Tilburg University

Coordination failure in an industrial society

van de Klundert, T.C.M.J.

Published in:
De Economist

Publication date:
1987

[Link to publication in Tilburg University Research Portal](#)

Citation for published version (APA):
van de Klundert, T. C. M. J. (1987). Coordination failure in an industrial society. *De Economist*, 135(4), 467-487.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

COORDINATION FAILURE IN AN INDUSTRIAL SOCIETY

BY

TH. VAN DE KLUNDERT*

1 INTRODUCTION

Broadly speaking there are two different schools of thought in macroeconomics. Keynesian macroeconomics is based on some form of wage rigidity and sometimes also on price rigidity. Consequently, at least some markets clear through quantity adjustment. In the last decade a lot of work has been done to explore the implications of this fundamental assumption. In what is sometimes called disequilibrium theory rationing schemes and spillover effects from one market to another market have been given proper attention in static optimizing models (*e.g.*, Malinvaud, 1977) as well as in dynamic optimizing models (*e.g.*, Van de Klundert and Peters, 1986). The problem with this approach is that the theory is incomplete or at least partial if no justification is presented for wage or price rigidity.

Sticky money wages have been explained by different forms of wage contracts. In the theory of overlapping wage contracts (*e.g.*, Taylor, 1979) nominal wages depend on wage changes that have occurred amongst other groups in the period since the previous wage contract and on expected prices and wages over the interval of the new contract. Once contracts are made they have to be fulfilled. To explain nominal price stickiness on the other hand one has resorted to costs of price adjustment, which may be administrative (*e.g.*, Blanchard and Kiyotaki, 1985) or speed-dependent (*e.g.*, Van de Klundert and Peters, 1987).

The second school in macroeconomics, *i.e.* New Classical macroeconomic theory, assumes that wages and prices are fully flexible. Therefore general market clearing is its central analytical device. However, there may be some friction in the system, because people have incomplete information about all prices. If the general price level increases people may mistakenly think that the price of their output has increased relative to other prices and consequently increase their production. Misperceptions can still have quantity effects after agents discover their mistake, because there may be changes in investment too. This line of thought can of course be associated with the names of Lucas (1973) and Sargent (1979).

* Catholic University of Brabant, Tilburg, The Netherlands. I would like to thank S.K. Kuipers and A. van Schaik for their useful comments on an earlier version of this paper.

In classical and neoclassical equilibrium models with perfect competition market clearing prices cannot be realized without the costless coordination of a Walrasian auctioneer. But this is not the way things work. Actual prices are realized through bargaining or set unilaterally on a take-it-or-leave-it basis. A more realistic approach towards the problem of price setting paves the way for an analysis of coordination problems in trade and production. This is indeed the central topic of this article. Discussing some recent work on this issue, it will be shown that coordination failure may arise in models with externalities connected with imperfect competition. The theory of coordination failure is not intended as a third way in macroeconomics between Keynesianism and New Classical Macroeconomics. On the contrary, its real aim is to provide a sound microfoundation for Keynesian macroeconomics. And according to Hahn (1983) it is even the most promising one from a theoretical point of view.

The article is organized as follows. In section 2 search theory as conceived by Diamond (1982, 1984) is given proper attention. Coordination failure may arise in these models as a result of trade externalities. However, the world according to Diamond gives no proper reflection of modern industry with its large-scale production. The economic consequences of industrialisation are therefore worked out in section 3. Building upon the results of this section coordination failure connected with increasing returns and imperfect competition is analysed in section 4. In this section the seminal work of Weitzman (1982) occupies an important place. Section 5 discusses a study by Drazen (1986) which focusses on the interactions between the labour market and the product market through job matching. This work may be considered supplementary to theories of coordination failure based on demand externalities. The article closes with some conclusions.

2 SEARCH AND COORDINATION

The search process has been modelled in different ways to serve different purposes. Here we shall focus on the approach chosen by Diamond (1982, 1984) because his work has inspired others to consider the problem of coordination failure in more conventional models. Diamond analyses search and trade in markets for commodities. Search problems in the labour market will be given some attention in section 5, discussing recent work by Drazen (1986) which deals also with demand externalities in the market for commodities.

Modelling the trading process is a way to eliminate the Walrasian auctioneer. In a Walrasian setting all trade is at the equilibrium price level. All contracting comes first, trade follows. In Diamond's economy there is a single good which individuals produce but must trade before they can consume. Commodity production is for inventory in the hope of a quick sale. The greater the stocks of inventories of others the greater the chance of finding a trading partner (trading externality) and thus the greater the expected probability of producing for inventory (positive feedback). This combination of a positive

feedback with an externality implies the possibility of multiple equilibria and thus of coordination failures. It should be observed that there are no coordination failures with multiple equilibria if they are all Pareto-optimal, as may be the case in a Walrasian model (*e.g.*, Diamond 1984, p. 6). With externalities as a cause of multiple solutions the equilibria may be Pareto-ranked. The existence of low level activity equilibria of this type points to a coordination failure.

Diamond assumes that individuals face production opportunities which arrive stochastically and which have varying costs. After the decision to produce, based on profit maximization, agents seek trading partners, who also arrive stochastically. Trade is on a one-for-one basis and goods obtained are consumed, thus giving a certain utility. While Diamond uses a dynamic model of inventory accumulation, the essential part of his analysis can be presented in a static model. Following Cooper and John (1985) we assume that individuals face a single production opportunity with costs expressed in terms of utility (disutility of labour) given by a probability distribution. There is also a given probability of finding a trading partner. If no trading partner is found the produced commodity perishes.

