DEMAND UNCERTAINTY AND UNEMPLOYMENT IN A MONOPOLY UNION MODEL

Omar Licandro[*]

Abstract_____

The main concern of this paper is to show the importance of demand uncertainty in the determination of the "natural rate of unemployment". In the goods market there is demand heterogeneity -coming from preferences, and demand uncertainty -related solely to heterogeneity. Demand uncertainty is introduced in a monopoly union model where unions set wages at the first stage of the game, without knowing with certainty the demand for the good produced by the firm. Because the union assigns a positive probability at the event "underemployment equilibrium", it expects that the expected unemployment rate be positive. Since all the uncertainty is firm specific (i.e., there is not aggregate uncertainty), aggregate employment is equal to the union expected employment and then there is unemployment at equilibrium. In some islands the idiosyncratic demand shock is high and firms produce constrained by its full-employment capacity, but at the same time in the other islands the idiosyncratic demand shock is low and firms optimally produce less than its full-employment output.

Key words
Unemployment; Monopoly Union; Demand Uncertainty.

1 Introduction

In unionized economies, nominal wages are normally set for a relatively long time of period, say one year, while employment fluctuates during the year depending on firms' particular situation. The standard "right to manage" model, as in McDonald and Solow (1981), even if it assumes that wages are set before the firm decides employment, does not reflect completely this important sequence in the decision process, assuming that both decisions are taken under the same information concerning the environment. In this paper, new information is reveled in between both decisions, allowing the firm to decide employment with a richer information that the union has when deciding wages[1]. This sequence in the wage bargaining process leans on the assumption of nominal wages rigidities.

Many different types of uncertainty are relevant to the analysis of wage bargaining. Information concerning the aggregate price index, as in Lucas (1972) must generate some type of Lucas' supply curve. Technological uncertainty or aggregate demand uncertainty could also be important to explain the behavior of employment and wages over the business cycle, as it is reported by Hansen and Wright (1992). However, we concentrate our attention on the effects of demand uncertainty coming from miss-information about individual preferences. As it is frequently reported in the literature on Marketing, firms are mainly concerned with forecasting their market shares[2]. However, macroeconomists seem to be more interested in the effects of technological shock and aggregate demand shocks than in the effects that idiosyncratic demand shocks have on the aggregate equilibrium.

The main structure of the model is taken from Licandro (1992) and Arnsperger and de la Croix (1993)[3]. The economy is, in some way, organized as the Lucas island economy. In each island, there is only one firm

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[1]Manning (1987) and Espinosa and Rhee (1989) develop more general frameworks to analyze the question: are wage bargaining contracts efficient or do the union let the firm to manage employment? In both papers it is assumed that, even if both decision are taken sequentially at two different stages of the game, the information concerning the environment is the same in both stages. The existence of asymmetric information, or costly information research, or costly bargaining process, could be useful to attempt an explanation for this particular sequence of the wage bargaining process.

[2]See Lambin (1993).

[3]It is an attempt of reconciling the "fix-price" or "quantity rationing approach" with the "New-Keynesian economics," in particular with the monopolistic competitive general equilibrium approach. We show in this paper that the main results in Licandro (1992) and Arnsperger and de la Croix (1993) do not depend on the existence of "quantity rationing" in the goods market. The essential element of the model is related with the sequence of decisions and the structure of information.

-which produces a differentiated good, a given number of households and a union, which represents households. The information structure of the model is crucial. It is a one period model, where decisions are made at two different moments in time. Ex-ante, when preferences are not yet revealed, households decide to live and to work in a particular island and unions set the nominal wage. Unions are organized at the firm level, given place to some type of descentralized negotiation. Ex-post, when all relevant information is public, monopolistically competitive firms decide prices, employment and production and households decide consumption. The goods market is organized as in Dixit and Stiglitz (1977). Individual preferences are not symmetric, allowing for demand heterogeneity, i.e., some firms will have a high demand and some other firms a small demand. All the uncertainty is idiosyncratic (i.e, there is no aggregate uncertainty) and it is directly related to demand heterogeneity.

