NBER WORKING PAPER SERIES

OPTIMAL LABOR CONTRACTS, IMPERFECT COMPETITION AND UNDREMPLOYMENT EQUILIBRIA: A FRAMEWORK FOR ANALYSIS

Russell Cooper

Working Paper No. 2060

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
October 1986

Much of this research was conducted while I was a Visiting Scholar at the Board of Governors of the Federal Reserve System. I am very grateful to that institution for its support. Seminar participants at the 1986 NBER Summer Institute, the University of Delaware, the Univerity of Iowa and the University of Pennsylvania provided numerous helpful comments and suggestions. Financial support from the National Science Foundation, NSF #SES86-05302, is gratefully acknowledged. The research reported here is part of the NBER's research program in Economic Fluctuations. Any opinions expressed are those of the author and not those of the National Bureau of Economic Research.

NBER Working Paper #2060
October 1986

Optimal Labor Contracts, Imperfect Competition and Underemployment Equilibria: A Framework for Analysis

ABSTRACT

This paper examines the macroeconomic properties of imperfectly competitive economies. The focus is on the coordination failures that might arise in these economies, a study of alternative policies and the comparative static properties of these models. This paper differs from others in this area by modeling the labor market from the perspective of optimal contract theory. This permits an evaluation of the role of labor market behavior in producing these coordination failures and a study of labor market policies (such as unemployment insurance and alternative compensation schemes).

Russell Cooper
Department of Economics
College of Business
Administration
University of Iowa
Iowa City, Iowa 52242

I. Introduction

This paper is about coordination failures in decentralized economies. In particular, it concerns the possibility that allocations decentralized through the price system may not have desirable welfare properties. If so, prices have failed to coordinate trades between agents and opportunities for mutually advantageous trades may exist in equilibrium. In some cases, these coordination failures may be of an aggregate nature and hence important for understanding macroeconomic behavior. This paper studies the positive and normative properties of model economies exhibiting macroeconomic coordination failures.

To begin, it is useful to contrast this approach with that stemming from the study of the Arrow-Debreu general equilibrium model. In a model economy with complete markets, perfect information, no externalities and perfect competition, the first Fundamental Theorem of Welfare Economics states that competitive equilibria are Pareto Optimal. In a competitive equilibrium, no feasible mutually advantageous trades exist between agents so that coordination failures, as defined above, do not exist. Fluctuations in output and employment arise through the intertemporal substitution of agents and the flow of resources between sectors of an economy in response to exogenous shocks to the system. However, there are no gains to stabilization policy in such an economy.

Hence, to formally study coordination failures, the first step is to specify perturbations to the underlying Arrow-Debreu framework. The source of these coordination failures must be found in modifications of

the Arrow-Debreu model which either relax some of the assumptions outlined above or in one way or another weaken the ability of the auctioneer to facilitate trades between agents. Models which include direct externalities in technology or preferences are examples of the first approach while those that assume incomplete markets and/or rigid prices are examples of the second.

A third approach is to relax the assumption of price taking behavior by studying imperfectly competitive general equilibrium models. The inefficiencies generated in such economies (some of which we know of from partial equilibrium analysis) may have interesting macroeconomic implications. General equilibrium models, such as the one studied here, go beyond the partial equilibrium analysis of imperfect competition by stressing spillover effects across multisector economies and by emphasizing the interaction of product and factor markets. Of course, the basic inefficiency in these models is closely linked to that displayed in the partial equilibrium analysis.

Hart [1982] argues that models of imperfect competition are capable of generating macroeconomic results such as underemployment equilibria, multiplier effects and so forth. Related results on coordination failures in this class of models are reported by Heller [1985], Kiyotaki [1985], Roberts [1984,1986] and Cooper-John [1986]. Finally, Startz [1986] illustrates that many of the textbook results on policy effectiveness in Keynesian models also hold in models of monopolistic competition.

As suggested by Cooper-John [1986] these models of imperfect competition share an important feature: the strategic interaction

between agents creates positive feedback effects. This "strategic complementarity" arises from the pattern of demands across sectors of a multi-sector economy.[1] Firms in one sector are induced to produce more if firms in other sectors increase their own output as long as consumption goods are normal. Given that the assumption of normality is not very strong, these complementarities are likely to be present in a wide range of economies. Because of the non-cooperative nature of the interaction between firms, mutually advantageous expansions may not be consummated. Hence these models of imperfect competition can generate coordination failures in that the non-cooperative equilibrium is Pareto sub-optimal. As discussed further below, these models may also have multiple equilibria which can be Pareto ranked. These complementarities are also present model of trading externalities and coordination failures explored by Diamond [1982], Howitt [1985] and others.

The results in these models of imperfect competition are quite promising from the perspective of building a microeconomic foundation for understanding coordination failures. The strong Keynesian results (e.g. coordination failures, multipliers, importance of quantities in individual decisions) emerging from these models are not driven by assumed rigidities in prices and/or wages. Instead, the price system fails to coordinate trades due to the presence of imperfectly competitive agents who, in part, base quantity decisions on the quantities chosen by other agents in the economy.

There are, of course, a number of open issues in this growing literature. First, these models have not been developed to the extent

that a full comparison with alternative approaches to understanding business cycles is possible. Are these models successful in reproducing observed co-movements in output, employment, prices and wages? What are the sources of these fluctuations? To address these issues requires the development of dynamic stochastic models of imperfectly competitive economies.

Second, what is the role of labor markets in helping to coordinate the activities of firms in the product market? If there is an underemployment equilibria, why are there no forces operating in the labor markets to remedy the situation? From a theoretical perspective, it is critical to clarify whether the inefficiencies found in these models are merely a consequence of some form of suboptimal labor arrangement.

A good example of this second issue arises in the work by Weitzman [1985]. Weitzman supposes that a "wage system" exists for the trading of labor services in which the wage is predetermined and employment is demand determined. Cooper [1986] shows that an imperfectly competitive economy with this structure of labor contracts will generate underemployment equilibria and multiplier effects. That contracts such as these produce socially suboptimal behavior is not surprising since these contracts are generally not even privately optimal. Hence, an important aspect of Weitzman's argument for the introduction of a share system appears to rest on the assumption that agents trade labor services in a privately suboptimal fashion. Furthermore, Hart [1982] stresses the importance of market power by the <u>suppliers</u> of labor in his study of imperfectly competitive economies.[2] The "contracts"

between workers and firms in Hart's model are not privately optimal in that the allocation does not lie on a contract curve between the contractants. In a number of other studies in this area, the contracting structure is either suboptimal or not completely specified.

Augmenting these models with optimal labor arrangements (from the perspective of the contractants though not necessarily society) would strengthen the argument that these are interesting models of coordination failures and macroeconomic behavior. That is, if these coordination failures remain in the presence of optimal labor contracts, then it should be clear that the labor markets will not operate to offset the imperfect competition in the product markets.

The approach taken here is thus to introduce labor contracts into a simple general equilibrium model of imperfect competition as a mode of transacting in labor markets. This analysis will attempt to address the question, raised above, about the coordinating ability of labor markets. Furthermore, as is well understood, optimal labor contracts sever the connection between compensation and employment so that in partial equilibrium models a wide variety of correlations between wages and employment are feasible. As noted by Blanchard-Kiyotaki [1985], it is important to see whether these model of imperfect competition are capable of matching the stylized fact that wages tend to fluctuate much less than output or employment. This paper is thus an attempt to integrate the partial equilibrium models of labor contracts into the general equilibrium models of imperfect competition as a means of understanding coordination failures and generating predictions of labor market outcomes.

An overview of this exercise is presented in Section II and the imperfectly competitive contracting equilibrium is analyzed in Section III. The results in this paper provide full support for the view that economies with imperfectly competitive product markets can experience underemployment equilibria even in the presence of optimal labor contracts. In contrast to Hart [1982], this arises with optimal contracts and a bargaining setting in which the power of unions is not an important determinant of the degree of underemployment.

In Section IV, this framework is used to study the comparative static properties of these class of models. Shocks to the system are magnified by the demand linkages across sectors just as in the case of Weitzman's wage system (see the discussion in Cooper [1986].) While output and employment fluctuate quite a lot, the predicted correlation between real wages and employment depends on the form of the insurance arrangements within the labor contract. Hence the model can generate correlated movements in output and employment across sectors of an economy without large movements in the real return to labor. In contrast to the "real business cycle" models these fluctuations do not rely on the intertemporal substitution of leisure today for consumption tomorrow and/or technological linkages as in Long-Plosser [1983]. Instead, these correlated movements in output across sectors is possible because of the underutilization of resources prevalent in imperfectly competitive economies and the presence of demand linkages across these sectors.