The strategic decision to be made by individuals is now to accept or to reject a given production opportunity. For this purpose it is necessary to introduce a cut-off rate of production cost. Only production possibilities with costs smaller than or equal to the cut-off value will be accepted. In this way a continuous strategy variable, *i.e.* the cut-off rate of production cost, is introduced. Agents determine the optimal value of this variable by maximizing the expected utility of production and search.

Some simple algebra may be introduced to illustrate these thoughts. Let π be the expected pay-off in utility terms of engaging in production and trade. Production costs are denoted by $\bar{x}$ and the optimal cut-off value is denoted by x . Therefore agent i produces for $\bar{x}_i \leq x_i$. The number of agents in the economy is equal to m . The assumption that generates the externality is that the probability of finding a trading partner is an increasing function of the number of other individuals searching for a trading partner. Consequently, the chance for agent i of successful trade increases as other agents raise their cut-off rates, which are symbolized by x_{-i} . The probability of finding a partner may then be given by the function $\Omega = \Omega(x_{-i})$. Now let the constant u be the utility derived from consuming a produced good and let $g(\bar{x})$ be the probability density function associated with the distribution of production costs, then the expected pay-off of agent i is

$$\pi_i = \int_0^{x_i} (\Omega u - \bar{x}_i) g(\bar{x}_i) d\bar{x}_i \quad (2.1)$$

Individuals take the strategy variables of other agents as given when choosing their optimal strategy. In addition, we assume that all pay-off functions are

identical. Therefore all solutions of the implied game are symmetric Nash equilibria.

To make things more easily understandable we shall restrict the analysis to a special case discussed by Cooper and John (1985), which gives rise to a continuum of Pareto-ranked equilibria. First, suppose that the costs of production are uniformly distributed over the interval $[0, u]$. Equation (2.1) can then be written as

$$\pi_i = \int_0^{x_i} (\Omega u - \bar{x}_i) \frac{1}{u} d\bar{x}_i = \Omega x_i - \frac{x_i^2}{2u} \quad (2.2)$$

Differentiating π_i with respect to x_i and putting the result equal to zero results in the optimal value for the cut-off rate:

$$x_i^* = \Omega u \quad (2.3)$$

Second, suppose that trading partners meet at random after their decision to search is made and that an agent is able to trade if and only if the other agent also choose to produce. From these assumptions it follows that

$$\Omega = \frac{1}{m-1} \sum_{j \neq i} \frac{x_j}{u} = \frac{x_j}{u} \quad (2.4)$$

Combining equations (2.3) and (2.4) we get

$$x_i^* = \Omega u = x_j \quad (2.5)$$

As appears from equation (2.5) there exists a continuum of symmetric Nash equilibria, which are Pareto-ranked with higher levels of x preferred and $x_i = u$ as a Pareto optimum. Finally, we inspect the second-order derivatives of the pay-off function in equation (2.2). Differentiating this function twice we find

$$\frac{\partial^2 \pi_i}{\partial x_i^2} < 0, \quad \frac{\partial^2 \pi_i}{\partial x_i \partial x_j} > 0 \quad (2.6)$$

The second-order condition with respect to the strategy variable x_i has the right sign for a maximum. The cross derivatives are positive, which is a necessary condition for multiple symmetric Nash equilibrium. The latter property of the pay-off function is termed strategic complementarity by Cooper and John (1985).

What is meant by strategic complementarity can be illustrated by considering a symmetric duopoly game. If the pay-off functions exhibit strategic complementarity, the efforts of one player will be an increasing function of the ef-

forts of the other player. The reaction functions of both players will then be upward sloping, which opens the door for multiple symmetric equilibria. Some examples are shown in Figs. 1a, 1b and 1c. The strategy variables of both players are indicated by respectively x_1 and x_2 . Symmetric Nash equilibria (SNE) should be located on a 45° ray from the origin. In Fig. 1a point A represents a unique SNE, whereas there are multiple SNE in Fig. 1b, indicated by A and B. Fig. 1c shows the case of a continuum of SNE along the line OC. The latter example can be seen as a two-dimensional illustration (for agents i and j) of the solution obtained in the model with a trading externality (*i.e.* equation (2.5)).

Returning to search along the lines of Diamond one may wonder whether his theory is as realistic, relevant and robust as the author claims it to be (*e.g.*, Diamond, 1985). Despite a great deal of ingenuity the trading models, even the more elaborate ones with bargaining and money as a medium of exchange, remain rather abstract. However, this is not the main issue. The Walrasian model, although more familiar, may not be better in this respect. What is really at stake is how markets are functioning. It is the rational expectations equilibrium model, or classical market approach pioneered by Lucas, which is under attack. As Diamond (1984) sees it, search theory is not an alternative for Keynesian theory. On the contrary, in his view the search approach provides what simple fixed-price Keynesianism is missing: a sound microeconomic foundation. Long-run relationships, with their informational asymmetries and bargaining aspects can then be taken into account. Thus search theory can be complementary to the implicit contract theory or long-term contract theory mentioned in section 1.

Passing judgement on the search-theoretical approach by Diamond, two points should be born in mind. First, from a theoretical point of view there is great need for theories which do away with the Walrasian auctioneer or his likewise unrealistic counterparts. Second, the idea of coordination failures is intuitively appealing with respect to an explanation of business cycles or persistent equilibria with involuntary unemployment. However, it remains to be seen whether price setting and trade occur predominantly in the way envisaged by

Figure 1a

Figure 1b

Figure 1c

Diamond. In industrial societies imperfect competition seems to be the rule rather than the exception. Under these circumstances prices are set by firms facing demand curves for their products. As we shall see, externalities leading to coordination failure may emerge in models of monopolistic competition too. In our opinion, the latter type of models may be more relevant for understanding factors that lie behind business cycles and long waves than Diamond's rather abstract analysis of trading processes.

