$)

$$p_2(J; K_1; K_2) = \frac{J}{(1+\mu)K_1 + K_2} \tag{16}$$

and each of type $1$ person being employed is given by

$$p_1(J; K_1; K_2) = \frac{(1+\mu)J}{(1+\mu)K_1 + K_2} \tag{17}$$

The lottery process which gives us these probabilities may be thought as follows. When the employment exchange gets $K_1$ and $K_2$ job applications and $J$ jobs to allocate ($K_1 + K_2 \geq J$),

earlier (that is in section 3) it may have been thought as allocating $\frac{K_1 J}{K_1 + K_2}$ jobs to type 1 applicants and $\frac{K_1 J}{(1+\mu)K_1 + K_2}$ to type 2. Now it sets aside $\frac{(1+\mu)K_1 J}{(1+\mu)K_1 + K_2}$ jobs to type 1 applicants and $\frac{K_2 J}{(1+\mu)K_1 + K_2}$ to type 2; picking within each category by some unbiased lottery mechanism.

From here we can proceed along two alternative routes. First, we could assume that households are unaware of their differing probabilities of being employed and so both types use the aggregate employment rate as expected probability of finding jobs. Second, we could assume that households are more discerning and compute their own probability of being employed as $p_1$ and $p_2$ depending on whether they are of type 1 or type 2: Both routes lead to the same conclusion but we illustrate the argument by making the second assumption. Then, given $w$, $p_1$ and $p_2$, we can use (3), as before and determine the supply of labor of a type 1 household to be given by

$$s_i = s(w; p_i)$$

where the function $s(:; :)$ is the same as before. Then, given $w$, $p_1$ and $p_2$, the total supply of type $i$ workers will be

$$S_i(w; p_i) = h_i s(w; p_i)$$

As before, $p_1^e$ and $p_2^e$ are *rational expectations* of finding a job on the part of type 1 and type 2 households if and only if

$$p_2(D(w); S_1(w; p_1^e); S_2(w; p_2^e)) = p_i^e; \quad i = 1; 2:$$

Equilibrium, with or without minimum wage legislation, is defined as in section 4.

Now, consider an equilibrium where there is unemployment. It will be found that in households where men are unemployed, the women will be more likely to be unemployed and households where men are employed, the women will be more likely employed. This occurs despite the fact that the added worker effect (as in Theorem 1) is there for each household and there is no discouragement effect. Without denying a certain discouragement effect that may result from search costs, empirical evidence supporting it whereby an unemployed persons wife drops out of the labor force might overstate this effect.

This is how we would interpret much of the empirical evidence on discouragement effect. Bard-

han (1984, Chapters 1 and 2), for instance, finds in his household level empirical study of rural West Bengal that a greater likelihood of men being unemployed usually goes hand in hand with a greater likelihood of the women in the household being unemployed. Bardhan interprets this as showing that women believe that there is "no use being in the farm labor force when even the men in the household do not have enough farm work," [Bardhan, 1984, p.20]. Since Bardhan equates being in the labor force with being employed, it is entirely possible that what his study captures is that in some districts there are fewer jobs for both men and women and so even though a man's unemployment may make it more likely that his wife will look for work, the data gives the opposite impression.

In addition, as stressed earlier, it seems important to measure the added worker effect as the households and their secondary workers' labor supply response to the worsening job prospects of the primary worker, instead of the actual loss of employment of the primary worker used in much of the empirical literature.

## 6. Conclusion

Whenever decision-making occurs at the level of the household (whether we conceive the household as a single decision-making unit or an arena of bargain), it is natural that what is expected to happen to one person in the labor market will affect the behavior of other members of his or her household. Hence, the aggregate labor supply curve cannot strictly be derived without knowledge of what the demand curve looks like. The aim of this paper was to formally model the dependence of supply on demand. Since many textbooks do treat the household as the basic unit of decision-making, when such books then go on to derive the supply of labor, without taking note of the demand conditions, they are committing a methodological inconsistence. The aim of this paper is to rectify this.