The model is also used to study the effects of alternative government policies. First, we find that increases in unemployment

insurance produce unemployment since the cost of reducing output by a given firm-union pair is lower. This alters reaction curves in the product market game and produces an equilibrium with lower activity. As in Hart [1982] and Startz [1986], we also study the effects of a balanced budget policy by the government. Following the advice of Weitzman [1983,1985], the model is used to consider direct interventions in labor markets as an alternative form of government policy. These results are presented in Section V.

While these models are successful in predicting underemployment of resources, the contracting structure does not provide support for the view that unemployed workers "envy" those with jobs. That is, the presence of severance pay implies that workers (with the assumed structure of preferences) will be indifferent with respect to employment status. Extensions of the model by adding some distortions into the labor contract associated with asymmetric information and moral hazard problems within the firm are discussed in Section VI.

In that section, we also discuss the effects of alternative union and industrial structures on the equilibrium of this type of model. To the extent that coordination failures emerge because firms can not coordinate their output decisions, it is interesting to see whether unions which represent workers in a number of sectors can play this coordinating role. A similar implication of mergers is noted as well. Finally, we also discuss examples of multiple equilibria and the possibility of "catastrophic" changes in the level of economic activity.

II. Overview of Model

Before delving into the details of the model, it is useful to begin with an informal overview of the basic approach to this problem. The model contains two key components. First is the design of a labor contract between a group of workers and a firm. Second is the interaction of this coalition of workers and a firm with other such coalitions in the determination of a product market equilibrium. The timing of decisions in the model is, as always, quite important.

Figure 1 displays the interactions between a single firm and the group of workers it contracts with and the product market in which it sells. The next section of the paper will provide a detailed discussion of these decisions. For now, we focus on the behavior of a single firm to motivate the subsequent analysis.

Labor contracts are negotiated prior to the determination of the state of the economy. The state will be described by the level of endowment of a non-produced good, preferences and technology. Given the insurance role that contracts play, it is reasonable to assume that they are determined ex ante so that the maximal gains to risk sharing are feasible. At this stage, we assume that both the firm and the workers costlessly observe the state so that contingent compensation and employment rules are feasible. Note that we are allowing the contractants to negotiate both compensation and employment rules rather than allowing the firm the latitude to select employment ex post given wages. This is in keeping with the literature on optimal labor contracts stemming from the initial contributions of Azariadis [1975] and Baily [1974]. This is an important element of the model since any

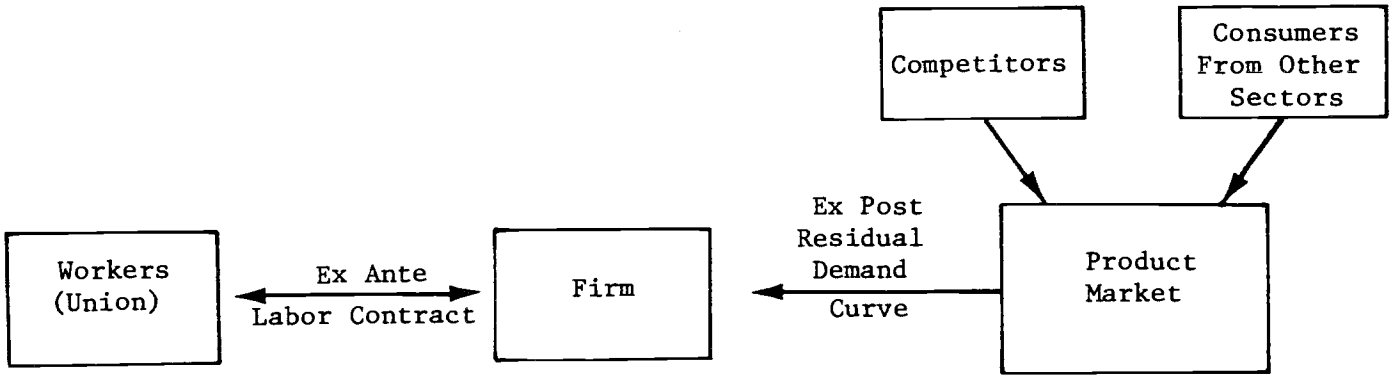
Competitors
Consumers From Other Sectors
Ex Post Residual Demand Curve
Workers (Union)
Ex Ante Labor Contract
Firm
Product Market

Figure 1

inefficiencies in the equilibrium will not be the consequence of direct restrictions on contracts.

The labor contract is negotiated between a group of workers and a single firm and is determined by maximizing a weighted sum of expected profits for the firm and expected utility for workers. The bargaining weight is assumed to be exogenous so that the comparative static effects of variations in union strength can be analyzed. The contracts are assumed to be fully enforceable once the state is known.

Following the negotiation of these contracts, the random endowments, preferences and technology of the agents in the economy are determined and the product markets open. As described in the following section, the economy is composed of a number of sectors producing different products. In each sector, there are a small number of firms who act as oligopolists. These firms select quantity as their strategy variable taking as given the quantities selected by other firms in their sector and the firms in <u>other</u> sectors. This interaction of firms across sectors arises because the level of economic activity in one sector determines the position of the demand curve facing firms in another sector. These demand linkages create the strategic complementarities discussed in the Introduction.

Of course, the agents negotiating the labor contract in the first stage of the game anticipate the subsequent behavior of firms in the product market game. Since these contracts are binding, the equilibrium can be determined by characterizing the Nash equilibrium for the contingent employment rules stipulated in the optimal contract. For ease of exposition, we will split the analysis into two parts: the

determination of an optimal labor contract and the second stage product market game.

Demands in the economy are structured to highlight the specificity of production relative to consumption. In particular, workers and firms are assumed to consume all products in the economy except for the output they produce. This structure of demands is common to models of coordination failures and imperfect competition (see Hart [1982], Heller [1985], Roberts [1984] and Cooper [1986] as examples). The model also includes a non-produced good which is the endowment of a third group of agents, termed outsiders. The endowment of the outsiders is assumed to be random and this produces one type of fluctuation in the economy. The shock to endowments will often be called a demand shock since variations in endowments influence economic behavior through the demands of the outsiders. In future work on dynamic models of demand complementarities as discussed in Section VI, this non-produced good will be modelled as money.

The structure of this model can be contrasted with that of the Long-Plosser [1983]. The models share a common goal of attempting to understand the co-movement of output and employment in a multi-sector economy. Long-Plosser [1983] also consider the propagation of shocks across time which is not addressed in this paper. In both models, the normality of goods in agent's preferences spreads the effects of a shock in one sector to others. In the Long-Plosser model these increased demands are met by the allocation of additional inputs into an expanding sector. Employment may also increase if the intertemporal substitution effects are strong enough.

The model of imperfect competition explored here has as a key feature the underutilization of workers. As a consequence, increases in demand can be met by expanding output without the need to induce workers to supply more labor by increasing real wages. In addition, wages do not decentralize employment decisions due to the presence of optimal labor contracts and prices do not decentralize product market behavior because of imperfect competition. Thus evidence that wages and prices fluctuate little relative to quantities is consistent with this class of models. These models imply that quantity variations can arise, even though prices are constant, if other quantities in the economy are varying as well.

III. Structure of the Economy and a Characterization of Equilibrium

Consider an economy composed of S sectors indexed by $s = 1,2,....,S$. In each sector there are F identical firms producing a homogenous product. Firms in each of the S sectors produces a distinct commodity so that there are S produced goods in the economy. There are N workers per firm in each sector who provide labor services to their respective firms. This allocation of workers to firms is not really a restriction given the symmetry in the model. For simplicity we will often term a group of N workers, a union, and view contracts as negotiated between a union and a firm. So, for the sake of presentation, we focus on explicit contracts. Subject to the appropriate conditions of enforceability, one could also think of these as implicit arrangements.

Finally, there is a non-produced good in the economy which is the endowment of the outsiders. These outsiders trade their endowments for the goods produced in each of the S sectors.

a) Preferences

The structure of preferences employed in this model is quite simple. In models of this genre, identical homothetic preferences are often used to avoid the issues of aggregation and distribution effects. These preferences imply that demand curves are linear in income which makes the calculations of the Nash equilibrium in product markets easier. We take a step further and assume that all workers and firms have Cobb-Douglas preferences over the commodities they consume. This permits us to generate a closed form characterization of the equilibrium which is useful for expositional purposes and tractability. We comment in Section VI on relaxing these strong assumptions.

In addition to this restriction on preferences, we also assume a strong pattern to the demands by a worker or firm in sector s. In particular, we assume that agents do not consume the commodity they are active in producing. Hence, workers and firms in sector s consume the goods produced in the other sectors and the non-produced good. This assumption highlights the specificity of production relative to consumption. More importantly, this assumption implies that the demand for sector s output comes solely from other sectors so that coordination failures emerge. Relaxing this assumption would lead firms to recognize that output expansions would influence the position

of their demand curves so that the underemployment effects discussed here would be somewhat weakened.