3 THE ORGANIZATION OF INDUSTRY

In Diamond (1982) production of commodities is somewhat archaic. Applying the tropical island metaphor the author introduces individuals who are strolling along the beaches when employed. They are looking for coconuts to pick from the trees. After harvesting workers go searching for trade – nuts for nuts – which will lead to consumption.

In an industrial society production processes are more sophisticated and the laws of returns must be given proper attention. As observed by Sraffa (1926) long ago, everyday experience shows that a very large number of firms work under conditions of increasing returns or diminishing average costs on the Marshallian long run. Increasing returns which are internal to the firm may be related to indivisibilities of durable producers' goods, as in Brems (1968). Large firms suffer less from the lack of harmony between production and physical capacity of durable producers' goods than do small firms. In this sense what is called the Law of Harmony is an important economy of scale. In addition, the Law of Technique expresses another and clearly distinct economy of scale. According to the latter law some techniques are specific for larger plants, whereas other techniques may be well-suited for smaller plants. Examples are given in Brems (1968, Ch. 10). Increasing returns may also be related to organisational aspects of modern industry. Organizing production overhead costs, which are spread by increasing output, are of conclusive importance.

As shown by Sraffa (1926), and is nowadays common knowledge, increasing returns and perfect competition are not to be reconciled. Or, as Weitzman (1982) puts it even more aptly, increasing returns are the natural enemy of perfect competition and thus the primary cause of imperfect competition. There is a second obstacle to perfect competition, which is of fundamental importance. It is the absence of indifference on the part of the buyers of commodities regarding the different firms, which can be explained in a number of ways. To quote Sraffa (1926, p. 544):

'The causes of the preference shown by any group of buyers for a particular firm are of the most diverse nature, and may range from long custom, personal acquaintance, confidence in the quality of the product, proximity, knowledge of particular requirements and the possibility of obtaining credit, to the reputation of a trade-mark, or sign, or

a means with high traditions, or to such special features of modelling or design in the product as – without constituting it a distinct commodity intended for the satisfaction of particular needs – have for their principal purpose that of distinguishing it from the products of other firms.’

Monopolistic competition and increasing returns imply a well-defined market equilibrium with interesting features. For our purpose it is worthwhile to consider the details of that equilibrium. Preferences as enumerated by Sraffa can be modelled in several ways. Here we proceed by postulating a CES utility function for different varieties of a certain commodity (*e.g.*, Blanchard and Kiyotaki, 1985; Van de Klundert and Peters, 1987).¹ The choice problem all consumers are facing can then be formulated as:

$$\text{Max. } \{c_{ij}\}^u = \left[\sum_{j=1}^m \gamma_j c_{ij}^{(n-1)/n} \right]^{n/(n-1)}, \quad \sum_{j=1}^m \gamma_j = 1 \quad (3.1)$$

$$\text{s.t. } \sum_{j=1}^m c_{ij} p_{ij} = c_i p_i, \quad (3.2)$$

where

u : utility index

c_{ij} : consumption of variety j of good i

c_i : consumption of composite good i

p_{ij} : price of variety j of good i

p_i : price index of composite good i

m : number of firms (varieties)

η : elasticity of substitution between each pair of varieties ($\eta > 1$)

Consumers choose a bundle of varieties of the composite good i , with preferences given according to equation (3.1) and given the prices of these varieties, the number of firms (varieties) as well as total expenditure for the composite good i ($c_i p_i$). The latter can be found by modelling the consumer's problem as a whole, *i.e.* the choice between composite commodities satisfying different wants on the one hand and the choice between varieties of each or most of the composites on the other. This problem can be handled conveniently by postulating a nested CES utility function to characterise the whole set of preferences. However, for our purpose, there is no need to go into such detail. We assume that the optimal choice between composite commodities has already been made. In what follows we therefore skip the index i .

1 An alternative specification of consumer's preferences which can easily be applied to monopolistic competition is the circular road model (*e.g.*, Varian, 1984; Weitzman, 1982). It can be shown that in this model the elasticity of demand evaluated in a symmetric Nash equilibrium is negatively related to the price of the commodity and is positively related to the number of firms.

The problem formulated in equations (3.1) and (3.2) yields the following solution:

$$c_j = \gamma_j c \left[\frac{p_j}{p} \right]^{-\eta}, \quad \text{with} \quad (3.3)$$

$$p = \left[\sum \gamma_j p_j^{\eta-1} \right]^{1/1-\eta} \quad (3.4)$$

Equation (3.3) is the demand curve firm j is facing, which can be rewritten as:

$$p_j = p \left[\frac{c_j}{\gamma_j c} \right]^{-1/\eta} \quad (3.5)$$

Total revenue can be found by multiplying both sides of (3.5) by c_j :

$$c_j p_j = p (\gamma_j c)^{1/\eta} c_j^{(\eta-1)/\eta} \quad (3.6)$$

Let the cost function of the firm be of the generalized Cobb-Douglas type (*e.g.*, Varian, 1984, p. 28)

$$f_j = (\alpha + \beta) \left[\frac{1}{\varepsilon} \left(\frac{w_1}{\alpha} \right)^\alpha \left(\frac{w_2}{\beta} \right)^\beta \right]^{1/(\alpha + \beta)} c_j^{1/(\alpha + \beta)}, \quad (3.7)$$

where w_1 and w_2 denote the given prices of two variable inputs 1 and 2, and where α and β denote the corresponding factor elasticities of the generalized Cobb-Douglas production function, and ε stands for the general efficiency parameter. Increasing returns to scale require $\alpha + \beta > 1$. Combining equations (3.6) and (3.7) we get the profit function or pay-off function

$$\pi_j = p (\gamma_j c)^{1/\eta} c_j^{(\eta-1)/\eta} - (\alpha + \beta) \left[\frac{1}{\varepsilon} \left(\frac{w_1}{\alpha} \right)^\alpha \left(\frac{w_2}{\beta} \right)^\beta \right]^{1/(\alpha + \beta)} c_j^{1/(\alpha + \beta)} \quad (3.8)$$