To stress the importance of information problems, we analyze a simple monopoly union model, in which there is full-employment at the equilibrium with perfect information. However, when there are information problems, which take the form of demand uncertainty, the nominal wage set by the union does not grant full-employment at equilibrium. The existence of unemployment does not rely on the existence of union power, as in the standard "right to manage" model. In this sense, this paper provides an explanation for the "natural rate of unemployment," which is related to the existence of firm specific demand uncertainty and nominal wage rigidities.

The paper is organized in the following way. Section 2 describes the general characteristics of the economy. In Section 3 the representative household problem is solved and the demand for goods is computed. In Section 4 we solve for the firm problem and the monopoly union problem. Section 5 gives the aggregate equilibrium. Conclusions are presented in Section 6.

2 The Economy

There are three types of economic agents: households, unions and firms. Each household supplies a given quantity of labor to a particular firm and demands goods. Households are represented by unions, which are organized at the firm level and set wages. Firms hire labor from households, produce differentiated goods and set prices.

A particular information structure is assumed: there are two times in the model, ex-ante (before the revelation of individual preferences over goods) and ex-post (when all relevant information is public). Households supply

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labor and unions decide wages without knowing with certainty the demand for the good produced by the firm. When wages are already set, households reveal their preferences and demand goods and firms set prices, hire workers and produce.

As in McDonnald and Solow, there are two stages in the game. In the first stage the union sets the nominal wage and in the second stage the firm sets prices and hires workers in order to satisfy its demand. The main difference with the standard monopoly union model is that the firm information concerning the environment, when deciding employment, is richer than the union information when deciding wages. When the union sets the nominal wage the demand for the firm is not revealed yet, while the firm knows its own demand before deciding how many workers to hire. In this sense, the model imposes some type of wage rigidity.

3 The Demand Side

Households behave as in Dixit and Stiglitz. Let us assume that all of them have the same utility function, hold the same initial money balances and supply the same given quantity of labor.

The Representative Household

There is a continuum of households in the interval $[0, n]$, each of them offering one unit of labor. There is also a continuum of goods in the interval $[0, 1]$. Households are indexed by j and goods by i. Households are identical except for the fact that their labor incomes are not necessarily the same. The representative consumer optimization problem is

$$\max_{\{c(i)\}, \frac{M}{P}} C^{\gamma} \left(\frac{M}{P}\right)^{1-\gamma}$$

where

$$C = \left(\int_0^1 v(i)^{\frac{1}{\theta}} c(i)^{\frac{\theta-1}{\theta}} di\right)^{\frac{\theta}{\theta-1}}$$

$$\theta > 1 \quad \text{and} \quad \int_0^1 v(i) di = 1;$$

subject to

$$\int_0^1 p(i) c(i) di = I;$$

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I, p and $p(i)$ $\forall i \in [0,1]$ are given. C is an index of consumption utility, M represents money holdings and p the aggregate price index. $c(i)$ and $p(i)$ are the consumption and the price of the good i, respectively. The parameters γ, θ and $v(i)$, $\forall i \in [0,1]$, are supposed given. I represents total nominal revenues of the representative consumer and it can be different from one household to another.

Optimal consumption and money holdings are[4]

$$C = \gamma \frac{I}{p}$$

and

$$M = (1 - \gamma)I.$$

Notice that the "indirect utility function," which can be derived by substituting both optimality conditions in the utility function, is proportional to real revenues.

The optimality condition for $c(i)$ is

$$c(i) = \left(\frac{p(i)}{p}\right)^{-\theta} C \, v(i), \tag{1}$$

where

$$p = \left(\int_0^1 v(i)p(i)^{1-\theta}di\right)^{\frac{1}{1-\theta}}$$

is the "true price index" associated with the representative household utility function[5].