Workers in sector s have preferences given by

$$(1)\quad U(c_{-s},m,n) = U(\pi_{k\neq s}\ (c_k^{\alpha})\ \ m^{\beta} - rn)$$

where n equals one if the worker is employed and zero if the worker is unemployed. The disutility of work equals r and is assumed to be less than one. Assume that $(S-1)\alpha + \beta = 1$, so that preferences are homothetic, and that U( ) is strictly increasing and strictly concave so that workers are risk averse. The demands coming from these preferences are

$$(2)\qquad c_i = (\alpha / p_i)Y \quad \text{for } i\neq s \quad \text{and } m = \beta Y$$

where Y is the worker's income.

Firms (i.e. a technology which is wholly owned by an agent in this economy) in sector s spend the proceeds from their production activities on commodities other their output and the non-produced good. Firm's (shareholder's) preferences are given by

$$(3)\quad V(c_{-s},m) = V(\ \pi_{k\neq s}(c)_k^{\alpha}m^{\beta})$$

where V( ) is increasing and concave. Since firms and workers in the same sector have identical ordinal preferences, firms' demands are given by (2) as well with Y equal to the profit level per firm of π. Firms' attitudes towards risk are characterized by V( ).

The outsiders split their demands evenly across the S sectors and consume the

nonproduced good as well. Their preferences are also Cobb-Douglas with demands given by

$$(4) \qquad c_k = (\tau / p_k)\,\bar{M} \text{ for } k = 1,2,\ldots.S \text{ and } m = (1-S\tau)\,\bar{M}$$

where $\bar{M}$ is the aggregate endowment of the outsiders.

b) Technology

The presence of imperfect competition in product markets derives from some element in the industry which prevents the free entry and exit of firms. These barriers to entry are certainly important in understanding the long run behavior of a particular industry. Here, the model is very short run in nature so that these barriers will not be explicitly introduced into the analysis. That is, we will simply assume that there are F firms per sector and not model the source of this market power. Extensions of this framework to study dynamics will require the formulation of a model of entry and exit.

The technology will simply be a proportional relationship between output and labor input with one unit of labor producing θ units of output. Later in the analysis we will view θ as a random variable and consider sector specific shocks. Assume that θ has a mean value of one. Again, fixed costs or increasing returns to scale could be introduced to make the model more compatible with the underlying technological features of imperfectly competitive industries. (See the discussion in Section VI).

We also assume that worksharing is not feasible so that workers are either employed or unemployed. This may reflect features of technology which make hours and people imperfect substitutes. This structure is imposed so that the model will generate employment fluctuations rather than variations in hours which allows us to investigate the role of unemployment insurance.

c) Uncertainty

In the next section of the paper we will study the properties of the model in the face of a variety of shocks to the economy. For the purposes of describing an equilibrium, we need to specify the variables which are unknown to workers and firms when contracts are negotiated. To do so, we differentiate between the two types of variables in the economy. First are the exogenous variables which may be stochastic such as the endowments of the outsiders ($\tilde{M}$), the preferences of the outsiders (τ), the preferences of the workers and firms (α,β) and technology (θ). Second, there are the strategic variables which are outside of the control of a firm negotiating a contract with a group of workers. These variables, essentially the output levels of other firms in the economy, are determined ex post and are conjectured, on a state-by-state basis, by the contractants when negotiating a contract ex ante. In equilibrium, these conjectures are correct. So a labor contract, outlined next, will be written contingent on the realization of the random variables in the economy given conjectures about the ex post quantity decisions of other firms in the economy. For simplicity we let Γ denote the vector describing the state of nature and model contracts as contingent on Γ.

d) Market Structure and Equilibrium

As discussed in the previous section of the paper, there are two types of markets in the economy. The first is the ex ante labor market in which workers and firms determine the rules of employment and compensation through a labor contract. The second set of markets open after the random variables describing

the state of the economy have been realized. In these markets, goods are exchanged between the non-competitive firms and the consumers.

An equilibrium is, in part, described by a labor contract for each union-firm which specifies state contingent employment and compensation schedules. That is, the contract states the employment level for each realization of the exogenous random variables. Given the linear technology linking outputs to inputs, the labor contract thus determines the output decision in a particular state for the union-firm coalition. Recall though that the contract is designed given a conjecture (correct in equilibrium) about the behavior of other firms.

So, ex post, the quantities of output stipulated in the contracts will determine the Nash equilibrium for the product markets. These output levels represent a best response of the firm-union pair to the output levels chosen by other firms (as conjectured ex ante). Prices for the produced commodities are determined so that these markets clear. This is, of course, fully anticipated by the contractants in the labor market.

e) Optimal Labor Contracts

The heart of this problem is the determination of the labor contract. We focus on the contracting problem between an arbitrary firm f of sector s and a group of N workers who form a union. The structure of unions and the size of their membership is taken as exogenous for this exercise. Section VI comments on this issue.

Since the economy is symmetric, we will focus on symmetric Nash equilibria. The contract devised for this firm and group of workers will therefore be

optimal for all other union-firm pairs in the economy. All expectations used in describing the contracting problem will be relative to the distribution of Γ.

The optimal contract between firm f of sector s and that firm's N workers is characterized by three schedules: $w^e(\Gamma)$, $w^u(\Gamma)$, and $L(\Gamma)$. The first schedule is the state-contingent wage paid to employed workers, the second is the state-contingent level of severance pay and the third is the employment rule contingent on Γ as well. For simplicity of notation we will denote a contract by δ and eliminate most of the superscripts and subscripts. The union-firm choose δ to maximize

$$(5)\quad E\{V(z\pi) + \sigma[(L/N)U(zw^e - r) + (N-L/N)U(zw^u)]\}$$

$$\text{subject to:}\quad L(\Gamma) \leq N \text{ and}$$

$$w^e, w^u, L \text{ non-negative for all } \Gamma.$$

In the objective function, σ represents the bargaining weight attached to workers' expected utility. The ratio L/N is the probability that a given worker is employed if L workers are employed under the optimal contract in some state. The firms utility function depends on the product of the firm's profit π and a variable z (which also appears in the workers' payoffs). The profit level π is determined by

$$(6)\quad \pi = R(L,\Gamma) - w^eL - w^u(N-L).$$

The function $R(L,\Gamma)$ is the firm's revenue if it employs L workers and the state is Γ. The presence of Γ in this revenue function is the key linkage between the contracting problem and the remainder of the economy. Embedded in Γ are the quantities chosen by other firms in the economy as well as the parameters describing the tastes, endowments and technology of agents in the economy.

Since all of these variables lie outside of this contracting problem, they are all subsumed in Γ for now.

The other variable which requires explanation is z, which appears in the payoffs of both the firm and the worker. This enters into the indirect utility functions of the agents from their demands as generated by the Cobb-Douglas preferences. For later reference,

$$(7)\quad z = \beta^{\beta}\, \pi_{k \neq s} (\alpha/p_k)^{\alpha}.$$

and is a price deflator for the market basket of goods generated by these Cobb-Douglas preferences.

Assuming for the moment that the constraint on the employment level not exceeding N does not bind, the first order conditions for the problem can be summarized by

$$(8)\quad U'(w^e z - r)\sigma/N = U'(w^u z)\sigma/N = V'(z\pi) \quad \text{and}$$

$$(9)\quad R_L(L,\Gamma) = r/z \text{ for all } \Gamma$$

where R_L is the derivative of $R(L,\Gamma)$ with respect to L.

Equation (8) implies that risks are shared efficiently between the firm and its workers. Because of the strict concavity of U( ), (8) implies that workers are indifferent between the states of employment and unemployment; i.e. the level of severance pay compensates the unemployed worker for the lost wage income less the utility of leisure (r). As a consequence, workers' welfare is independent of employment status. Note though that as long as the firm is not risk neutral, the utility level of workers will depend on the level of economic activity in the economy. Section VI of the paper discusses the implications of adding asymmetric information on the sharing of employment risks.

Equation (9) represents the employment rule in the optimal contract. Since workers are indifferent between employment and unemployment, the only cost to the firm of employing an additional worker is the value of that workers leisure in terms of the consumer basket, r/z. The gains to employing another worker is the marginal revenue gained from selling an extra unit of output. If the constraint that $L \leq N$ binds, then employment is set at N and (9) does not hold with equality.