Maximization of π_j with respect to c_j , ignoring the effect of actions taken on the general price level, gives as the optimal volume of output

$$c_j = \left[\left(\frac{\eta-1}{\eta} p \right)^{\alpha + \beta} (\gamma_j c)^{(\alpha + \beta)/\eta} \varepsilon \left(\frac{\alpha}{w_1} \right)^\alpha \left(\frac{\beta}{w_2} \right)^\beta \right]^{\eta/(\eta + (\alpha + \beta)(1 - \eta))} \quad (3.9)$$

The second-order condition for a maximum of π_j requires $1 + (\alpha + \beta) \frac{1-\eta}{\eta} > 0$, as can be easily checked. Consequently, with $\eta > 1$ there will be more room for increasing returns the less pure competition is, *i.e.* the further $\frac{1-\eta}{\eta}$ will be from one. For $\eta \rightarrow \infty$ the second-order condition will only be satisfied if

$\alpha + \beta < 1$. Profit maximization under perfect competition requires decreasing returns, as is well known at least since Marshall. The optimal price to be set by the firm can be found by inserting equation (3.9) into equation (3.5). Alternatively, one should write

$$p_j = \frac{\eta}{\eta - 1} \frac{\partial f_j}{\partial c_j} \quad (3.10)$$

Prices are determined by a mark-up over marginal cost, which depends on the degree of imperfectness of the market.

If profits, defined in equation (3.8), are positive new entrants may appear on the market and if profits are negative existing firms may close down. Ultimately, there may result a Chamberlin solution with no firms making positive profits. Entry and exist are long-run phenomena. The short run could be typified as a situation in which the number of firms is fixed. However, production functions with substitutability between factors are usually applied to a short run in which one of the factors is fixed. Therefore, in order to avoid confusion we introduce a different, and perhaps not less realistic, cost function instead of equation (3.7). Following among others Weitzman (1982), Cooper and John (1985) we assume that operating costs are constant and that overhead costs consist of a fixed amount. The underlying production function is given by

$$c_j = \frac{1}{\alpha_j} l_j - \beta_j, \quad c_j \geq 0, \quad (3.11)$$

where l_j stands for the volume of different inputs used in fixed proportions. Denoting by w the given remuneration of this composite factor of production, the profit function now reads

$$\pi_j = p(\gamma_j c)^{1/\eta} c_j^{(\eta-1)/\eta} - (\alpha_j c_j + \alpha_j \beta_j) w \quad (3.12)$$

Maximization of equation (3.12) under conditions of monopolistic competition yields

$$p_j = \frac{\eta}{\eta - 1} \alpha_j w \quad (3.13)$$

$$c_j = \left(\frac{\eta - 1}{\eta} \frac{p}{\alpha_j w} \right)^{\eta}_{v_j c} \quad (3.14)$$

The optimal price set by firms is proportional to fixed operating costs. Both the optimal price level and the optimal volume of output are independent of overhead costs (βw). This highlights the fact that monopolistic competition has a well-defined short-run solution under constant returns to scale. But, as observed above, this is not a world we consider to be realistic.

For a subsequent analysis of market equilibrium it is convenient to assume complete symmetry between all firms concerned ($\gamma_i = \gamma_j = \gamma$, $\alpha_i = \alpha_j = \alpha$, $\beta_i = \beta_j = \beta$ for every $i \neq j$). The price set by each firm is then the same and equals the general price level according to equation (3.4). The optimal value of output is in this case

$$c_j = \gamma c \quad (3.15)$$

Taking account of free entry and exit the long-run market equilibrium condition

$$\pi_j = \left(\frac{c_j}{\eta - 1} - \beta \right) \alpha w = 0 \quad (3.16)$$

provides the optimum value of output in the zero profit situation:

$$c_j = (\eta - 1) \beta \quad (3.17)$$

Combination of equations (3.15) and (3.17) results in the number of firms supporting the long-run equilibrium.

$$m = \frac{c}{(\eta - 1) \beta} \quad (3.18)$$

The long-run or Chamberlin solution for the individual firm is illustrated in Fig. 2. The optimal price and output quantities are indicated by a star. In the optimum situation the average cost curve (AC) is tangent to the demand curve or average revenue curve (AR). At this level of output marginal cost (MC) equals marginal revenue (MR). Consequently, profits are zero in the long-run optimum. The issue of entry remains a tricky one and we shall discuss it in more detail in the next section.

4 DEMAND EXTERNALITIES AND COORDINATION

The model presented in section 3 can be applied on an economy-wide scale if one assumes that there are no clearly defined sectors of production, but just differentiated products all over the place. Then the model must be closed somehow to get a general equilibrium solution. The question therefore is: how can c , which is exogenous in a partial equilibrium analysis, be determined endogenously? As in general equilibrium models only relative prices are explained, the nominal wage rate can be fixed. The model does not determine nominal prices. To do so would require introduction of money as a store of value as well as a unit of account.