The empirical literature in labor economics (and very few theoretical papers) has shown awareness of this inter-dependence and there is a body of writing that has looked into the 'supply response' to demand shifts. However this empirical literature was handicapped by not having an adequate theoretical structure to work on. Indeed, as we tried to show in this paper, theoretical investigation does bring to light new results and insights. One of the most interesting insights concerns the re-

sponse of the labor market to wage rigidity, whether it be from minimum wage legislation or some kind of efficiency wage. In particular this paper showed that a minimum wage law can result in an overall drop in wages.

Our model also allowed us to identify conditions under which a drop in demand would cause additional labor supply and ,alternatively, a shrinkage in labor supply. We tried to explain why empirical studies may have a tendency to overstate the 'discouragement effect' of unemployment.

The paper also analyzed the effect of a household-level guarantee scheme which insures worker households against the worst ravages of an economic slump. It was argued that unemployment benefits can be justified not just in terms of equity but also efficiency.

The model developed here can be extended in several ways. For one, there are other policy interventions (for instance, differently designed guarantee schemes or unemployment benefits) that need to be examined. This can be useful in designing social welfare interventions.

Secondly, in constructing our model, we kept coming up against matters which, essentially, involve dynamics or at least a modicum of inter-temporal decision-making. People may, for instance, want to revise their labor supply decision <u>after</u> they learned what happens to the household. Of course, one then has to allow a third round of adjustment, and a fourth round and so on. Moreover, a household could try to smoothen its consumption not only by offering and with drawing its secondary workers but by having its primary workers over work when work is available and save for the rainy season.

We made several strong assumptions to desist from getting drawn into these dynamic and inter-temporal questions, not because the questions are unimportant but, because even in a simple one-period model such as ours, the interdependence between supply and demand is complex enough. We hope that modeling this carefully will in fact encourage the building of long-run dynamic models.

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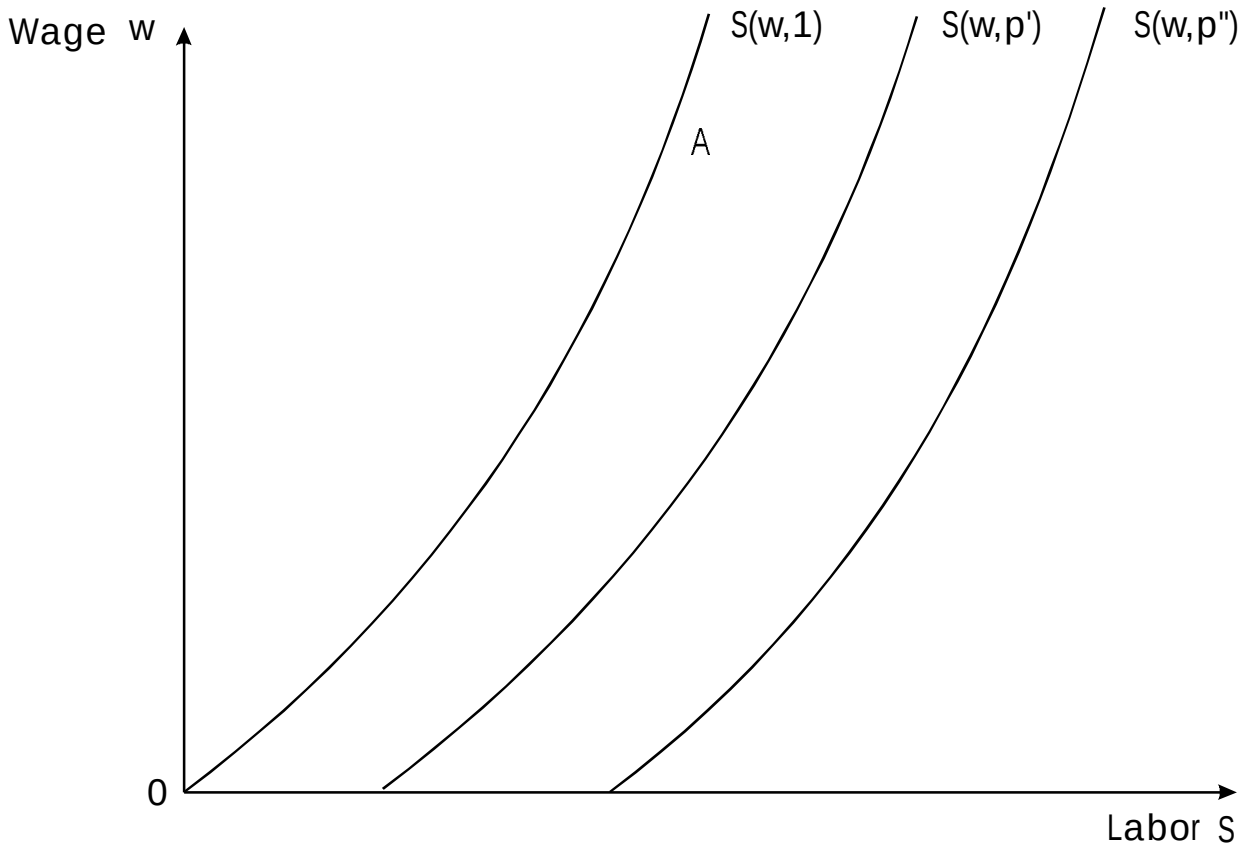
# Figure 1



