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# MACROECONOMIC PRICE AND QUANTITY RESPONSES WITH HETEROGENEOUS PRODUCT MARKETS

*By* HUW DAVID DIXON

*Department of Economics, University of York, Heslington, York YO1 5DD*

## 1. Introduction

THIS paper examines some of the implications of imperfect competition in product markets for the macroeconomic properties of the economy. Most, if not all, economies are composed of a variety of product (and labour) markets that function in different ways. At the partial equilibrium level, the different sectors of the economy may respond in different ways to changes, such as an increase in demand. However, the overall response of the macroeconomy to (say) an increase in the money supply will depend very much on the general-equilibrium interactions between these different sectors. Most papers on imperfect competition and macroeconomics have tended to make assumptions about household preferences which greatly limit the possible interactions across sectors (e.g. by assuming constant budget shares or elasticities of demand). Furthermore, it is also common to adopt a representative sector methodology in which relative output prices cannot vary. I will argue that the macroeconomic externalities across different types of markets can be particularly signficant when those markets are heterogeneous. As such, this paper extends the approach of Blanchard and Kiyotaki (1987) and Cooper and John (1988) which tackle the issue of macroeconomic externalities in a 'representative sector' framework.

The paper presents a simple stylized model which focuses on a key macroeconomic issue: how an increase in nominal aggregate demand is divided between price and quantity changes. There are two general lessons to be drawn from this exercise. First, that the macroeconomic response of the economy to an increase in the money supply depends on the precise composition of the economy: in our model, we provide scenarios that range from a Keynesian Pareto-improving pure output response (Propositions 1, 2), to a classical pure price response (Proposition 3). Secondly, we argue that the presence of nominal rigidities in some sectors can spill over to the rest of the economy, leading to prices becoming more rigid in other sectors. This would indicate that the new Keynesian menu-cost theory of economic fluctuations (see Akerlof and Yellen 1985; Mankiw 1985; Rotemberg, 1982; *inter alia*) does not require menu-costs in all industries; it may be enough to have menu-costs in only some (possibly small) proportion of sectors to generate significant price rigidity.

We explore an economy with a perfectly competitive labour market, where the nature of competition in product markets differs. There are three types of market: oligopolistic sectors with Cournot-Nash firms choosing output to maximize profit; competitive sectors with price-taking firms; and 'rigid' sectors with fixed-prices which we interpret as a monopolistic sector where firms face menu-costs. Whilst the model we consider is based on specific assumptions, they are common in the imperfect competition and macroeconomics literature, and are by no means pathological. Households have a homothetic sub-utility function $u$ defined over consumption of the produced goods in the economy, and Cobb-Douglas preferences over $u$ and the non-produced good, 'money'. Firms have increasing returns to scale technology in the oligopolistic sector and diminishing returns in the competitive.

The outline of the paper is as follows. In Section 2 we present the basic structure of the model, and characterize the equilibrium. In Sections 3 and 4 we consider the effect of an increase in nominal demand (caused by an increase in the money supply) on output, employment and prices. Section 3 considers the economy with a perfectly elastic labour supply. There are two 'benchmark' models which are special cases, one yielding a Keynesian pure-output response, the other a Classical pure-price response. These cases are also particularly simple to analyze, since in both cases relative prices across sectors remain unchanged. Section 4 considers the model with a bounded labour supply elasticity. In both cases, we find that a whole range of behaviour is possible, from classical to Keynesian, depending on such factors as the relative/absolute size of different types of sector, the aggregate labour supply elasticity, and the nature of preferences.[1]

## 2. The model

The economy consists of $s$ sectors, where $s$ is best thought of as a large number. There is a continuum of identical households of measure $H$: each household $h$ has one unit of labour which it can supply with fixed disutility $\theta_h$, and initial money balances $M^0/H$. Households either supply one unit of labour (the employed), or none (the unemployed). There are $s$ produced consumer goods $\mathbf{X}$, and (non-produced) money $M$. Households have a Cobb-Douglas utility function over total consumption and real money balances,[2] and a homothetic subutility function $u$ defined over $\mathbf{X} \in \mathbb{R}^s_+$

$$(u(\mathbf{X})^c)(M/b)^{l-c} \tag{1}$$

where $b$ is the cost-of-living index for $u$. There is thus a two-stage budgeting procedure: irrespective of relative or absolute prices, a proportion $c$ of income is 'spent' on consumption, and $(l - c)$ is 'saved' to accumulate money balances; then given the $s$-vector of prices $\mathbf{P}$ for outputs, expenditure is allocated to

[1] This confirms the similar conclusions of a companion paper that introduced heterogeneity into labour markets (Dixon 1992).