Figure 2

A Walrasian closure of the model is obtained by assuming that all income, *i.e.* income accruing to factors of production including profits, is spent:

$$cp = \sum_{j=1}^m l_j w + \sum_{j=1}^m \pi_j \quad (4.1)$$

Substitution of equations (3.13) and (3.16) in equation (4.1) and taking advantage of symmetry gives

$$c = \frac{l}{\alpha} - m\beta, \quad (4.2)$$

where $l = ml_i$ is the total amount of labour employed. As appears from equations (4.2) there is a continuum of symmetric Nash equilibria within the boundaries defined by the inequalities: $\eta \alpha \beta \leq l \leq l^*$. The first weak inequality follows from the condition that profits should be non-negative, while the second weak inequality states that labour demand cannot exceed a given labour supply (l^*). It should be observed that the demand for labour does not depend on the real wage rate, which follows from equation (3.13). It is assumed that the real wage rate exceeds the marginal disutility of work, which may be constant as in Cooper and John (1985). Under these conditions the labour market does not

clear. Things are different in the model of Heller (1986). Real wages are flexible and the conditions of demand and supply on the labour market allow for market clearing. There is no involuntary unemployment, but coordination failure translates into more underemployment. A similar result is reported by Hart (1982) with regard to an extension of his basic model.

To make sense a particular unemployment equilibrium, which could come into force by accident, must be sustainable. However, a necessary condition for sustainability may be the zero profit condition, because otherwise new firms may enter and the circular flow will have its way in an upward direction. This is the view strongly supported by Weitzman (1982). If $\pi_j = 0$ for all j the equality between income and expenditure boils down to

$$cp = lw \quad (4.3)$$

Substitution of equation (3.13) in equation (4.3) results in

$$c = \frac{\eta - 1}{\eta} \frac{l}{\alpha} \quad (4.4)$$

Again, we have a continuum of symmetric Nash equilibria with labour supply generating an upper limit. There is no exact lower limit in this case, but m should of course be large enough to warrant a Nash solution.

After completing our algebra it may be desirable to give a verbal account of the Weitzman story. In the short run the number of firms is fixed. Each firm makes a profit or a loss depending upon the variable and fixed costs it incurs and the extent of the market. Aggregate demand is also exogenously fixed. Profit maximization of firms then determines output, prices and employment. The long-run situation allows for entry and exit of firms. If incumbent firms make a profit, new firms will be attracted. In a partial equilibrium analysis with total demand given, competition by newcomers will drive profits down to zero. There is no reason for this to happen in our general equilibrium model, because entrants create their own demand. This is just a nice example of Say's law. To obtain the results we look for, *i.e.* zero profits through competition of newcomers, we need an additional assumption, which is implicit in the circular road model of monopolistic competition adopted by Weitzman. In the latter model the attribute space is represented by a circle with a given circumference. Therefore, if the number of firms increases, the distance in attribute space between the products of any two firms decreases and competition is intensified. To get a similar result in our model it must be assumed that the elasticity of substitution (η) is a positive function of the number of firms (m).² Under this assumption profits may go to zero when new entrants appear on the market, as ap-

² This assumption corresponds to a property of the circular road model referred to in the previous note.

pears from equation (3.16). However, we should take notice of a warning expressed by Weitzman (1982, p. 797):

‘The story can only be defined as an approximation. Entry and exit are complicated phenomena, involving difficult game theoretic issues that defy neat analytic formulation.’

Which long-run equilibrium the economy attains depends on dynamic specifications of the adjustment process, the shocks the system is exposed to and the initial conditions. Hysteresis effects are an essential element in stories that can be told.

According to Weitzman a long-run unemployment equilibrium could not exist under constant returns to scale. The unemployed could then easily establish firms of their own and Say’s law would operate to generate a full employment equilibrium. But increasing returns prevent supply from creating its own demand because the unemployed cannot go into business without spoiling the market through a discrete jump in supply.

This argument has been challenged vigorously by De Meza and Perlman (1985). Newcomers will create their own demand and with rational expectations, as Weitzman claims to be relevant, nothing will prevent them from entering the market. There must be other reasons for non-entry in Weitzman’s model. As such De Meza and Perlman offer two alternatives. The first is that positive profits are necessary to induce entry. The second is that entry will not occur if potential entrants *expect* profits to be negative. The case of positive profits as a requirement for entry does not discriminate between Weitzman’s model and a standard perfectly competitive model with U-shaped cost curves on the firm level and constant returns to scale on the industry level. With perfect competition there can be a long-run equilibrium with unemployment and zero profits if prices correspond to minimum average costs. If by assumption positive profits are required to induce entry there is nothing to change such a situation.

The second alternative of De Meza and Perlman considers entry to take place when profits are positive or zero, but assumes that entry will not take place if expected profits are negative. As observed above, Say’s law operates in the model, but newcomers may have mistaken expectations that total demand is fixed and therefore that entry will spoil the market. Either under monopolistic competition or perfect competition with U-shaped cost curves, new entrants expect that the demand curve facing them will be lower than the demand curve of incumbent firms. Thus the potential entrants expect negative profits if existing firms have very low or zero profits.