The important element about (9) is that once Γ is specified, this expression is also the firm's reaction curve in the ex post product market game. The union and the firm act as a coalition in this product market game with their product market strategy determined in the ex ante labor contract. There is no pressure in this economy to be at full employment. In contrast to Hart [1982] this reflects the joint market power of the union-firm coalition in product markets and not the labor market power of the union per se. The optimal contract allows some workers to remain unemployed as a means of obtaining the largest surplus possible given the market power of the firm. The compensation rule then determines how this surplus is to be divided between the firm and the union.

Note that the employment rule is independent of the parameter measuring the bargaining power of the union, σ. Of course, the level of wages does depend on σ. This separation of employment and compensation arises from the structure of preferences (i.e. no income effects) for the contractants. The decisions of the union-firm in the product market game are thus equivalent to that of a firm facing a marginal cost of labor (in terms of the numeraire) of r/z.

There is also a strong connection between (9) and the characterization of equilibrium in Weitzman's wage system given in Cooper [1986]. In Weitzman's

economy, the firms took as given the real wage and determined labor demand to maximize profits in the product market game with other imperfect competitors. Here, that assumption of a constant real wage is not really needed. Essentially the ratio r/z replaces the real wage as the true cost of an additional unit of labor. Nonetheless, as discussed below the operation of this economy looks very much like that of Weitzman's wage system.

Equations (8) and (9) completely specify the employment, wage and severance pay schedules in an optimal contract between firm f in sector s and its N workers. Recall that we have omitted any notation regarding the identity of this firm or its sector of operation. Given the symmetry of the problem, the conditions describing this optimal contract also characterize that for other union-firm pairs in other sectors. The only change that is necessary is to define z to correspond to the sector of interest. Given this optimal contract, we are able to compute the Nash equilibrium in the product market.

f) Goods Market Equilibrium

To complete our characterization of an equilibrium, we need to model the interaction of firms in product markets, ex post. The labor contracts negotiated ex ante with their unions, specifies an employment rule for a firm contingent on the realization of random variables in the economy and the actions taken by all the other firms in the economy. Recall that we have assumed that workers and firms are equally informed about the state of the economy.

Given the structure of workers' preferences, (9) alone determines the employment and hence output decisions of the firms. To understand (9), note that the revenues earned by firm f of sector s are:

(10) $R(L_s^f,\Gamma) = p_s q_s^f = q_s^f E_s / \sum_f q_s^f$.

where $q_s^f = L_s \theta$ for all f.

The key aspect of this expression is that the Cobb-Douglas preferences imply that each commodity has a constant budget share for each of the consuming agents in this economy. Hence, the price in sector s is simply the total expenditure in that sector, E_s, divided by the total output in sector s. As stated earlier, we will concentrate on symmetric Nash equilibria for this economy. Denote by q_s the level of output for each firm in sector s if they are all producing at the same level. Since the expenditure on sector s is independent of q_s, we can solve for the symmetric partial equilibrium in sector s by finding that level of output per firm in that sector which is a best response to the output levels chosen by the other firms in that sector <u>given</u> the level of expenditure on that sector. To do so, use (10) to solve (9) yielding

(11) $R_L(L,\Gamma) = \theta_s E_s \mu / Fq_s = r/z_s$

where μ is defined as (1 - 1/F). Note that (11) holds only when the constraint that $L \leq N$ is not binding. The variable μ will serve as a useful measure of the market power of firms in the economy. As $F \to \infty$, $\mu \to 1$ while $\mu \to 0$ as the industry approaches monopoly. Recall that the sectors are symmetric so that μ is not indexed by the sector. Using (11), the price in sector s is simply

(12) $p_s = r/\mu\theta_s z_s$.

It is important to note that z depends on prices in other sectors as well as parameters of preferences so that, in (11) and (12), we index it by s.

To characterize the symmetric Nash equilibrium for this economy, note that (11) and (12) hold for all s. Since z_s depends on the prices in other sectors, we can solve for the output price, common to all sectors, using (7). This will be

$$(13)\quad p = \frac{r\mu/\theta^{1/\beta}}{\alpha^{1-\beta/\beta}\ \beta}$$

where θ is a productivity shock (assumed for now to be) common across firms and sectors. Note that prices can be determined independent of output levels. This is a feature of homothetic preferences and constant marginal costs. This implies that variations in the endowments of outsiders $\bar{M}$ will cause output but not prices to change. With these strict assumptions on preferences, the model is incapable of matching observed cyclical movements in markups as reported in, for example, Domowitz, Hubbard and Petersen [1986].

To determine the reaction curve of an arbitrary firm in sector s (given that all firms are producing the same level of output in the partial Nash equilibrium), we need to specify the level of expenditure on sector s. Using the Cobb-Douglas preferences, this is given by

$$(14)\quad E_s = \alpha F \Sigma_{k\neq s}\ p_k q_k + \tau\ \bar{M}.$$

Again note that the summation here is for sectors other than s. Using (12), in a symmetric Nash equilibrium, (14) can be rewritten as

$$(15)\quad E_s = Fp[\alpha \Sigma_{k\neq s} q_k + \tau \Phi \bar{M}].$$

where $\Phi = 1/Fp = \theta\mu z/Fr$.

This is a very appealing expression. It states that the total expenditure on sector s depends on the level of economic activity in all the other sectors and is proportional to the endowment of the outsiders. This is similar to a simple model of income determination in which there are autonomous expenditures and an expenditure term which depends on the level of economic activity.

Inserting (15) into (11) implies that

(16) $q_s = \alpha\Sigma_{k\neq s} q_k + \tau\Phi\bar{M} = \alpha\Sigma_{k\neq s} q_k + \tau\bar{M}/Fp.$

So the per firm level of output in sector s is a linear function of the aggregate level of activity in other sectors and the per firm endowments of the outsiders (in terms of the produced commodity). For S large enough (so that each sector is small), (16) implies that the level of output per firm in sector s is a linear function of the aggregate output level in the economy.

Figure 2 displays a "reaction curve" for sector s for a given level of activity in other sectors. Note that this is not literally a "reaction curve" for a particular firm but rather an expression for the sector specific Nash equilibrium for given output levels in other firms. The intercept of this "reaction curve" is the sector specific level of autonomous expenditures.

The strategic complementarities discussed in the Introduction are also clear from this expression. As the output levels in other sectors increase, all of the firms in sector s will expand as well. So even though the firms in a given sector are producing perfect substitutes, the complementarities are present between firms across sectors in a symmetric Nash equilibrium. Perhaps this is a good point to stress that these complementarities are not a product of the specific demand structure we have assumed beyond the natural assumption that

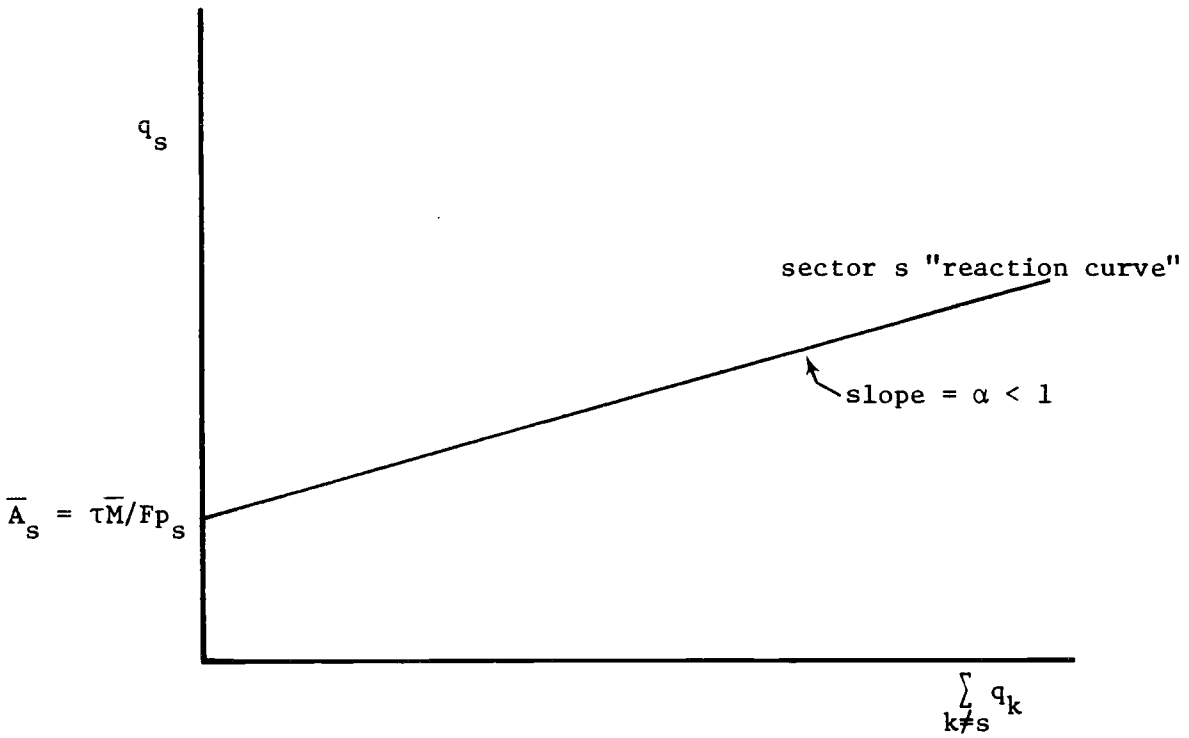
q_s
sector s "reaction curve"
slope = $\alpha < 1$
$\bar{A}_s = \tau\bar{M}/Fp_s$
$\sum_{k \neq s} q_k$

Figure 2

there are no inferior goods in the economy. The value of the Cobb-Douglas preferences is the tractability they generate.