# Figure 2

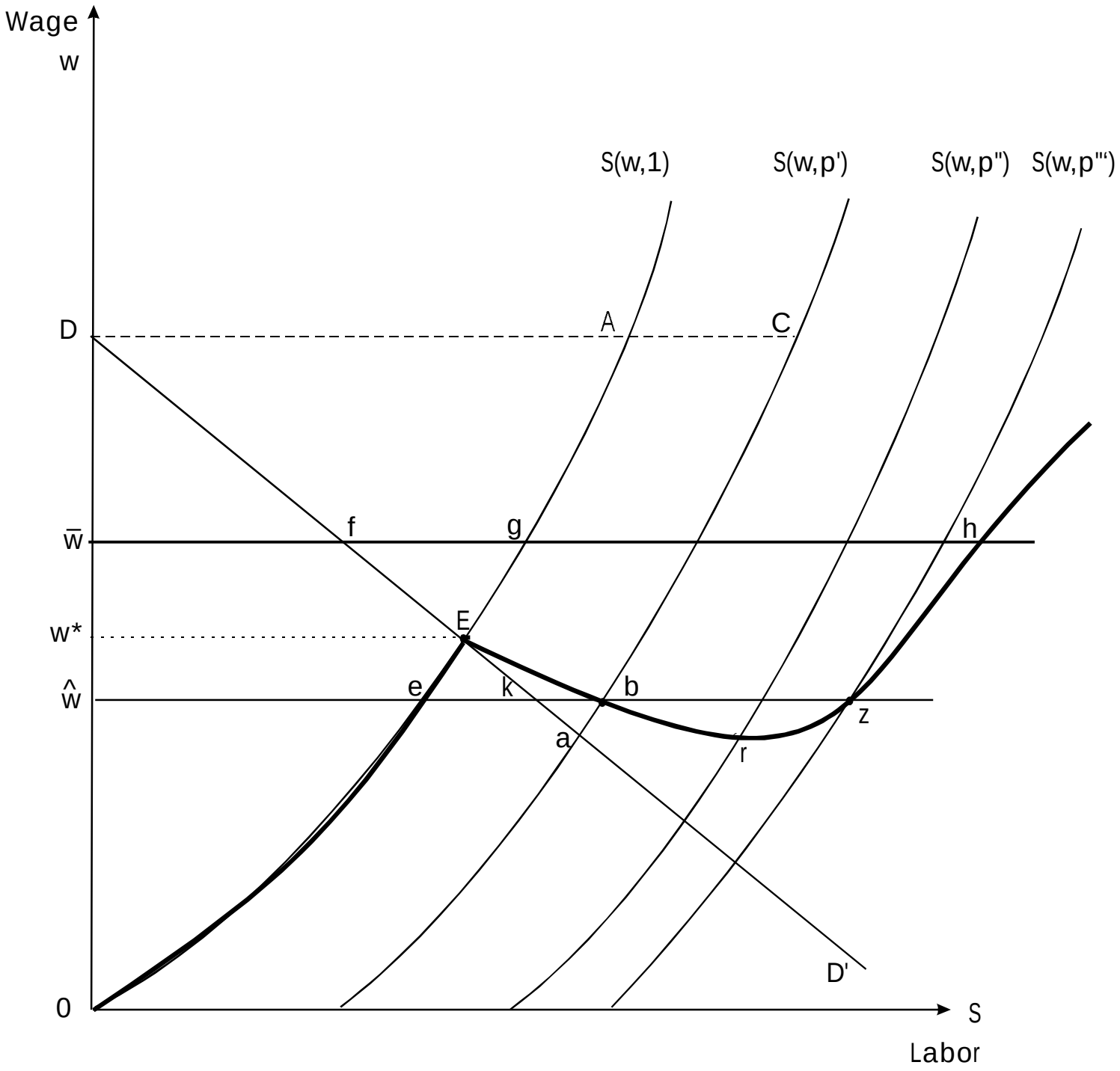