The discussion of motives for entry obscures the real issue, which is that monopolistic competition involves a demand externality. Profit maximization is based on price and quantity signals. The quantities that can be sold depend on the output of other firms in the economy. There is the possibility of coordi-

nation failure just as in the Diamond model with trading externalities. The laws of returns have nothing to do with this directly. Also with constant returns to scale demand externalities can lead to coordination failure. This point has been stressed by Cooper and John (1985) and Heller (1986), who assume a two-sector economy to illustrate more clearly what it is all about. Wages and profits generated in one sector are spent entirely on commodities of the other sector. The number of firms in each industry is fixed and equal to m . Firms behave as Nash-Cournot competitors within each sector.³

The main result obtained by Cooper and John can be presented in terms of the symbols introduced above. Making use of the production function given in equation (3.11), profits of firm j in sector i are by definition:

$$\pi_{ij} = p_i c_{ij} - (\alpha c_{ij} + \beta) w = c_{ij}(p_i - \alpha w) - \alpha \beta w \quad (4.5)$$

The demand curve facing sector i is given by

$$c_i = \frac{p_{-i} c_{-i}}{p_i} \quad (4.6)$$

Equation (4.6) shows that total expenditure on commodities of sector i equals total income in the other sector (symbolized as $-i$) and *vice versa*. The inverse of equation (4.6) can be written as

$$p_i = \frac{p_{-i} c_{-i}}{x_{ij} + c_{i,-j}}, \quad (4.7)$$

where $c_{i,-j}$ is the output of other firms (non- j) in sector i , which in a Nash-Cournot game is taken as given, along with price and output in the other sector. Maximization of equation (4.5) subject to condition (4.6), assuming complete symmetry, results in:

$$p_i = \frac{m}{m-1} \alpha w \quad (4.8)$$

$$c_{ij} = \frac{m-1}{m^2} \frac{1}{\alpha w} p_{-i} c_{-i} \quad (4.9)$$

As there is symmetry across sectors we also have

$$p_i = p_{-i} = \frac{m}{m-1} \alpha w \quad (4.10)$$

$$c_{ij} = \frac{c_{-i}}{m} = c_{-i,j} \quad (4.11)$$

3 In the models of Cooper and John (1985) and Heller (1986) firms are conceived as Cournot oligopolists in the sense that they take the quantities produced by other firms as given when making their own decisions with regard to output and prices.

Output in one sector is determined by output in the other sector. The model exhibits strategic complementarity. Again, there exists a continuum of equilibria within the boundaries set by the condition of non-negative profits and by the condition that labour demand cannot exceed labour supply. The assumption of decreasing cost is immaterial to these results. The same conclusions hold with $\beta = 0$. Heller's model is more sophisticated, but leads basically to the same perceptions. The main difference is that Heller obtains multiple, discrete, Pareto-ranked equilibria instead of a continuum of equilibria as in the other models discussed here.

When $\beta > 0$ one may endogenize the number of firms assuming free entry (exit). But there is no reason to suppose that entry may go on if profits are zero in the Cooper-John model. Newcomers have to share a given sector demand with incumbents unless there is a simultaneous increase in the number of firms in the other sector. Coordination failure applies to broad sectors of the economy which are interrelated through output and demand. When firms in all or many sectors enjoy substantial profits the situation may be ripe for a concerted expansion of all sectors. To develop these ideas a natural starting point would be the classical article by Allyn Young (1928) on the relation between increasing returns and economic progress. However, this task lies beyond the scope of the present article. What remains to be done here is to show how a modern view of the labour market fits in a static or stationary framework of coordination failure.

5 INTERACTIONS BETWEEN THE LABOUR MARKET AND THE PRODUCT MARKET

Search theory applied to the labour market has gone through a number of interesting developments. Whereas in the older approaches only workers search for a job, in more recent studies (*e.g.*, Mortensen, 1982; Pissarises, 1986, 1988) job matching is the central issue. Firms with a vacancy look for workers who are unemployed and want a job and the other way around unemployed workers search for firms with a vacancy. In these matching models there may be externalities, because the chosen intensity of search for trading partners by one side of the market affects the optimal intensity of search on the other side of the market. As a result unemployment may be inefficiently high. These observation may sound familiar after what has been said on the work of Diamond in section 2.

Recently Drazen (1986) has combined the externality mentioned above (type 1) with a specific demand externality (type 2). This second externality is the spillover from demand for commodities to search intensity by firms in the labour market. Therefore, product market conditions affect the labour market. On the other hand labour market conditions affect sales and product market equilibrium. In Drazen's model type 2 externality is not very far-reaching. Assuming monopolistic competition in the market for commodities, along the lines sketched in section 3, labour demand will be a function of output sold.

Demand for commodities will be lower the higher is unemployment. Thus, on the assumption that there are no leakages in the system it is straightforward to construct a continuum of equilibria. It may nevertheless be instructive to examine Drazen's models more closely to show how job matching fits in.

There is an equal and fixed number of firms and workers. A firm consists of a single job, which may be filled or vacant. Technology is kept simple: one unit of output is produced by one worker. Firms supply differentiated products but are similar in other respects. Ultimately, the real wage level is set equal to the minimum level required for participation of all workers. Wage determination follows from a bilateral monopoly problem, since workers and firms have to bargain on the conditions of the contract. In the model real wages are set at the minimum level to emphasize that unemployment will not result from wages being too high, as may be the case in fixed price models.

Let Ω be the instantaneous rate of contact between unemployed workers and vacant firms. It will also be the rate at which searching workers find employment. The rate of contact depends on the intensity of search by both sides of the market. Denoting the intensity of search by workers by x_l and the recruiting intensity of firms by x_f we may write

$$\Omega = \Omega(x_l, x_f) \quad (5.1)$$

By assumption, equation (5.1) exhibits positive but decreasing marginal returns in both x_l and x_f . It is further assumed that Ω is zero if one party does not search and also that Ω has a finite upper bound if x_l and x_f become infinitely large. The termination rate of jobs (δ) is exogenous. In a stationary state the flow into unemployment must equal the flow out of unemployment, which results in an equilibrium unemployment rate

$$u = \frac{\delta}{\delta + \Omega(x_l, x_f(S))} \quad (5.2)$$

For the time being the intensity of search by workers is assumed constant. It can be shown that the optimal recruiting effort by firms depends on sales per firm (S). Labour market equilibrium, as expressed by equation (5.2), thus relates to the level of sales.