[2] The reader may choose to interpret $M$ as a non-produced good yielding direct utility, or as money in an indirect utility function. Note that since preferences over money and consumption are Cobb-Douglas, it makes no difference to demand whether we define utility over 'real' or 'nominal' money balances. We have chosen to deflate by $P$ the cost of living to make neutrality/non-neutrality results directly comparable with the neoclassical synthesis framework. Since households have homothetic preferences, we will simply deal with an aggregate consumer to save on notation.

maximize $U(\mathbf{X})$. For obvious reasons, we can intuitively interpret $c$ as the marginal propensity to consume. This assumption generalizes existing models of imperfectly competitive macroeconomics where $u$ is usually Cobb-Douglas (e.g. Cooper and John 1988; Dixon 1987, 1988), CES (e.g. Blanchard and Kiyotaki 1987; Startz 1990).

The homothetic subutility function $u(\mathbf{X})$ is represented by the corresponding expenditure function

$$e(\mathbf{P}, u) = b(\mathbf{P})\cdot u \tag{2}$$

where $\mathbf{P} \in \mathbb{R}^s_+$ are the prices $p_i$ of outputs; $b(\mathbf{P})$ is the cost-of-living index, which is homogeneous of degree one in $\mathbf{P}$, and which we assume to be normalized so that if all prices $p_i = \lambda$ then $b(\mathbf{P}) = \lambda$. Total nominal income[3] in this economy will consist of the flow of wages, profits, and the initial stock of money balances. Since households have identical homothetic preferences, we can ignore the distinction between profits and wages, and denote the total flow component of income as $Y$. From the income-expenditure identity, we can thus denote the total flow of expenditure as $Y$, and further subdivide this into expenditures $Y_i$ on each of the outputs. Given (2), the budget share of the $i$th output $\alpha_i$ is a function of prices $\mathbf{P}$

$$Y_i = \alpha_i(\mathbf{P})\cdot Y \tag{3a}$$

where $\alpha_i$ is homogeneous to degree zero (Hod0) in $\mathbf{P}$. Since preferences are symmetric, if prices are equal then $\alpha_i = l/s$ for $i = l \dots s$. To obtain the Marshallian demands for outputs, we simply deflate $Y_i$ by $P_i$

$$X_i(\mathbf{P}, K) \equiv \alpha_i(\mathbf{P})\cdot\frac{Y}{P_i} \tag{3b}$$

Throughout the paper we will assume that goods are (weak) gross-substitutes so that the budget share $\alpha_i$ is non-increasing in $P_i$, and $\alpha_j$ are non-decreasing in $P_i$. This of course implies that we can invert (3b) to express $P_i$ as a function of $X_i$.

Turning to the first-stage of the housholds' budgeting process, we can solve for the income-expenditure system in this economy. With Cobb-Douglas preferences expenditure $Y$ is a linear function of total income (the flow component $Y$ and wealth $M^0$), $Y = c(Y + M^0)$ so that

$$Y = \frac{c}{l - c}M^0 \tag{4}$$

(4) is the reduced form income-expenditure equation which gives total nominal expenditure on output $Y$: using (3a) we can then see how this divides between outputs given $\mathbf{P}$. Equations (3a) and (4) summarize the households' consumption behaviour at the microeconomic and macroeconomic level. We will now turn to the labour market and the three different types of output markets.

[3] Throughout this paper, we use the term 'nominal' price to mean the price relative to the non-produced good (money).