Let us call $I(j)$ at the total revenues of the household j:

$$I(j) = \frac{\bar{M}}{n} + w(j)l(j) + \int_0^1 \frac{1}{n}\pi(i)di,$$

where $\bar{M}$ represents aggregate initial money holdings, $w(j)$ is the nominal wage rate and $l(j) \in \{0,1\}$ represents employment. Profits, denoted by $\pi(i)$, are distributed among households. The share of the firm i is supposed to be the same for all households and equal to $\frac{1}{n}$. The only difference among households comes from the equilibrium value of labor incomes $w(j)l(j)$.

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[4]Since the utility function is concave in its arguments and the budget constraint is linear, the first order conditions are necessary and sufficient for a maximum.

[5]The normalization condition imposed over the v parameters in problem (1), implies that $p = \bar{p}$ if $p(i) = \bar{p}\,\forall i \in [0,1]$.

Let us define profits as

$$\pi(i) = p(i)y(i) - w(i)l(i).$$

Aggregating revenues over consumers, we have that

$$\int_0^n I(j)dj = \bar{M} + p\bar{y}.$$

Variable $\bar{y}$ represents aggregate production, and it takes the same functional form that the quantity index C.

Imposing the condition $\int_0^n C(j)dj = \bar{y}$ on the goods market, which must verify at equilibrium, from previous conditions we get

$$\bar{y} = \left(\frac{\gamma}{1-\gamma}\right)\frac{\bar{M}}{p}.$$

Let $c(i,j)$ represent the demand of good i from household j. Integrating equation (1) over households we have that total demand $d(i)$ for good i is

$$d(i) = \left(\frac{p(i)}{p}\right)^{-\theta}\bar{y}\,v(i). \tag{2}$$

Aggregate demand, $\bar{y}$, is distributed among the differentiated goods depending on relative prices and the $v(i)$ parameters[6].

Demand heterogeneity is directly related to the distribution of the v parameter among firms. It plays a very import role in the model, because all uncertainty comes from the absence of perfect information concerning this parameter.

4   The Supply Side

In the supply side of this economy there is a continuum of monopolistically competitive firms, each of them producing a variety of the unique good. The index i also identifies firms. Each worker supplies one unit of labor

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[6]The firm i market share is

$$\frac{p(i)d(i)}{p\bar{y}} = \left(\frac{p(i)}{p}\right)^{1-\theta}v(i),$$

which depends on both the relative price and the $v(i)$ parameter. At the symmetric equilibrium the market share is equal to $v(i)$.

to an specific firm[7]. Workers are uniformly distributed among firms and, from previous assumptions, the number of workers offering their labor to a particular firm is n. There is a continuum of unions, each of them represents the workers offering their labor to a particular firm. Unions are also indexed by i. At the firm level, unions set wages as a monopoly.

An important assumption is imposed to produce full-employment capacities at the firm level: labor markets are segmented. Each worker is offering his labor to an specific firm and, if a firm decides not to hire a worker, this worker is unable to offer his labor to another firm. Labor market segmentation can be justified by differences in human capital, labor mobility costs, turnover costs, etc. Under this assumption each firm faces an upper-bound on production, i.e., the "full-employment output". This assumption is crucial to have unemployment at equilibrium.

4.1 Firm Behavior

Let us assume that the labor marginal productivity is constant and equal to one, i.e., there is a constant returns to scale technology

$$y(i) = l(i)$$

where $y(i)$ and $l(i)$ represent firm's i production and employment. Notice that firm's employment, $l(i) \in [0, n]$, is different to household's employment $l(j) \in \{0, 1\}$. Full-employment output is equal to n for all i.

Under the previous conditions, the representative firm must solve the following optimization problem:

$$\max_{p(i), y(i)} \pi(i) = (p(i) - w(i))y(i) \qquad (3)$$

subject to

$$y(i) = \left(\frac{p(i)}{p}\right)^{-\theta} \bar{y} \, v(i),$$

$$y(i) \leq n,$$

where $\bar{y}$, p, n and $w(i)$ are given. Parameters θ and $v(i)$ come from household preferences.