Product market equilibrium follows from profit maximization by firms under conditions of monopolistic competition and the equality between sales and demand. Profit maximization determines the optimal value of revenue or sales (S) *via* fixed mark-up pricing in line with the analysis in the previous section.⁴ The number of firms producing will be $(1-u)m$, where m is the total number of firms (and workers). Total sales will then be equal to $S(1-u)m$. De-

4 Prices are normalized to one in equilibrium. Since firms produce one unit of output employing one unit of labour, the maximum value of sales per firm is equal to one.

noting average consumption of workers by c total demand is cm . In equilibrium these two quantities must be equal, yielding

$$S = \frac{c}{1 - u} \quad (5.3)$$

Average consumption must be related to income. Stationary income depends on the state of the firm (filled or vacant) and of the worker (employed or searching for a job). Careful consideration of each possibility leads to four income streams which can be added to give total income (y). Here we take a short-cut by presenting the final result

$$y = (1 - u)S - uh - ug, \quad (5.4)$$

where h is the amount of search expenditures incurred by workers and g in the flow of expenditures on recruiting by firms. In both cases search costs are a convex function of the relevant intensity of search to guarantee optimal solutions.

Drazen considers two cases with respect to consumption out of income. The first case is where search expenditures h and g are part of the demand for goods and where all income (wages and profits) is consumed:

$$c = y + uh + ug \quad (5.5)$$

Combining equations (5.4) and (5.5) results in

$$c = (1 - u)S \quad (5.6)$$

From equations (5.3) and (5.6) it now follows that any technologically feasible level of sales will reproduce itself *via* Say's law. However, there is a lower bound on S as revenue must be sufficient to allow a value of wages necessary to induce labour force participation. The lower bound ($\underline{S}$) on S will therefore depend on the (marginal) utility of leisure, which is assumed constant. There is a continuum of equilibria all of which must satisfy equation (5.2). This continuum of steady states is shown in Fig. 3.

If $S = 1$ unemployment is at its minimum level, which depends on the technology of search (pure search unemployment). For lower values of S the unemployment rate will be higher, reflecting both aggregate demand factors and search activities.

The second case considered by Drazen with respect to consumption out of income is more complicated, because now 'leakages' from the system are allowed for. It can then be shown that multiple equilibria may arise.

Returning to equation (5.1) it can be argued that type 1 externalities are a source of multiple equilibria independent of the type 2 externalities discussed

Figure 3

above. If both workers and firms search optimally the search intensity of workers will depend on the search intensity of firms and *vice versa*. The optimal recruiting intensity is also a function of sales, as we have seen. Therefore, we may write

$$x_f(S) = x_f(x_f(x_f), S) \quad (5.7)$$

The value of x_f for given S resulting from equation (5.7) need not be unique. Consequently, there may be a multiplicity of unemployment rates for a given state of aggregate demand. Again, this is an example of the possibility of coordination failure.

6 CONCLUSIONS

What is new about modern theories of coordination failure? The principle of effective demand has belonged to the core of economic theory since Keynes wrote *The General Theory*. Moreover, Kalecki (1935) already introduced imperfect competition to the microfoundations of macroeconomics in the early 1930's. What is really new in the theories discussed in this article is the proof

that coordination failure may arise in models with *complete markets* and *flexible, market-clearing prices*. The main channel through which this is effectuated is the introduction of demand externalities by assuming that monopolistic competition is the rule rather than the exception. Problems of trade coordination and reciprocal search on the labour market give additional support to the view of coordination failure, but are in our opinion supplementary. According to Kaldor (1983) it is the twin assumptions of perfect competition and constant returns to scale which lead to a Walrasian situation, in which resources are fully utilized and the production of each commodity is at its maximum. 'But in the absence of these twin assumptions the mere existence of competition between sellers ('firms') will not in itself ensure the full utilization of resources unless all firms *expand in concert*' (*ibid.*, p. 9).

Despite its intellectual appeal the theory of coordination failure is incomplete in a number of respects. Substitution between capital and labour is ignored, the role of expectations remains somewhat in the background and there is no proper analysis of dynamic processes. These critical notes need further consideration.

Coordination failure leads to lower levels of output than would be possible. In most models this translates into unemployment, because there are fixed input coefficients combined with exogenous labour supply (under the condition that the real wage rate does not fall short of the marginal disutility of labour). The model by Heller (1986) is an exception in the sense that labour supply depends on the real wage rate. In this case coordination failure translates into underemployment instead of unemployment. None of the models discussed assumes that labour demand is a negative function of the real wage rate. One could of course argue that there are very limited substitution possibilities in the industrial sector of the economy. Another escape is the presumption that firms maximize with long-run considerations in mind. But these excuses are not very satisfactory. A more sophisticated theory of coordination failure should allow for some substitution between capital and labour and should at the same time contain a proper view on the process of wage setting (*e.g.*, Cooper, 1986).

Expectations do matter but are hard to track down. With arbitrary assumptions almost anything can happen. Rational expectations on the other hand, when taken literally, lead without failure to a Walrasian equilibrium. The theory of coordination failure holds a position between these two extremes. Decision-makers in this theory have only partial equilibrium knowledge instead of complete information on the workings of the economy. This may not be unrealistic, for as Heller (1986, p. 159) observes: 'It is quite likely that purely partial equilibrium knowledge is common when there are many markets intertwined, with long and complicated chains of interaction.'