Since (16) holds for all s, we can use it to compute the output level per firm in each sector in a symmetric Nash equilibrium. This output level is given by

$$(17) \quad q = \frac{\tau \bar{M}/Fp}{1 - (S-1)\alpha} = \frac{\bar{A}}{\beta}$$

where $\bar{A}$ is the level of autonomous expenditure on the produced good. Recall that β is the budget share of the numeraire good and represents the share of income that leaks out of the income stream connecting the firms in the economy.

To guarantee that this level of output is feasible, we need to check that $q \leq N\theta$ since each firm had available only N workers. This inequality (and hence the condition that $L(\Gamma) \leq N$) is satisfied as long as $\bar{M}$ is not too large and β not too small. We will use (17) as an equation for the equilibrium level of output even though it contains the price in it. From (13), we know the reduced form of the price level. Given that p is independent of q, (17) will be a useful expression.

When the level of output given in (17) exceeds θN, then the economy is at full employment and the expressions derived in this section will not apply. Each firm will then simply employ all N workers and prices in each sector will adjust so that markets clear at full employment.

Finally, and perhaps most importantly, note that the equilibrium levels of output, employment and prices are actually independent of a number of labor market variables in this economy: the number of workers N and the bargaining weight σ. This independence of the equilibrium of the number of workers is also a property of many efficiency wage models (see, for e.g., Weiss [1980] and

Yellen [1984]). If the level of per firm output satisfying (17) is less than N, we have an underemployment equilibrium. Furthermore, increasing the number of workers in this economy (assuming that they all join a union) will only increase the unemployment rate and will not alter the form of the optimal contract between the union and the firm. Again, the optimal contract specifies employment to obtain the maximal amount of payoffs for the coalition of workers and the firm and this decision rule is independent of the number of workers N and the bargaining weight. Therefore, this economy has the property that there are no forces at work to reduce the rate of unemployment since the agents in the economy have no incentive to employ the excess labor force.

In this economy, a coordination failure emerges because prices do not provide all the necessary information for selecting output levels and firms are unable to coordinate trades to take advantage of mutually advantageous opportunities. In Section V of this paper we address the topic of welfare improving actions by the government to overcome this coordination failure. Before doing so, we discuss some of the comparative static properties of this model economy.

IV. Comparative Statics

These models generate interesting multiplier effects from changes in exogenous variables. (This point is made by Hart [1982] and Startz [1986] as well.) From the perspective of attempting to match macroeconomic times series, these multiplier effects can be rather useful since they create large aggregate fluctuations from either (relatively small) aggregate shocks or from sector specific shocks. Thus, it is not necessary to explain aggregate fluctuations from aggregate shocks of the same magnitude.

In addition, these quantity fluctuations arise even though observed movements in wages and prices may be relatively small. This arises in these models

because wages and prices do not completely decentralize allocations. Employment is determined directly in the labor contract and depends, in part, on the quantity decisions of other agents in the economy.

In addition to focusing on the multiplier effects of "small" fluctuations in exogenous variables, versions of these models which allow for multiple equilibria (as discussed in Section VI) have an additional property. Changes in the exogenous variables may alter the set of equilibria in a dramatic way so that economic activity is changed quite a lot as well. This interpretation of a multiplier effect rests on the presence of "catastrophic behavior" found in models of multiple equilibria. As discussed later, this catastrophic behavior is of additional interest in models of coordination failures because the equilibria may be Pareto comparable. Hence, a change in an exogenous variable may have a large effect on observed economic behavior and welfare.

Finally, as noted in Hart [1982] and other studies of imperfectly competitive economies, there is a multiplier effect present in the face of changes in policy variables. This will become important in the discussion of interventions in the following section.

Expression (17) is quite useful for understanding the multiplier effects associated with aggregate shocks. Unless stated otherwise, we will assume that we are starting from an equilibrium in which the full labor force is not employed. From (17) we see that

$$(18)\quad dq/d\bar{A} = 1/\beta$$

This expression is quite familiar from the simple Keynesian models of income determination. A change in autonomous expenditure creates a larger change in the level of output and employment because of the demand interaction across sectors of this economy. As each sector expands from the increase in

autonomous expenditure, the demand curves for the other sectors simultaneously shift out which leads them to further expand output. The process converges because of the non-zero "leakage" effect associated with the consumption of the non-produced good. This effect is measured by β.

From the definition of $\bar{A}$, we know that these multiplier effects could be associated with changes in either $\bar{M}, \tau$, p or F since $\bar{A}$ depends on all of these variables. Recall that p is given in (13) and depends on the parameters of preferences, the productivity shock and the measure of competitiveness μ. So fluctuations in an economy of this type are due to movements in the aggregate endowment of the non-produced good, changes in tastes by the outsiders (τ), productivity shocks or changes in the number of active firms. If one reinterprets the non-produced good as one which is produced by a competitive sector(s), then variations in $\bar{M}$ can be viewed as a form of productivity shock for that sector. The point here is that these shocks are magnified by the demand linkages across sectors of this economy.

Perhaps more interestingly, this model is also capable of producing aggregate fluctuations from sector specific shocks. To see this, suppose we define the autonomous expenditure on sector i by $\bar{A}_i$. One can think of the outsiders as being split into a number of classes by the type of produced commodity they consume. So the autonomous expenditure on sector i measures the demand by outsiders for the commodity produced in that sector either due to a change in tastes or endowments. Suppose that the autonomous demand for sector i increases. This will again lead to an increase in output by all firms in that sector. Because of the normality of other goods produced in the economy, some of the additional income earned by firms and workers in the initial sector will be spread to other sectors, inducing them to expand as well. Starting from the

symmetric Nash equilibrium given in (17), the equilibrium change in the output in sector i due to a change in autonomous expenditure on that sector (computed from (16)) is given by

$$\frac{dq_i}{d\bar{A}_i} = 1 + \alpha \sum_{s \neq i} (dq_s / d\bar{A}_i)$$

So we see that the initial effect of a change in autonomous expenditures in sector i is augmented by spillovers from other sectors. Furthermore, the equilibrium changes in output in one of the other sectors is

$$\frac{dq_{-i}}{d\bar{A}_i} = \alpha \sum_{s \neq -i} (dq_s / d\bar{A}_i)$$

This expression indicates that the demand spillovers from the sector in which the shock originates leads to output changes in other sectors which then feed on each other. So that sector specific shocks will produce positive correlations in output and employment in this multisector economy. These sectors are able to expand together because of the presence of unemployed workers. If the economy starts at a full employment point (which is possible for some values of $\bar{M}$, N, F etc.) then these shocks will simply produce variations in prices.

This model can also be used to understand the effects of sector specific shocks to the productivity of labor. Suppose that sector i experiences a reduction in productivity (such as a drought in the agricultural sector) so

that θ_i falls. From (12) this will lead to an increase in that sector's price and (from (11)) a reduction in output and employment in that sector. The price increase in sector i will influence the prices in other sector through z_k for $k \neq i$. From (7), the "cost of living" for other sectors will rise due to the price increase in the sector experiencing the productivity reduction. (The strength of this effect will depend on the number of sectors so that as S gets large each sector will have a small effect on the price index). This increase in the marginal cost of employment in sectors other than i will lead to a rise in prices in other sectors (from (9)), so that output and employment will fall in other sectors as well. Furthermore, the initial reduction in activity in sector i will spillover to other sectors as described above. Thus an adverse productivity shock in one sector will create an overall reduction in economic activity in all sectors. Note that the model predicts that prices (in terms of the numeraire commodity) will be countercyclical in the face of productivity shocks.

It should be noted that the fluctuations in the economy caused by either sector-specific or aggregate shocks have implications for the welfare of both workers (the union) and firms. From (8) we know that the optimal labor contract provides a vehicle for the contractants to share risks. If workers' are risk averse and firms are <u>risk neutral</u> then from (8) we know that the compensation level to employed and unemployed workers will be independent of Γ. Hence, fluctuations in economic activity will not affect the welfare of workers in this special case.