## 2.1. *The labour market*

Labour is assumed perfectly mobile across sectors, with a unified economy-wide labour market with nominal wage $W$. There is a continuum of households of measure $H$, each with one unit of labour to sell at disutility $\theta$ where $\theta_h \in [\underline{\theta}, \bar{\theta}]$, $\underline{\theta} > 0$. The distribution for $\theta_h$ is given by $F$. If all households have the same disutility, $\underline{\theta} = \bar{\theta}$. The aggregate labour-supply consists of all those households for whom the real-wage exceeds their $\theta_h$

$$N^s(W/b(\mathbf{P})) = F(W/b(\mathbf{P}))\cdot H \tag{6}$$

If $F$ is strictly-monotonic and continuous on $[\underline{\theta}, \bar{\theta}]$, we can invert this relationship to obtain

$$\theta = \theta(N) = F^{-1}(N/H)$$

where $\theta$ is the disutility of work for the '$N$th' worker, the real-wage that must prevail if $N$ households are to want to work

$$\frac{W}{b(\mathbf{P})} = \theta(N) \tag{7}$$

The only exception to strict-monotonicity of $F$ we shall consider is with identical households, in which case $\theta(N) = \bar{\theta}$ for all $N \in [o, H]$. Clearly, the elasticity of $\theta$ with respect to $N$ is the inverse of the aggregate elasticity $\sigma$ of the labour-supply with respect to the real-wage. When $\theta(N) = \bar{\theta}$ for all $N$, we have an infinite labour supply elasticity. We will rather loosely refer to $\theta(N)$ as the 'marginal disutility of labour', by which we mean the disutility of the marginal worker.

## 2.2. *The oligopolistic output markets*

A proportion $d$ of the $s$ output markets are Cournot-Oligopolies, in each of which there are $n$ firms $k = 1 \ldots n$. Firm $k$ in sector $i$ chooses output $X_{ik}$ treating the outputs of the other firms $j \neq i$ as fixed. The resultant price $P_i$ in sector $i$ clears the market given total output $X_i = \Sigma_k X_{ik}$. Letting $P_{-i}$ be the $(S-1)$-vector of prices in other markets, we can invert the Marshallian demand (3b) to give price as a function of quantity

$$P_i = P_i(\underset{-}{X_i}, \underset{+}{P_{-i}}, \underset{+}{Y} \tag{8}$$

This equation defines the 'objective' demand function for the $i$th sector under the assumption that firms take as given the prices in other sectors, and the outputs of firms in their own sector.

The firms in the oligopolistic sector have an increasing returns technology of the form

$$X_i = N_i - \bar{N}, \quad \bar{N} \geqslant 0$$

$\bar{N}$ represents the fixed set up cost of production, and if $\bar{N} = 0$ we have the special case of constant returns to scale. Marginal cost is equal to $W$.

We assume that the firms in sector $i$ choose outputs to maximize nominal profits treating the aggregate cost-of-living index $b(\mathbf{P})$ as given. We believe that it is reasonable for firms to ignore the effect of their own actions on the general cost-of-living under the assumption that there are many sectors in the economy ($s$ is large). The total nominal profits for firm $f$ in sector $i$ are therefore

$$\Pi_{ik} = X_{ik}P_i - W \cdot (X_{ik} + \bar{N})$$

where $P_i$ is given by (8). Assuming a unique, symmetric equilibrium with strictly positive and bounded output,[4] we have the typical oligopolistic sector's equilibrium price-cost margin

$$\frac{P_i - W}{P_i} = 1/n\varepsilon_i(\mathbf{P}) \tag{9}$$

where $\varepsilon_i(\mathbf{P})$ is the elasticity of demand. Since preferences are homothetic, $\varepsilon_i$ is Hod0 in $\mathbf{P}$, and by weak gross-substitution non-increasing in $P_i$. Equation (9) implicitly defines the equilibrium oligopolistic price $P^0$ as a function of the equilibrium nominal wage $W$. The equilibrium output of each oligopolistic sector is then given by (3b)

$$X^0 = X(P^0, P_{-i}, Y)$$

The total revenue of firms $Y_i$ is then distributed to households in the form of wages and profits.[5]

Another way of interpreting (9) is to note that the nominal wage is determined by (7) so as to equate the real wage with the marginal disutility of labour $\theta$ hence

$$\frac{P^0}{b(\mathbf{P})} = \frac{n\varepsilon_i(\mathbf{P})}{n\varepsilon_i(\mathbf{P}) - 1} \cdot \theta(\mathbf{N}) \tag{10}$$

Thus in equilibrium, the real price in the oligopolistic sector $P^0/b$ is a fixed markup on the marginal disutility of labour $\theta$. Since preferences are homothetic, so that the elasticity $\varepsilon_i$ only depends on relative prices $\mathbf{P}$, this is unaffected by the income level. In what follows, it is notationally convenient to define the markup $\mu$ as

$$\mu_i(\mathbf{P}) = \frac{n \cdot \varepsilon_i(\mathbf{P})}{n \cdot \varepsilon_i(\mathbf{P}) - 1} \tag{11}$$

where from the properties of $\varepsilon_i$, $\mu_i$ is Hod0 in $\mathbf{P}$, and $\mu$ decreasing in $P_i$.