Finally, there is the question of dynamics. Nice and inspiring stories can be told about shocks that propel the economic systems towards an equilibrium state with higher or lower employment levels. Hysteresis effects may be brought in to suggest that there are fundamental forces in operation. But the real work

has still to be done.⁵ The theory of coordination failure is in need of dynamic extensions. Moreover, the question arises whether, under unchanged circumstances, the Folk Theorem on repeated games can be applied to the models discussed in this paper. As observed by Friedman (1986, p. 103) outcomes usually associated with cooperation can be supported by noncooperative equilibrium strategies if conditions required for the Folk Theorem to be valid are met.

REFERENCES

- Blanchard, O.J. and N. Kiyotaki (1985), 'Monopolistic Competition, Aggregate Demand Externalities and Real Effects of Nominal Money,' NBER, Working Paper, No. 1770.
- Brems, H. (1968), *Quantitative Economic Theory. A Synthetic Approach*, New York.
- Cooper, R. and A. John (1985), 'Coordinating Coordination Failure in Keynesian Models,' Cowles Foundation Discussion Paper, No. 745 R, New Haven.
- Cooper, R. (1986), 'Optimal Labor Contracts, Imperfect Competition, and Underemployment Equilibria: A Framework for Analysis,' NBER, Working Paper No. 2060.
- Diamond, P.A. (1982), 'Aggregate Demand Management in Search Equilibrium,' *Journal of Political Economy*, 90, pp. 881–894.
- Diamond, P.A. (1984), *A Search-Equilibrium Approach to the Micro Foundations of Macroeconomics*, The Wicksell Lectures, 1982, Cambridge, Mass.
- Diamond, P.A. (1985), 'Equilibrium Without an Auctioneer,' Paper presented at the 5th World Congress of the Econometric Society.
- Drazen, A. (1986), 'Involuntary Unemployment and Aggregate Demand Spillovers in an Optimal Search Model,' The Foerder Institute for Economic Research, Working Paper No. 32–86*, Tel Aviv.
- Friedman, J.W. (1986), *Game Theory with Applications to Economics*, Oxford.
- Hahn, F.H. (1983), Comment, in: D. Worswick and J. Trevithick (eds.), *Keynes and the Modern World*, Cambridge.
- Hart, O. (1982), 'A Model of Imperfect Competition with Keynesian Features,' *Quarterly Journal of Economics*, 97, pp. 109–138.
- Heller, W.P. (1986), 'Coordination Failure under Complete Markets with Applications to Effective Demand,' in: W.P. Heller, R.M. Starr and D.A. Starrett (eds.), *Essays in Honour of Kenneth J. Arrow*, Vol. II, *Equilibrium Analysis*, Cambridge.
- Kaldor, N. (1983), 'Keynesian Economics after Fifty Years,' in: D. Worswick and J. Trevithick (eds.), *Keynes and the Modern World*, Cambridge.
- Kalecki, M. (1935), 'A Macrodynamic Theory of Business Cycles,' *Econometrica*, 3.
- Klundert, Th. van de, and P. Peters (1986), 'Tax Incidence in a Model with Perfect Foresight of Agents and Rationing in Markets,' *Journal of Public Economics*, 30, pp. 37–59.
- Klundert, Th. van de, and P. Peters (1987), 'Price Inertia in a Macroeconomic Model of Monopolistic Competition,' *Economica* (forthcoming).
- Lucas, Jr., R.E. (1973), 'Some International Evidence on Output-Inflation Tradeoffs,' *American Economic Review*, 63, pp. 326–334.

5 A number of interesting suggestions for a dynamic extension of the theory can be found in Moss (1984).

- Malinvaud, E. (1977), *The Theory of Unemployment Reconsidered*, Oxford.
- Meza, D. de, and M. Perlman (1985), 'Increasing Returns and the Foundation of Unemployment Theory,' *Journal of Post Keynesian Economics*, 7, pp. 385–394.
- Mortensen, D.T. (1982), 'The Matching Process as a Noncooperative Bargaining Game,' in: J.J. McCall (ed.), *The Economics of Information and Uncertainty*, Chicago.
- Moss, S. (1984), *Markets and Macroeconomics*, Oxford.
- Pissarides, C.A. (1986), 'Unemployment and Vacancies in Britain,' *Economic Policy*, pp. 500–541.
- Pissarides, C.A. (1988), *Equilibrium Unemployment Theory*, Oxford (forthcoming).
- Sargent, Th.J. (1979), *Macroeconomic Theory*, New York.
- Sraffa, P. (1926), 'The Laws of Returns Under Competitive Conditions,' *Economic Journal*, 36, pp. 535–550.
- Taylor, J.B. (1979), 'Staggered Wage Setting in a Macro Model,' *American Economic Review, Papers and Proceedings*, pp. 108–113.
- Varian, H. (1984), *Microeconomic Analysis*, (2nd ed.), New York.
- Weitzman, M.L. (1982), 'Increasing Returns and the Foundations of Unemployment Theory,' *Economic Journal*, 92, pp. 787–804.
- Young, A. (1928), 'Increasing Returns and Economic Progress,' *Economic Journal*, 38, pp. 527–542.

Summary

COORDINATION FAILURE IN AN INDUSTRIAL SOCIETY

Different macroeconomic theories of coordination failure are dealt with. Using simple models it is shown that externalities may lead to multiple Pareto-ranked equilibria or, under suitable assumptions, to a continuum of equilibria. It is argued that in industrial societies imperfect competition is predominant. Therefore, demand externalities may be the main cause of low level equilibria. Trading externalities and searching externalities may play a supplementary role. The theory of coordination failure is based on complete markets and price flexibility. Despite its strong appeal, it has certain shortcomings which are also discussed in the paper.