More generally, if the firm is not risk neutral then when the firms profits are high the payoffs to employed and unemployed workers will be high as well. That is, because of the risk aversion of both parties, profits and compensation

will be positively correlated with the degree of correlation reflecting the relative degrees of risk aversion of the two parties.[3] The point is that economic downturns -- caused by an exogenous shock and magnified by the multiplier effects -- are "bad" for all agents in the economy. The presence of severance pay in the contracts provides for full layoff insurance so that unemployed workers are not worse off than their employed counterparts. We comment later on extensions of the model to reduce the amount of layoff insurance it predicts.

These comparative static effects should be contrasted with competitive models to understand the role of imperfect competition. Long-Plosser [1983] model the co-movement of output and employment in a multisector economy. In that model, the correlated behavior is produced by the interaction of demand spillovers with the ability of sectors to expand output simultaneously. As stressed by Long-Plosser, the key element in the model is that sectors have the ability to expand simultaneously and meet increased demand with additional output rather than price increases. This is brought about by their focus on productivity shocks in one sector which allows other sectors to expand <u>if</u> the initial shock is to a production process whose output is subsequently used in the production of other commodities. Hence, the key element in the Long-Plosser model is the presence of technological linkages between sectors. A sector which is not technologically connected with other sectors would not be expected to fluctuate with the rest of the economy.

In the imperfectly competitive economy described above, the technological linkages stressed in Long-Plosser is absent and the stress is on the demand spillovers in the economy. Increases in demand are met by quantity changes to

the extent that there are unemployed workers in a particular sector. This occurs for both aggregate and sector specific shocks.

If some sectors are producing near capacity (in terms of labor utilization) while others are not, the model would imply that some sectors will meet the increased demand with price increases while others would respond with output increases. From (7) and (12), price increases in one sector will spill over to other sectors. So, we would observe prices increasing in the face of a demand shock and sectors having idle workers expanding as well. The comparative statics discussed above are for the extreme case in which all sectors have idle workers at the initial equilibrium (i.e (17) holds).

It should be noted that similar fluctuations in output and employment could be generated by an economy which is perfectly competitive and workers are either employed or out of the labor force. It is possible to construct an equilibrium in which real wage is bid down to workers reservation wages. In such an economy, competitive firms would select employment at the going wage and this employment level would fluctuate as agents change their participation decision in the face of shock to the economy. Of course, workers welfare would be independent of the state since they would be indifferent between working and not working and firms would always be earning zero profits. Nonetheless, the time series for output and employment produced by the competitive and imperfectly competitive economies would look very similar.

There are a couple of important differences between the predictions of these models. First, as discussed above, downturns are bad for workers and firms in the imperfectly competitive economy while agents are indifferent to the level of economic activity in the competitive model. Second, in both the competitive and imperfectly competitive models there are regions in the parameter space in

which an equilibrium with the labor force not fully employed can arise. The imperfectly competitive economy is more likely to be in the underemployment region because of the mark-up associated with $\mu<1$. Prices being higher is similar to having a lower endowment of $\bar{M}$ which increases the probability that the equilibrium is in the underemployment region. It is possible to construct versions of this model (by altering the preferences of workers so that they only consume produced goods) so that the competitive equilibrium always entails full employment while the imperfectly competitive equilibrium may still be one of underemployment. The presence of imperfect competition increases the likelihood that we will observe the multiplier effects noted above. Of course, once the imperfectly competitive economy crosses over to the full employment region, then it will exhibit price fluctuations rather than quantity fluctuations.

V. Welfare Issues

As is common in models of imperfect competition, the equilibrium in this economy is sub-optimal. The partial equilibrium result of underemployment of resources carries over to this economy as well. There is a gap between the marginal rate of substitution and costs in this equilibrium. A planner could produce a Pareto dominating allocation by engineering a simultaneous increase in the level of activity in all sectors of this economy. The decentralized economy does not realize these gains since the private agents have no means to coordinate their activity. The competitive equilibrium for this economy can be determined simply by setting $\mu=1$.

As we discuss later, there is a second type of inefficiency that arises in the presence of multiple Nash equilibria which are Pareto ranked. In that

case, it is possible to be at an equilibrium which is Pareto dominated by another equilibrium. Furthermore, economic downturns in this economy represent "bad times" for workers and firms. As a consequence, we can inquire into government policies which can stabilize the fluctuations in the economy and support the Pareto optimal outcomes.

Here we will consider government policies of two distinct types: tax and spending policies such as those considered by Hart [1982] and direct interventions in labor markets including the share contracts discussed by Weitzman [1983,1985]. We also discuss the impact of unemployment insurance in this economy. Before proceeding to these policies, it is useful to recall the nature of the fundamental problem of this economy. Prices do not provide adequate signals for the decentralization of resources here due to the presence of imperfect competition. As a consequence, coordination failures emerge as the firm-union coalitions behave in a non-cooperative manner. The government can take actions to assist in this coordination by providing a means for the agents to cooperate. This is close to a planning solution and may be undesirable for reasons outside of this model. Alternatively, the government can use its tax and expenditure policies to influence the non-cooperative equilibrium. That is the approach taken here where the government selects policies which the private economy takes as given in determining the non-cooperative equilibrium.

Government tax and expenditure policies work here to the extent that government spending patterns differ from those of private agents. Recall that workers and firm spend a portion β of their income on the non-produced good. This is income that "leaks out" of the income expenditure stream and reduces the level of demand for produced goods in the economy. As demonstrated by

Hart, the government can therefore influence the overall level of economic activity through a balanced budget multiplier. The government simply taxes the workers and firms and spends the proceeds equally over all the produced goods but does not spend any of the tax revenues on the non-produced good.

To see how this works specifically, suppose that the government taxes income (both profits and compensation) at the rate t and spends the income equally on all sectors. So the total expenditure on sector s, E_s, is now determined by

$$(19) \quad E_s = \alpha F \Sigma_{k \neq s} p_k q_k (1-t) + r\bar{M} + tF\Sigma_{k \neq s} p_k q_k/(S-1)$$

This expression is similar to (15) except that the income spent on sector s by other sectors is a proportion of income net of taxes. In addition, there is a new term in this expression which comes from the government expenditure of total tax revenues earned in other sectors equally on each sector. That is, assume that the government does not spend tax dollars earned in one sector on the output produced in that sector. As long as $\alpha<1/(S-1)$, (19) is an increasing function of t. From the specification of preferences, $\alpha(S-1) + \beta = 1$. Hence, $\alpha < 1/(S-1)$ as long as $\beta>0$. So, the government can influence the level of economic activity from a balanced tax and spending policy because, in contrast to private agents, it returns each dollar taxed to the system. Note that this policy affects the slopes of the "sector reaction curves".

To pursue a stabilization policy of this type the government needs to set its tax and spending levels for each realization of Γ. In the event that realizations of Γ are not costlessly and instantaneously observable, this type of stabilization may prove difficult and/or costly.

To fully specify and evaluate this policy of tax and expenditures, we must be more specific about the disposition of the commodities that the government purchases. This will be important in the ultimate evaluation of government policies but the point here is that such policies can influence the overall level of economic activity. So that an allocation which Pareto dominates the imperfectly competitive equilibriua is obtainable by a government balanced budget spending program and the appropriate distribution of the commodities purchased by the government.

As an alternative to fiscal policy, the government could undertake policies which influence labor markets directly. That is, one can interpret the tax and spending policies described above as operating through the demand side and consider other policies which influence the equilibrium through input markets.

Two such policies will be considered here: unemployment insurance (UI) and share contracts. We know from the extant partial equilibrium contract models that altering the level UI will affect the optimal contract. Increases in UI make layoffs less costly to the workers-firm coalition and hence produce underemployment. That result will clearly hold in this model as well. In addition, it is important to note that the multi-sector model contains a spillover effect not brought out in the partial equilibrium analysis.

Suppose that the government offers unemployed workers a payment of x units of numeraire and finances these payments through lump sum taxes. Because of the homotheticity of preferences, these taxes and transfers have no impact on the level of demand in each sector. Further, suppose that individual worker-firm coalitions view their tax liability as outside their influence so that they tax the lump sum tax and the level of x as given when they design their contract.

The conditions describing the optimal contract are again to equalize the income of employed and unemployed workers so that

$$w^e z - r = (w^u + x)z$$

As a consequence, the employment rule is to equate R_L ( ) with x +r/z. So the introduction of the unemployment insurance reduces the cost of unemployment to the worker-firm coalition and hence reduces the level of output and employment by each firm for given levels of output for other firms. With x>0, exercising market power is easier for the workers-firm coalition.