The first order condition for this problem is:

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[7]Because the marginal desutility of labor is zero, the representative household is optimally willing to work the maximum feasible time, which is assumed to be one.

if $d(i) \leq n$,

$$p(i) = \left(1 - \frac{1}{\theta}\right)^{-1} w(i); \tag{4}$$

if not,

$$p(i) = p \left(\frac{\bar{y}}{n}\right)^{\frac{1}{\delta}} v(i)^{\frac{1}{\delta}}. \tag{5}$$

Depending on the relation between demand $d(i)$ and full-employment capacity n, the representative firm sets prices following two different rules. When demand is relatively small, the firm sets a price that verifies the standard condition for a monopoly, i.e., marginal costs equal to marginal revenues (interior solution). When the optimal condition for a monopolistic competitive firm verifies for a demand greater than full-employment capacities, the firm sets a higher price in order to satisfy demand at the full-employment level (corner solution).

Let us call

$$\bar{v}(i) = \left(1 - \frac{1}{\theta}\right)^{-\theta} \left(\frac{w(i)}{p}\right)^{\theta} \frac{n}{\bar{y}} \tag{6}$$

at the value of $v(i)$ at which the interior solution verifies at the corner, i.e., both conditions (4) and (5) verifies simultaneously.

From the restrictions in problem (3), and the corresponding optimal condition (equations (4) and (5)), we can deduce the optimal employment of firm i:

if $v(i) \leq \bar{v}(i)$,

$$l(i) = l_d(i) = \frac{v(i)\, n}{\bar{v}(i)} \leq n, \tag{7}$$

if not,

$$l(i) = n. \tag{8}$$

In the interior solution, the firm is choosing employment over its unconstrained labor demand curve, denoted $l_d(i)$ in equation (7). In this case, the firm does not employ all the workers living in the island and there will be unemployment in this segment of the market. In the corner solution, the firm is constrained by the labor supply and producing at its full-employment output.

4.2 Monopoly Union Behavior

In each island, a trade union represents the workers offering their labor to the firm producing the corresponding variety. The union is assumed to behave

as a monopoly in the labor market.

The objective function of the ith union is:

$$V(w(i), l(i)) = \left(\frac{w(i)}{p}\right) l(i),$$

where V is the sum of the indirect utility functions of the risk-neutral members after the deduction of the fall-back level,

$$\frac{\bar{M}}{p} + \int_0^1 \frac{\pi(i)}{p} di,$$

i.e., the non-human revenues.

The Standard Monopoly Union Model

To give a better understanding of the results provided in this paper, let us solve first the standard monopoly union model, in which wages and employment are decided under the same information set. Let us assume in this section (this assumption will be dropped in the next) that the union has full-information, in particular that it knows the value of $v(i)$ faced by the firm i. It can be easily shown that, under this assumption the monopoly union is optimally setting nominal wages in order to have full-employment at equilibrium. The main reason for that is that the inverse of the labor demand elasticity $(\frac{1}{\theta})$ is smaller than the elasticity of the indifference curves (which is equal to one), anywhere. In which case the union is interested in reducing wages until full-employment is reached. As Figure 1 shows, the optimal election for the union is to set a nominal wage that induces the firm to optimally choose to produce at full-employment. In other words, the union is choosing $w(i)$ in such a way that both equations (4) and (5) verify simultaneously.

Under these particular assumptions, if wages and employment are decided under the same information set, there is full-employment at equilibrium in the standard monopoly union model.

Monopoly Union Behavior under Demand Uncertainty

Let us assume that, when deciding wages, the ith union knows the "demand function" assigned to the variety i, equation (2) and the distribution of the $v(i)$ parameters, denoted by $F(v)$. However, we assume that the representative union does not know with certainty the specific $v(i)$ faced by the ith

firm. Since there is no aggregate uncertainty, the union can solve for the aggregate demand $\bar{y}$ and the aggregate price index p.