Figure 3

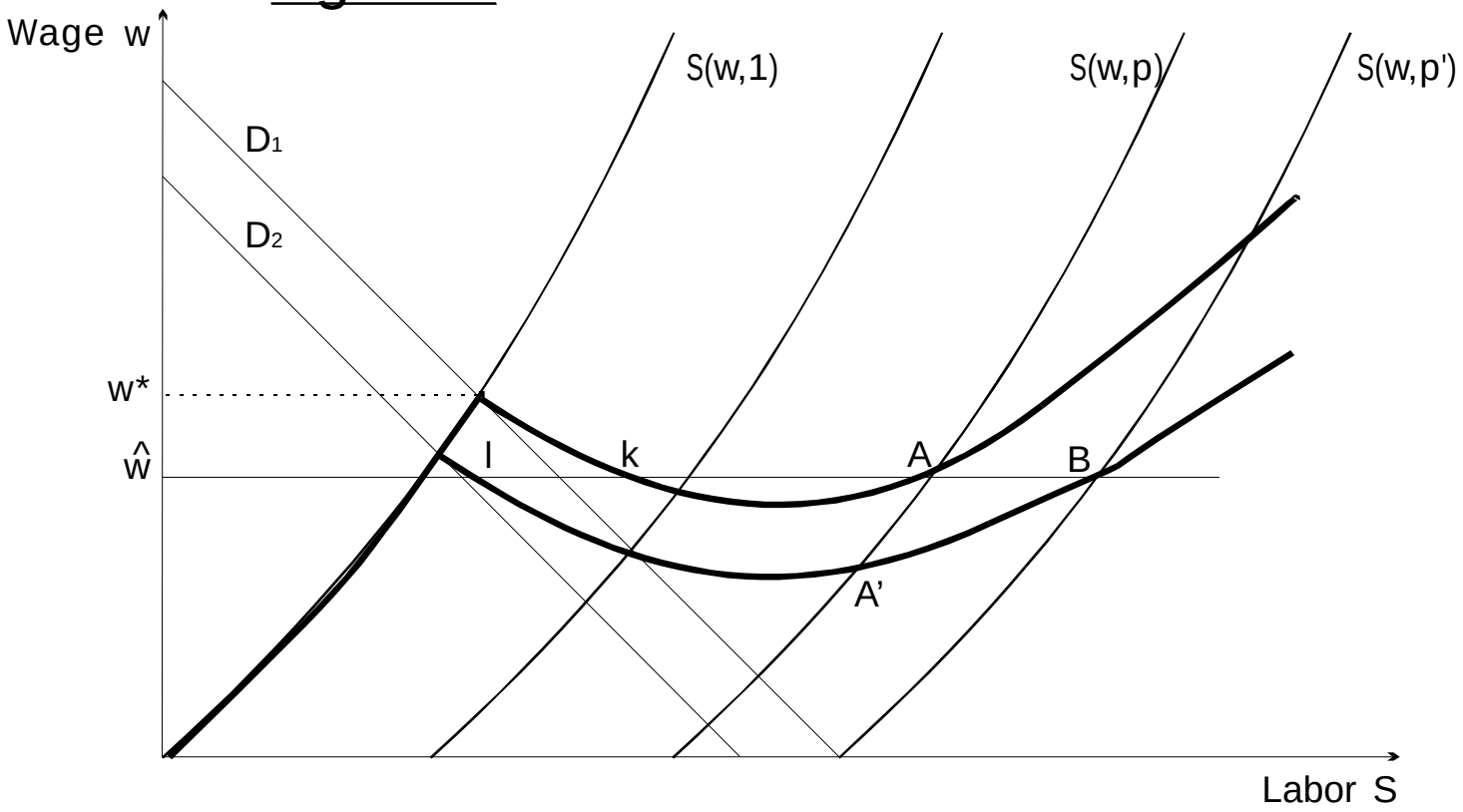