If this UI program is instituted in only one sector, the reduction in this sectors output will spillover to other sectors through the normality of consumption as stressed above. That is, reaction curve (recall Figure 2) for the sector in which UI is introduced will shift down and other sectors will follow by contracting their output and employment. Thus UI creates lower employment economy wide even though it is only present in one sector. Of course, the introduction of a UI program economy-wide will have larger effects.

Clearly, the point is that in the presence of severance payments by firms provided in optimal contracts, UI is not socially desirable. This model adds to this partial equilibrium statement the importance of spillover effects.

As an alternative form of intervention, we can consider the government's ability to institute a particular form of contracting structure in the labor market. Weitzman [1983,1985] has advocated the introduction of share contracts as a vehicle for providing automatic stabilization of the economy. In contrast to a wage system (in which wages are fixed, severance pay is excluded and the employment level is chosen by firms), a share system has the property that compensation per worker is a <u>decreasing</u> function of the number of workers at the firm. As a consequence, firms are induced to hire unemployed

workers if the compensation per worker falls fast enough. Weitzman argues that it is possible to construct a share system which has better macroeconomic properties than the wage system. This proposition is also investigated in a model of imperfect competition similar to the one presented here in Cooper [1986].

One of the weaknesses in this argument is the lack of a model predicting the wage system as an optimal contract. Thus, even though the wage system may be dominated by a share system, we do not know that the share system dominates an optimal (from the viewpoint of the workers-firm) labor contract. With that question in mind, we can introduce share contracts into the present model (which is based on privately optimal labor contracts) to determine if they can support a Pareto dominant equilibrium.

To do a full analysis of this question would lead us too far afield and will be left for future research. It should be noted that introducing share contracts into this model makes clear that this alternative compensation system differs from optimal contracts in two ways. First, the compensation rule differs from the privately optimal rule in that it will not satisfy conditions for efficient risk sharing. Second, the optimal labor contract does not specify employment on the firm's labor demand curve but instead determines employment directly. The share system, instead, stipulates that employment is demand determined.

In light of these two deviations, one may wonder how share contracts can be beneficial. The point of the argument is that privately optimal labor contracts are not necessarily socially optimal in the presence of imperfectly competitive product markets. Firm-union coalitions establish employment without taking the effects of these decisions on others into account. Hence

their may be room for socially beneficial adjustments in the terms of compensation schemes in individual labor contracts to stabilize employment and output. Of course, to the extent that share contracts do not satisfy the conditions for privately optimal contracts, the enforcement costs of such a compensation scheme may be prohibitive.

VI. Extensions and other Applications

A. Multiple Equilibria

The model presented here has a unique Nash equilibrium. One of the interesting features of other models of coordination failures is the possibility of multiple equilibria which can be Pareto ranked. While a competitive model (satisfying the conditions of the First Fundamental Welfare Theorem) can have multiple equilibria, these are Pareto non-comparable. Examples of economies exhibiting multiple equilibria are presented in Heller [1985], Kiyotaki [1985] and Cooper-John [1986]. Heller presents a method of constructing examples of imperfectly competitive economies with multiple equilibria by allowing a rich structure to demands -- in contrast to the simple Cobb-Douglas economy studied here. Kiyotaki and Cooper-John both use some non-convexities in technology to generate the multiplicity.

The contracting model studied here could be amended to also generate multiple equilibria. This would require adjustments in either technology or preferences, which, in light of the aforementioned papers, would lead to the desired results.

These examples are interesting because they generate a different type of coordination failure. Economies can get stuck at a low level equilibrium with full knowledge that other, non-cooperative, equilibria exist

which Pareto dominate the initial equilibrium. Yet there are no forces of adjustment in the non-cooperative economy. From the viewpoint of comparative statics, as emphasized in Cooper-John, it is possible to see discontinuities in economic activity as the exogenous variables are continuously varied. There is thus an element of "catastrophe theory" operating here in that these jumps are not likely to occur but are quite pronounced when the set of exogenous parameters passes through one of the "critical points."

There is a very simple way of altering the present model so that it displays a continuum of equilibria. Suppose that we simply assume that the non-produced good is absent from the model -- so we set both $\bar{M}$ and β equal to zero. As a consequence, the level of autonomous expenditure is zero and reaction curves have unitary slope. Hence there will be a continuum of equilibria indexed by the level of economic activity and welfare. This type of economy, which resembles that analyzed by Bryant [1983], is clearly quite special.

B. Other Preference Structures

The model in this paper is made quite tractable by the Cobb-Douglas preferences used here. Because these preferences generate demand curves which are linear in income, the resulting reaction curves for the product market game are quite easy to analyze. Hart [1982] uses homothetic preferences as well and we could generalize the model to that setting quite easily. The Cobb-Douglas preferences also imply that a unitary elasticity of demand.

Suppose that we consider alternative demand structure. As long as we remain within the class of homothetic preferences, the elasticity of demand will be independent of income so that the mark-up of price, over marginal cost, will be independent of the level of economic activity. So, as in the Cobb-Douglas

economy, we can decompose the problem into determining the price level and the level of output independently. If we allow demand to have a constant elasticity other than unity, then the price/marginal cost margin will reflect that elasticity and our analysis of the output game will not be altered. These models will not generate the prediction of a procyclical price/marginal cost margin unless the price elasticity of demand falls as income rises or the number of firms is countercyclical.

For the sake of tractability of the theoretical model, going beyond these simple specifications seems hazardous. It is possible to work on a more general version of the problem to study the problem of existence and welfare properties without attempting any of the calculations discussed here. The main virtue of a more general demand structure, as demonstrated by Heller, is the possibility of generating multiple equilibria.

In a similar vein, one can complicate the present model with a richer specification of technology. As noted earlier, some form of increasing returns can generate interesting multiple equilibria. Beyond not, nothing seems to be gained by moving away from constant returns to scale.

C. Dynamics

The present model is static and this is a drawback if one wishes to study intertemporal coordination failures and make any attempt at matching time series. An intertemporal model would also facilitate a study of propagation effects over time from the spillover effects across sectors. Furthermore, the role of beliefs in these results would become clearer in an intertemporal setting. Finally, to the extent that the number of firms per sector has been taken as a given, an intertemporal model would force one into being more specific about the role of entry and exit in these models.

It is not difficult to present the ideas of this paper in an overlapping generations structure. The multisector structure can be retained following Townsend [1980] and we may even wish to introduce some form of spatial separation to guarantee that money is demanded. The numeraire commodity is now clearly money and is held by individuals as the sole store of value. Agents would have demands only for the produced goods as money yields no direct utility. Workers and firms use their savings from youth to finance consumption in old age. Hence, the outsiders in the current model become the old agents, holding nominal money balances, in the overlapping generations model. The analysis of the static model presented above appears to hold with one important exception. The comparative static results associated with changes in the endowment of the numeraire do not hold since variations in $\bar{M}$ should be interpreted as changes in the nominal money supply. Thus the model has to provide some reason for changes in the nominal money supply to have real effects.

The overlapping generations model, as stated here, allows a dynamic representation of this economy but does not introduce any interesting intertemporal coordination issues. Extensions of the model to allow for production lags, the holding of inventories and savings/investment decisions will be interesting as well.

D. Contracting Under Asymmetric Information

The model presented in this paper has the feature that workers are indifferent about their employment status. There is nothing in the model to prevent contractants from fully insuring workers from layoffs. As a consequence, times of low output and employment are shared by both employed and unemployed workers. To the extent that the joint provision of public and

private unemployment insurance is thought to be less than perfect, this model would predict that states of low economic activity would be particularly bad for unemployed workers. Explanations for the absence of severance payments presumably lie in the presence of asymmetric information about workers' leisure time (see Kahn [1985]) or in moral hazard problems associated with worker search patterns (see Ito [1984]). It would be straightforward to include private information about the value of leisure, r, in the model as a source of imperfect severance payments. The search problem of unemployed workers would be more interesting though as this generates another interaction between aggregates and individual choice variables since the return to search depends on aggregate variables which influence the probability of locating a trading partner.[4]

This model of demand spillovers is also useful in stressing the aggregate implications of asymmetries of information at the worker-firm level. Suppose that we introduce some asymmetric information about technology into the contracting problem in one of these sectors. If the structure of preferences is chosen correctly, this asymmetric information can create a form of underemployment. In the model of demand spillovers, this will influence the level of expenditures on other sectors and causes an underemployment of resources in other parts of the economy as well. Grossman, Hart and Maskin [1983] discuss this for a competitive economy (see their Proposition 2) and it holds in this imperfectly competitive economy as well.[5]

E. Industry and Union Structure

As noted earlier, this model takes as given the structure of firms and unions and focuses on the equilibrium of a non-cooperative game. The paper provides no information about the source of this particular structure: i.e. it excludes

a theory of entry/exit and a theory of union representation. It should be made clear that variations in the structure of firms or unions will have dramatic effects on these results.