Notice that under this conditions all unions are ex-ante identical, even if ex-post the labor demand can be different from one island to another. Then, they set the same wage rate and they face the same $\bar{v}$. For this reason, we can drop the i index for the next.

Since the objective of the union is linear in l, under demand uncertainty, the union is mainly concerned with the forecast of expected employment. From equations (7) and (8), expected employment can be written as[8]

$$\mathrm{E}(l) = \frac{n}{\bar{v}} \int_{v \leq \bar{v}} v \, d\mathrm{F}(v) + n \int_{v \geq \bar{v}} d\mathrm{F}(v) \leq n, \qquad (9)$$

where $\bar{v}$ is given by equation (6).

As stated before, the distribution function $\mathrm{F}(v)$ represents the distribution of parameter v among the different firms and it depends on household's preferences. The union knows that its specific v is drawn from this distribution. If there is a strictly positive probability of being in a unemployment equilibrium, expected employment will be strictly smaller than full-employment.

Let us define the weighted probability of being in a full-employment equilibrium as

$$\mathrm{P}_w(l = n) = \int_{v \geq \bar{v}} \frac{n}{\mathrm{E}(l)} \, d\mathrm{F}(v),$$

and the weighted probability of being in an unemployment equilibrium as

$$\mathrm{P}_w(l \leq n) = \frac{n}{\bar{v}} \int_{v \leq \bar{v}} \frac{v}{\mathrm{E}(l)} \, d\mathrm{F}(v).$$

The representative union problem is

$$\max_{w} \mathrm{E}(V) = \left(\frac{w}{p}\right) \mathrm{E}(l),$$

where $\mathrm{E}(l)$ is given by equation (9) and $\bar{v}$ is given by equation (6). Because there is not aggregate uncertainty, the aggregate variables p and $\bar{y}$ are perfectly forecast by the union.

The first order condition for this problem is

$$\frac{\mathrm{E}(l)}{n} \, \bar{v} = \theta \int_{v \leq \bar{v}} v \, d\mathrm{F}(v). \qquad (10)$$

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[8]The expected value of the minimum condition has been largely analyzed in econometric disequilibrium models, in particular in the context of "aggregation over micro-markets in disequilibrium," as it is reported by Quandt (1988).

Condition (10) can be interpreted in the following way: the union is optimally choosing the weighted probability of being in an unemployment equilibrium, whose optimal value is equal to the the inverse of the demand elasticity of labor ($\frac{1}{\theta}$). Notice that the weighted probability of being in a full-employment equilibrium is equal to $(1 - \frac{1}{\theta})$.

Figure 2 gives a graphic representation of this problem. The union maximize its utility function over the expected employment curve. Because there is a positive probability of ex-post unemployment, the union expected employment curve is always below full-employment, in particular at the optimum. The expected employment locus is concave for any standard continuous distribution function, which is a sufficient condition for the existence of an interior solution.

5   Aggregate Employment

Aggregate employment can be obtained by aggregation over firm's employment and it must be equal to union's expected employment given by equation (9)[9]. Moreover, the optimality condition (10) must hold at equilibrium. Aggregate employment $\bar{l}$, aggregate production $\bar{y}$, aggregate real wages (which are equal over all islands) and $\bar{v}$ must satisfy at equilibrium the following conditions:

$$\left(\frac{\bar{l}}{n}\right) = \frac{1}{\bar{v}} \int_{v \leq \bar{v}} v \, \mathrm{dF}(v) + \int_{v \geq \bar{v}} \mathrm{dF}(v) \leq 1,$$

$$\left(\frac{\bar{l}}{n}\right) \bar{v} = \theta \int_{v \leq \bar{v}} v \mathrm{dF}(v),$$

$$\bar{v} = \left(1 - \frac{1}{\theta}\right)^{-\theta} \left(\frac{w}{p}\right)^{\theta} \left(\frac{n}{\bar{y}}\right),$$

and

$$\left(\frac{\bar{y}}{n}\right) = \left[\bar{v}^{\frac{1-\theta}{\theta}} \int_{v \leq \bar{v}} v \, \mathrm{dF}(v) + \int_{v \geq \bar{v}} v^{\frac{1}{\theta}} \mathrm{dF}(v)\right]^{\frac{\theta}{\theta - 1}},$$

To better understand this result let us present an example, in which we assume a particular form for the distribution function $F(v)$.