[4] Sufficient conditions for the existence of a unique symmetric equilibrium are given in Hart (1982), Lemma 1.

[5] Although it saves on notation to ignore the distinction between wages and profits, this could easily be done. For example, we could adopt the convention in Cooper and John (1988) that there is a class of 'capitalists' who own the non-produced good money who receive profits for example. However, since all households have the same preferences (1), the precise story told about distribution need have no substantive implications for the equilibrium.

## 2.3. *Fix-price sectors*

Of the $(1 - d)s$ non-oligopolistic sectors, a proportion $\psi$ are sectors with fixed nominal prices, and $(1 - \psi)$ are competitive. In the fix-price sectors, there are constant returns to labour with marginal productivity normalized to unity. The price is exogenously fixed at some value $f$ above the wage, so that $P_i = f, f > W$. This is a very general story outside the private sector either by the government (through price-controls in a regulated industry, or directly in a nationalized industry), or by international markets in the case of an open-economy (see Dixon 1990, for an explicit analysis of this case). Another interpretation that we will adopt is that the fix-price sector consists of monopolistic industries where firms incur menu-costs when they adjust prices. As is well known, if such firms face lump-sum costs of price adjustment, and their prices are initially at an optimum, then (small enough) changes in demand will not result in any price change (see Akerlof and Yellen 1985; Mankiw 1985; Rotemberg 1982). In the case of monopolistic industries, or an open-economy, $f > w$ is natural: with nationalized industries it avoids notation to assume an operating profit.[6] Whichever story we prefer, the point of introducing fix-price sectors is to recognize that in most economies there are sectors where prices may be rigid over a policy-relevant span of time.

## 2.4. *Competitive sectors*

In each of the remaining $(1 - \psi)d$ competitive sectors, it is assumed that there is a representative firm which acts as a Walrasian price-taker. The equilibrium price $z$ in the typical competitive sector equates supply and demand. Whilst it is appropriate to constant or increasing returns in the oligopolistic sector, we will rather assume that there are constant or diminishing returns to labour in the competitive sector. In each competitive industry, there is a representative firm $i$ with technology

$$X_i = N_i^{\rho} \qquad 0 \leqslant \rho \leqslant 1 \tag{12}$$

with

$$N_i = 1 \quad \text{for} \quad \rho = 0$$

When $\rho = 1$ there are constant returns. When $\rho = 0$ there is a fixed capacity with one unit output, and we restrict firms to employing one unit of labour to produce this (rather than any strictly positive $N_i$).[7] With nominal output price $z_i$ and wage $w$, for $0 \leqslant \rho < 1$ the supply function for the industry is

$$X_i = (z_i/w)^r \quad \text{where } r \equiv \rho/(1 - \rho)$$

[6] For example, in the case of a nationalized industry, this could be dealt with through a government raising taxes to subsidize the deficit. Since $f > w$ here, we allow for profits to be distributed by the government as in the oligopolistic sector.

[7] We need to be able to invert (12) to obtain a unique level of employment. When $\rho = 0$, $X_i = 1$ for any $N_i = 0$. We have chosen to set $N_i = 1$ in this case, although any positive value would do.

$r$ is the elasticity of supply with respect to the reciprocal of the own-product real wage. Dropping the $i$ subscript, the equilibrium output price in the representative competitive sector equates supply with demand. If we define the budget share of the representative competitive sector as $\alpha_z$, and partition the $s$-vector of prices into $(P^0, z, f)$ we have for $r$ bounded $(0 \leqslant \rho < 1)$

$$(z/W)^r = \alpha_z(P^0, z, f) \cdot Y/z \tag{13a}$$

Note that since $\alpha_z$ is non-increasing in $z$, a unique solution exists to (13a) given $(P^0, f, Y, W)$. In the case of $\rho = 1$ (when by convention we will say $r = \infty$), there is constant marginal cost so that the equilibrium price equals the wage and the real price $z/b$ is fixed relative to $\theta$.