Suppose that we vary the number of firms in a particular sector. Reducing the number of firms in sector s will increase the mark-up in that sector and will decrease the level of output in that sector. This is quite similar to the comparative static effect of reducing autonomous expenditure on a single sector. This reduction of output will again "spillover" into the other sectors causing an economy wide response. There is a multiplier effect associated with the entry and exit decisions of firms. If firms do not contemplate the effect of their decisions on activities in other sectors, this externality may imply that entry and exit decisions by firms are socially inefficient. (This is only a conjecture which needs to be understood within a model of entry/exit.) Note further that such a model would include in it a state variable (the number of firms) whose movement would have large effects on the underlying equilibrium of the economy.

Furthermore, the structure of firm ownership across sectors is important. If shareholders are dispersed in their preferences and own shares of all firms, perhaps the activities of these shareholders can coordinate the output and employment decisions of firms across this multisector economy.[6]

The structure of union representation has been set exogenously as well. Union membership has been set at N even though it is possible that this is not the optimal size of the union. Alternative models of union representation and bargaining could be analyzed as well. To some extent these alternative theories can be accommodated by considering variations in the bargaining weight σ. If the union has no power, then the bargaining weight is such that workers

expected utility equals their value of leisure and they are indifferent between participating in the labor market and simply enjoying their leisure.

Instead of considering the union-firm contracting problem, we could have analyzed a competitive ex ante contracting market in which the "price" of labor is the expected utility from accepting a contract. In that setting, the workforce of a firm would be endogenous. In some cases, an equilibrium would emerge in which some workers do not join a firm and the expected utility of workers equals the value of leisure. In other situations, firms may contract with all available workers. These possibilities can be accomodated through an appropriate value of the bargaining weight in the model used in this paper.

More importantly, the model has also assumed that union representation does not cross over firms or sectors. If a single union represents more than one firm in a sector, that union can coordinate the employment actions of those firms through the labor contract. The economy operates as if there were fewer non-cooperative firms. Similarly, a union representing workers in many sectors of the economy, can help to coordinate the output decisions and avoid some of the coordination failures discussed here.

A precise investigation of these issues is left for further research. Nonetheless, it is clearly important that we better understand the factors determining union representation and industrial structure as a basis for the coordination failures discussed here. There may be a wide variety of mechanisms for coordinating decisions that have been excluded from the analysis. These mechanisms need to be better understood as a means of predicting the structure of coalitions in the economy and hence the importance of coordination failures in non-cooperative games.

VII. Conclusions

The goal of this paper has been to provide a framework of analysis for coordination failures in imperfectly competitive economies. In contrast to other papers in this area, this paper includes a representation of labor markets through a contracting framework. This approach provides some perspective on the manner in which adjustments in the labor market influence the operation of product markets. To the extent that labor contracts bind workers and firms into a coalition that seeks to gain its share of surplus, there are no forces at work in labor markets to move the economy towards a efficient outcome. The model was then used to discuss some comparative static properties of imperfectly competitive economies and to conduct some policy experiments.

Section VI of the paper was an attempt to provide a road map for further research. The topics discussed in that section represent important extensions of this framework. The goal of this paper, in addition to analyzing the contracting equilibrium in an imperfectly competitive economy, was to provide a framework for considering these additional problems.

Footnotes

1. The term "strategic complementarities is used by Bulow, Geanakoplos and Klemperer [1985]. See Cooper-John [1986] for a discussion of its macroeconomic implications.

2. Hart [1982] notes that these results are dependent on the labor supply decisions of workers.

3. From (8), if both $U(\cdot)$ and $V(\cdot)$ are strictly concave then $z\pi$ and zw^u must vary in the same direction when elements of Γ change.

4. See Pissarides [1985] and Hosios [1986] as examples.

5. In addition, Kahn and Mookherjee [1986] present a private information model in which the demand spillovers determine the extent to which incentive compatibility conditions create inefficiencies in output and employment.

6. Shleifer and Vishny [1986] discuss the coordinating role of stock markets in a model of imperfect competition with private information.

References

Azariadis, C. "Implicit Contracts and Underemployment Equilibria," Journal of Political Economy, 83 (1975), 1183-1202.

Baily, M.N. "Wages and Employment under Uncertain Demand," Review of Economic Studies, 41 (1974), 37-50.

Blanchard, O. and N. Kiyotaki, "Monopolistic Competition, Aggregate Demand Externalities and the Real Effects of Nominal Money," NBER Working Paper #1770, 1985.

Bryant, J. "A Simple Rational Expectations Keynes-Type Model," Quarterly Journal of Economics, 98 (1983), 525-29.

Bulow, J., J. Geanakoplos and P. Klemperer. "Multimarket Oligopoly: Strategic Substitutes and Complements," Journal of Political Economy, 93 (1985), 488-511.

Cooper, R. "Sharing Some Thoughts on Weitzman's The Share Economy," NBER Working Paper #1734, revised July 1986.

_____ and A. John." Coordinating Coordination Failures in Keynesian Models," Cowles Foundation Working Paper #745R, revised September 1986.

Diamond, P. "Aggregate Demand Management in Search Equilibrium," Journal of Political Economy, 90 (1982), 881-94.

Domowitz, I., R. Hubbard and B. Petersen, "Business Cycles and the Relationship between Concentration and Price-Cost Margins," Rand Journal of Economics, 17 (1986) 1- 17.

Drazen, A. "A Rational Expectations Keynesian Model with Price Flexibility," Working Paper #2-85, Foerder Institute for Economic Research, Tel-Aviv University, 1985.

Grossman, S.; O. Hart and E. Maskin, "Unemployment with Observable Aggregate Shocks," Journal of Political Economy, 91 (1983),907-928.

Hall, R. "The Relation between Price and Marginal Cost," Stanford University, Working Paper #E-86-24, 1986.

Hart, O. "A Model of Imperfect Competition with Keynesian Features," Quarterly Journal of Economics, 97 (1982), 109-38.

Heller, W. "Coordination Failure Under Complete Markets with Applications to Effective Demand," University of California at San Diego, mimeo, 1985.

Hosios, A. "Layoffs, Recruitment and Interfirm Mobility," Journal of Labor Economics, forthcoming, 1986.

Howitt, P. "Transactions Costs in the Theory of Unemployment," American Economic Review, 75 (1985), 88-101.

Ito, T. "Implicit Contracts with Costly Search: The Incentive Constraint in Severance Payments," University of Minnesota, mimeo, 1984.

Kahn, C. "Optimal Severance Pay with Incomplete Information," Journal of Political Economy, 93 (1985),435-51.

_____and D. Mookherjee, "A General Equilibrium Contracting Model with Keynesian Features," mimeo, 1986.

Kiyotaki, N. "Implications of Multiple Expectational Equilibria Under Monopolistic Competition," Harvard University, mimeo, 1985.

Long, J. and C. Plosser, "Real Business Cycles," Journal of Political Economy, 91 (1983), 39-69.

Pissarides, C. "Short-run Equilibrium Dynamics of Unemployment, Vacancies, and Real Wages," American Economic Review, 75 (1985), 676-690.

Roberts, J. "General Equilibrium Analysis of Imperfect Competition: An Illustrative Example," Stanford University, mimeo, 1984.

_____. "Involuntary Unemployment and Imperfect Competition:A Game Theoretic Macro Model," Stanford University, mimeo, 1986.

Shleifer, A. and R. Vishny, "The Role of the Stock Market in Coordinating Macroeconomic Activity," mimeo, 1986.

Startz, R. "Monopolistic Competition as a Foundation for Keynesian Macroeconomic Models," University of Washington, mimeo, 1986.

Townsend, R. "Models of Money with Spatially Separated Agents," in Models of Monetary Economies, ed. by J. Kareken and N. Wallace, Federal Reserve Bank of Minneapolis, 1980, 265-304.

Weitzman, M. "Increasing Returns and the Foundations of Unemployment Theory," Economic Journal, 92 (1982), 787-804.

_____. "Some Macroeconomic Implications of Alternative Compensation Schemes," Economic Journal, 93 (1983), 763-83.

_____. "The Simple Macroeconomics of Profit Sharing,"American Economic Review, 75 (1985), 937-53.

Weiss, A. "Job Queues and Layoffs in Labor Markets with Flexible Wages," Journal of Political Economy, 88 (1980), 526-38.

Yellen, J. "Efficiency Wage Models of Unemployment," American Economic Review,Papers and Proceedings, 74 (1984), 200-205.