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[9]The proposed definition of aggregate employment is the standard addition of employed workers, which does not take into account that the marginal value of workers is not necessarily the same in all islands. For this reason the employment index and the production index are different, even if production is equal to employment for each firm. We keep the standard definition to be consistent with the literature on employment and unemployment.

EXAMPLE

Let us assume that v follows a lognormal distribution, with unit mean and variance denoted by σ. In this case we can apply Lambert(1988) and approximate expected employment by the following function

$$E(l) = n\left(1 + \bar{v}^\rho\right)^{-\frac{1}{\rho}}$$

where ρ is a decreasing function of σ. In particular, $\frac{\partial \rho}{\partial \sigma} < 0$, $\rho \rightarrow \infty$ when $\sigma \rightarrow 0$ and we assume that ρ is positive, i.e., the variance σ is not too large.

The representative union problem becomes

$$\max_{w} E(V) = \left(\frac{w}{p}\right) E(l)$$

where

$$E(l) = n\left(1 + \bar{v}^\rho\right)^{-\frac{1}{\rho}},$$

$$\bar{v} = \left(1 - \frac{1}{\theta}\right)^{-\theta}\left(\frac{w}{p}\right)^\theta \frac{n}{\bar{y}}$$

and p, $\bar{y}$ and n are given.

Solving this problem as in the previous section and solving for the equilibrium value of aggregate employment $\bar{l}$, we have

$$\left(\frac{\bar{l}}{n}\right) = \left(1 - \frac{1}{\theta}\right)^{\frac{1}{\rho}} \leq 1. \tag{11}$$

Since workers are distributed homogeneously among firms and the marginal productivity is the same for all of them (it was normalized to one), full-employment output n is equal across firms. Moreover, since unions are ex-ante identical, they set all the same real wage. Under these conditions the marginal cost function is the same for all firms and it is constant and finite until full-employment is reached, then it becomes infinitely elastic. Depending on their particular value for v, firms are setting prices and production either at the interior or at the corner solution. When demand is relativly small ($v < \bar{v}$) in an island, production is smaller that full-employment output. When demand is relativly large ($v \geq \bar{v}$), the firm produces at full-employment. At the aggregate there is unemployment.

The unemployment rate takes the following equilibrium value, denoted by u,

$$u = 1 - \left(1 - \frac{1}{\theta}\right)^{\frac{1}{\rho}}.$$

The unemployment rate at equilibrium depends on the elasticity of substitution θ and on the parameter ρ, which depends on the variance of the distribution of the v parameter. If $\theta \to \infty$ all goods become perfect substitutes, and if $\rho \to \infty$ the parameter v becomes the same for all goods. In both cases the heterogeneity of demand disapears and the unemployment rate goes to zero. The first derivative of u with respect to both parameters is negative, i.e., an increase in demand heterogeneity, coming from a greater elasticity of substitution or a great dispersion on the v parameters, always generates an increase in the unemployment rate.

6 Conclusions

The main concern of this paper is to show the importance of demand uncertainty in the determination of the "natural rate of unemployment." Demand uncertainty is introduced in a monopoly union model where unions set wages at the first stage of the game, without knowing with certainty the demand for the good produced by the firm. Because the union assigns a positive probability at the event "underemployment equilibrium," it sets an optimal nominal wage at which the expected employment is smaller than full-employment. In an economy where all the uncertainty is firm specific (i.e., there is not aggregate uncertainty), aggregate employment is equal to the union expected employment and then there is unemployment at equilibrium. In some islands the idiosyncratic demand shock is high and firms produce constrained by its full-employment capacity, but at the same time in the other islands the idiosyncratic demand shock is low and firms optimally produce less than its full-employment output.