$$\frac{z}{b(P^0, z, f)} = \theta(N) \tag{13b}$$

## 2.5. *The demand for labour*

Having derived the equilibrium prices in the various sectors given $W$, we can derive the aggregate demand for labour. It is convenient to define the sectoral demands

$$N^0(P^0, f, z, Y) = s.d.\ \alpha_0(P^0, f, z)\frac{Y}{P^0} \tag{14a}$$

$$N^z(P^0, f, z, Y) = s(1-\psi)(1-d)\left(\alpha_z(P^0, f, z)\frac{Y}{z}\right)^{1/\rho} \tag{14b}$$

$$N^f(P^0, f, z, Y) = s\psi(1-d)\alpha_f(P^0, f, z)\frac{Y}{f} \tag{14c}$$

Clearly, $(N^0, N^z, N^f)$ are each homogeneous to degree zero in $(P^0, f, z, Y)$. Note that $N^z$ is defined when $\rho = 0$ since from (12) $\alpha_z Y/z = 1$. Aggregate employment is then simply

$$N(P^0, f, z, Y) = N^0 + N^z + N^f \tag{15}$$

Having derived the labour demand we can combine (15) with labour supply (6) to define the equilibrium real wage. So long as $N < H$, the real wage will equal the marginal disutility of labour. We assume throughout the paper that this condition holds (i.e. not everybody is working) so that

$$\frac{W}{b(P^0, f, z)} \begin{cases} = \theta(N(P^0, f, z, Y)) & \text{(16a)} \\ = \bar{\theta} & \text{(16b)} \end{cases}$$

Where (16) gives the conditions that $(P^0, f, z, w, Y)$ must satisfy for labour market equilibrium when (b) labour supply is perfectly elastic, and (a) it is not.

## 3. The economy with perfectly elastic labour supply

Having outlined the microeconomic structure of the economy and its equilibrium, we will now proceed to analyze the macroeconomic properties of the economy under the assumption that the economy has a perfectly elastic labour supply. The main lesson to be derived fron this overall exercise is that the macroeconomic properties of the model depend crucially on the structure of the economy. Moreover, there need to no simple relationship between the behaviour of the whole and that of the parts.

With a perfectly elastic labour supply, eqs (10), (11), and (13a, b) represent the equilibrium for the economy

$$\frac{P^0}{b(P^0, z, f)} = \mu(P^0, z, f)\cdot\bar{\theta} \tag{17a}$$

$$\frac{z}{b(P^0, z, f)} = [\alpha_z(P^0, z, f)\cdot Y/z]^{1/r}\bar{\theta} \qquad r > 0 \tag{17b}$$

$$z = \alpha_z(P^0, z, f)\cdot Y \qquad \rho = r = 0 \tag{17c}$$

Employment and hence output is given by (14) and (15). The assumption of an infinite labour supply elasticity greatly simplifies the model since it dichotomises the economy, making the price eqs (17) independent of (14) since the real wage does not vary with $N$. In Section 4 we will consider the case of an imperfectly elastic labour supply.

We are going to consider the effect of an increase in nominal national income $Y$ on nominal prices $(P^0, z)$ and outputs. In our closed-economy framework nominal national income is proportional to the money stock from (4). It is easiest and most intuitive to take the logs of (17a, b) and totally differentiate with respect to $Y$, which yields for $r > 0$

$$\frac{\mathrm{d}\log P^0}{\mathrm{d}\log Y} = \frac{A_z + m_z}{\Delta(r)} \tag{18a}$$

$$\frac{\mathrm{d}\log z}{\mathrm{d}\log Y} = \frac{A_z + A_f - m_0}{\Delta(r)} \tag{18b}$$

$$\Delta(r) \equiv A_z(1 + \eta_f + r\cdot A_f) + A_f(1 - \eta_z + r(1 - A_z)) + m_0(\eta_z - r(1 - A_z)) - m_z(\eta_0 + rA_0)$$

where $\eta_z$, $\eta_f$, $\eta_0$ are the elasticities of the competitive budget share $\alpha_z$ with respect to $z$, $f$, $P^0$ respectively. $A_z$ and $A_f$ are the total budget shares of the competitive and fix-price sectors respectively, e.g. $A_z = s(1 - \psi)(1 - d)\alpha_z$. $m_0$ and $m_z$ are the elasticities of the oligopolistic markup $\mu$ with respect to $P^0$ and $z$. Note that since we are assuming (weak) gross substitutes $\eta_f, \eta_0 \geqslant 0$ and $\eta_z \leqslant 0$.