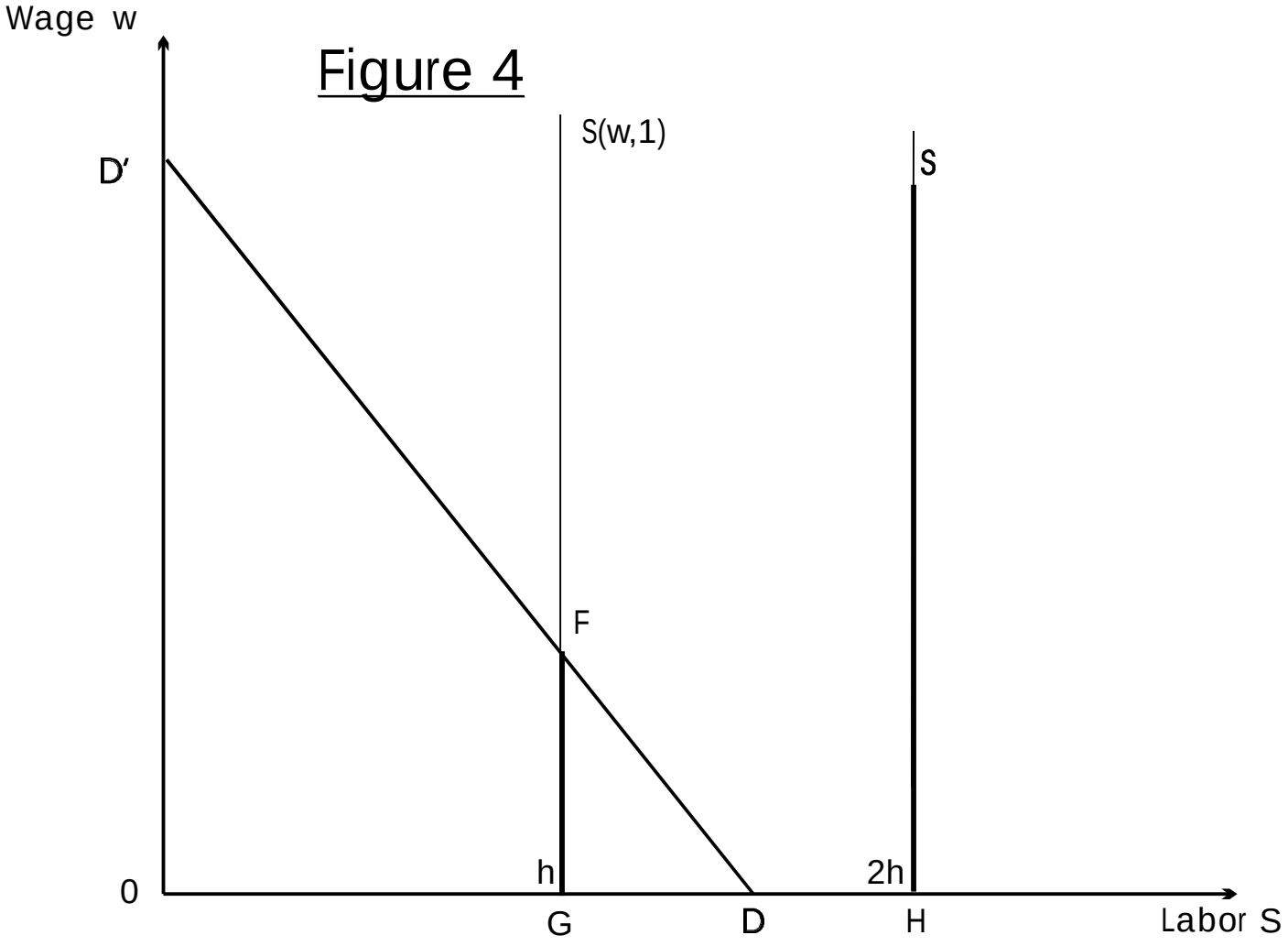
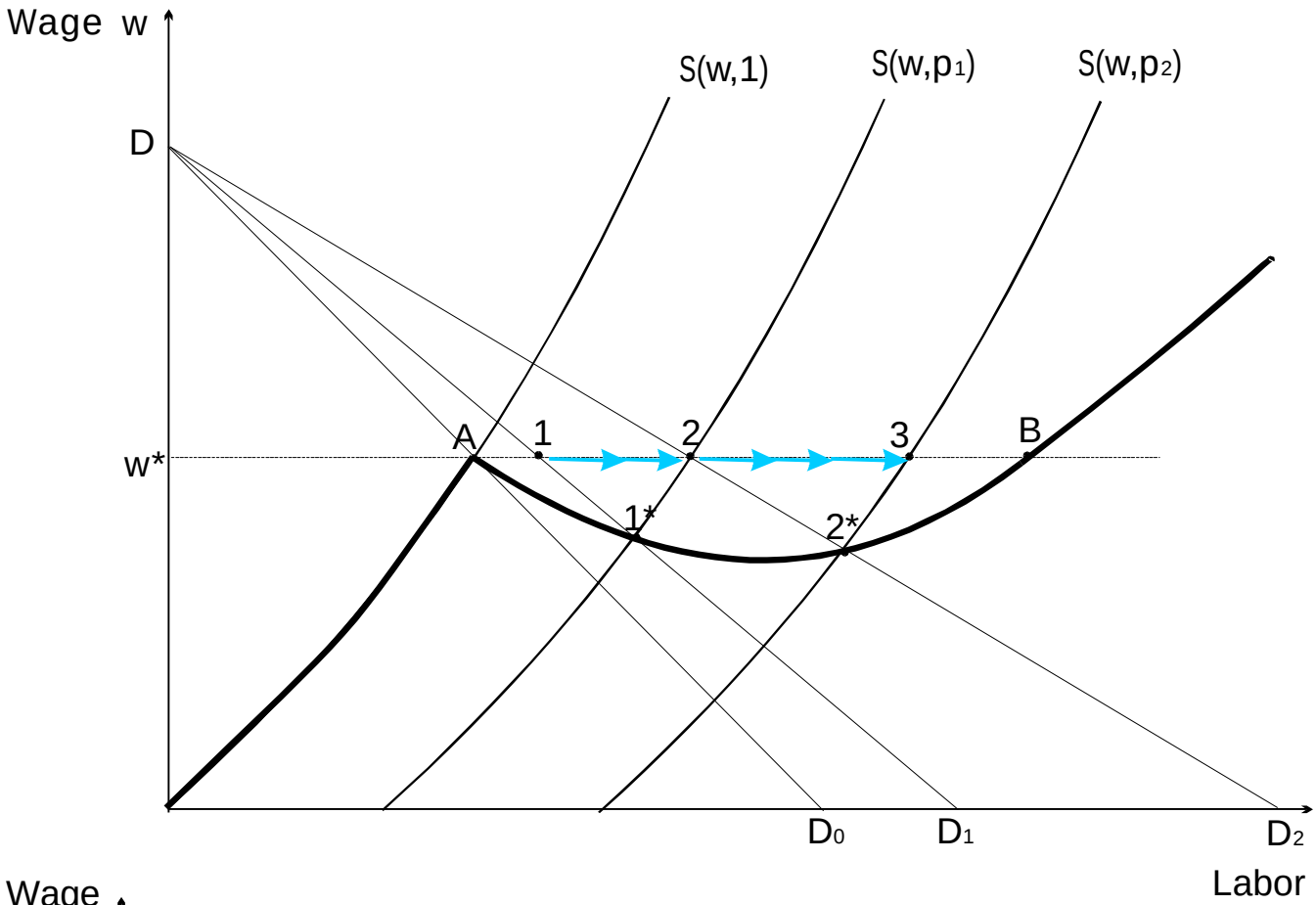



Figure 4



# Figure 5




# Figure 6