The existence of unemployment depends crucially on the assumption of demand heterogeneity and demand uncertainty. The assumptions of nominal wage rigidity and labor market segmentation are not sufficient to generate this result. Moreover, the assumption of only one firm per island (monopolistic competition) is not critical for the existence of unemployment at equilibrium, and the result holds even if there is perfect competition on the goods market of each island. In this sense, the "natural rate of unemployment," displayed by the model at equilibrium, relies mainly on the existence of "information problems" than on the existence of "coordination failures".

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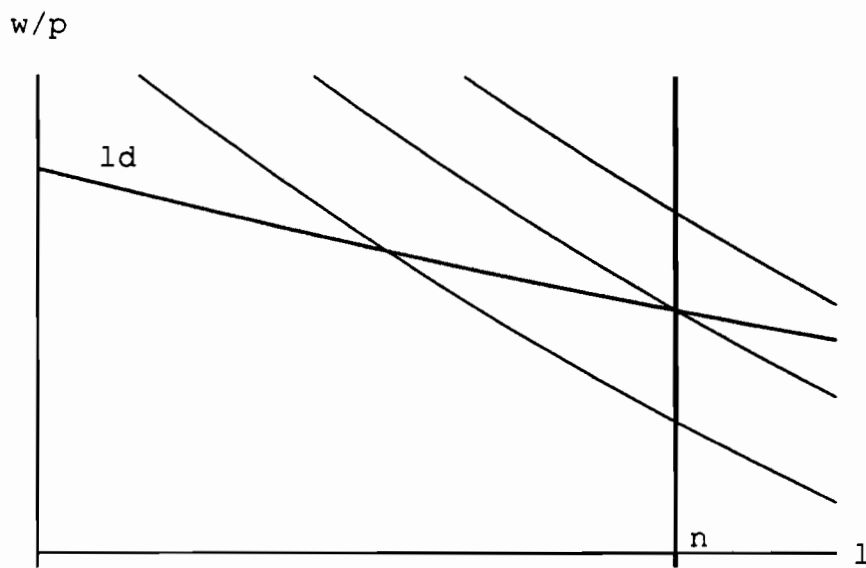
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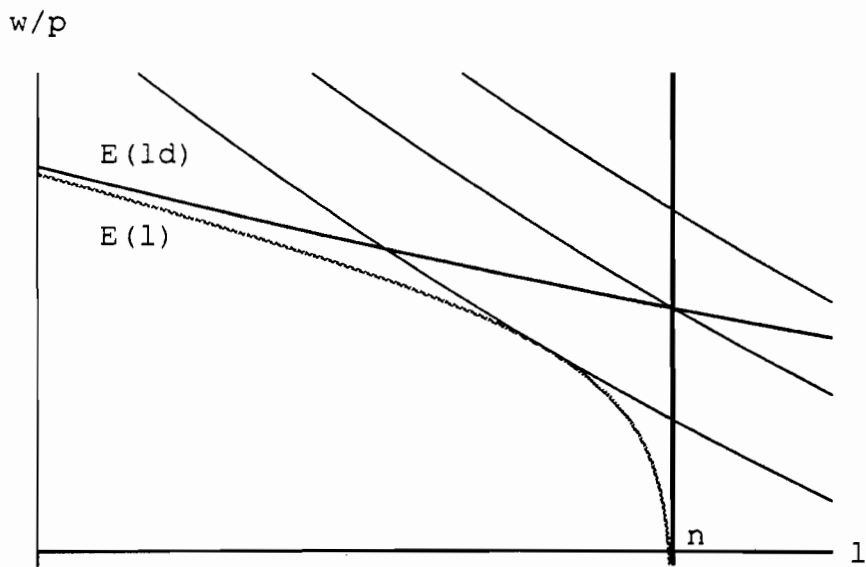**Figure 1**: The Standard Monopoly Union Model

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Figure 2: The Monopoly Union Model under Demand Uncertainty