Equations (18) are rather complex, reflecting the structural feedbacks across the three sectors. However, we can see quite clearly the operation of three externalities: cost-of-living externalities are captured by the budget shares $A_z$ and $A_f$ (since $\partial \log b/\partial \log P_i = \alpha_i$); budget-share externalities are captured by the elasticities of the competitive industry's budget share with respect to (w.r.t.) prices ($\eta_z, \eta_f, \eta_0$); elasticity externalities captured by the markup w.r.t. prices ($m_0, m_z$). In addition to the primary effect of the externalities, there are the feedback cross-effects captured by the 'mixed' terms $m_0\eta_0$ and $m_z\eta_z$.

Clearly the operation of these externalities is influenced by structure of the economy, the supply elasticity in the competitive sector, and household preferences. We examine the operation of the economy through three cases. The first two are benchmark special cases: one being Keynesian with the increase in nominal demand having no effect on prices (and hence only an output); the other being classical and only having an effect on prices (with output in all sectors constant at a 'natural Rate'). Each of these benchmarks is derived for general household preference (2) with particular restrictions on the structure or technology of the economy. The last case restricts household preferences (to Cobb-Douglas) and explores the operation of the economy as the structure and technology vary.

*Case 1:A Keynesian Economy* $\rho = 1$, $\psi > 0$, $d < 1$. To obtain the Keynesian case, we make an assumption about technology in the competitive sector (constant returns $\rho = 1$, or $r = \infty$), and an assumption about structure (that there is a fix-price sector, $\psi(1 - d) > 0$) The equilibrium of the economy can be represented by eqs (17a) and (17b). As we will now demonstrate, this economy behaves in a very 'Keynesian' fashion.

*Proposition 1* Let $\lambda > 0$. Treating $M^0$ as given, let $(P^{0*}, z^*, f)$ be an equilibrium. Then so long as there is not full-employment, $(\lambda P^{0*}, \lambda z^*, \lambda f)$ is also an equilibrium.

*Proof* If we turn to (17a) and (17b), both equations are Hod0 in $(P^0, z, f)$, thus establishing the proposition. The RHS of (17a) is Hod0 since $\mu$ is Hod0 in $(P^0, z, f)$. The LHS of (17a) and (17b) is Hod0 since $P^0$, $z$, $b$ are all Hod1 in $(P^0, z, f)$. □

Proposition 1 is a powerful result. In effect, whatever the level of non-produced money $M^0$ (so long as there is not full employment), the equilibrium nominal prices in the oligopolistic and competitive sectors will become 'pegged' to the fix-price sector price $f$ in the sense that the relative prices $z/f$ and $p^0/f$ are fixed in equilibrium. In particular these equilibrium relative prices are unaffected by $M^0$ (money does not appear in (17a, b)). The reason for this is that we have combined assumptions of constant returns with homothetic preferences, giving rise to the homogeneity of (17a, c). The Keynesian tableau thus represents an extreme case in which there is total nominal price rigidity in response to change in $M^0$. This is an interesting benchmark case.

Since nominal prices are fixed in equilibrium, the economy will behave in a very Keynesian manner, with traditional multiplier effects ('demand externalities'). An increase in the money supply (a helicopter drop) will also lead to a Pareto improvement:

*Proposition 2* An increase in the nominal money supply leads to a Pareto improvement.

*Proof* Given that prices are fixed, an increase in the nominal money supply leads to a direct increase in welfare, from (1). However, in addition there is an increase in output both in the competitive and oligopolistic sectors. In the competitive sector, the increase in utility from consumption is exactly equal to the disutility of the additional labour supplied (from 17b). In the oligopolistic sector, there is a 'surplus' and hence the consumption utility of additional output exceeds the disutility of work. This effect will also be present in the fix price sector $f > w$. □

This proposition draws out an important contrast between the welfare properties of competitive and oligopolistic industries. In the Cournot industries, the price is a markup over the disutility of labour, so that an increase in output yields more 'surplus' (equal in monetary terms to additional profits). This is depicted in Fig. 1, where the increase in $M^0$ causes output in the typical oligopolistic market to increase by $X^1 - X$, the additional surplus being the shaded square. Under our assumptions in the competitive sector the disutility of work is always equal to the utility of additional output. This Pareto improvement is only possible because of the oligopolistic markup in the Cournot sectors. Hence the possibility of Pareto-improving policy depends on the presence of imperfect competition (see also Startz 1990).

If we interpret the fix-price sector as a monopolistic sector with menu-costs, then Proposition 1 is significant, since it implies macroeconomic price-rigidity will result no matter how small the monopolistic sector so long as $\psi d > 0$. In this sense, the price-rigidity of the monopolistic sector is infectious, causing the (equilibrium) prices in the oligopolistic and competitive sectors to be rigid. Even a small monopolistic sector with menu costs can have very significant macroeconomic implications. Most importantly, the Keynesian tableau illustrates that the whole economy need not be monopolistically competitive with menu-costs to explain macroeconomic fluctuations.

*Case 2: A Classical Economy* $\psi = \rho = 0$. $1 > d > 0$. Having used our basic structure to provide an economy which is Keynesian in its property of nominal-price rigidity, we will now provide a classical economy as the opposite benchmark. On the structural side there is no fix-price sector ($\psi = 0$), and on the technological side there is a totally inelastic supply in the competitive sector ($r = \rho = 0$). This economy turns out to be totally 'classical' in the sense that money is neutral, and the classical dichotomy holds. In the absence of a fix-price sector, with limited capacity, equilibrium in the oligopolistic and competitive

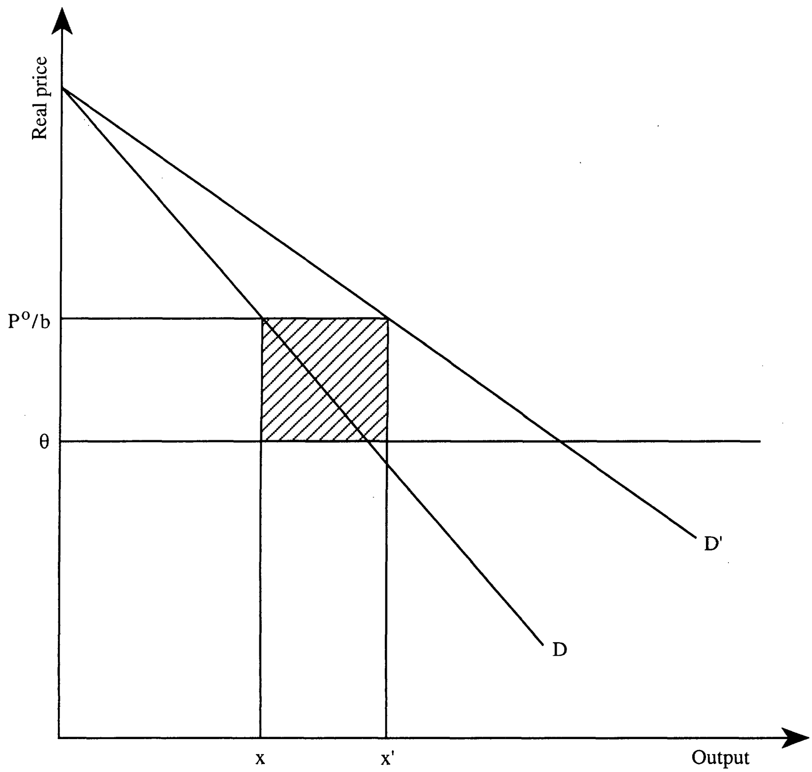


FIG. 1. A Pareto Improving Demand Increase

sectors is given by (17a, b) with $\mathbf{P} = (P^0, z)$.

$$\frac{P^0}{b(P^0, z)} = \mu(P^0, z) \tag{19a}$$

$$z = \alpha_z(P^0, z) \cdot Y \tag{19b}$$

Note, first, that here there is no fix-price $f$ to tie prices $(P^0, z)$ down; second, the money supply enters via $Y$ into eq. (19b) to determine the nominal price $z$. Note, however, that although different mechanisms are operating to determine prices in the oligopolistic and competitive sectors, in equilibrium the relative prices in the oligopolistic and competitive sectors $P^0/z$ will be fixed by (19a) for given $Y$, due to the fact that this equation is Hod0 in $(P^0, z, Y)$. If we turn to (19b), both sides are Hod1 in $(P^0, z, Y)$. So long as $P^0/z$ is tied down by (19a), the budget share $\alpha_z$ is constant; hence an increase in $M^0$ will (via the income-expenditure system) cause an equi-proportionate increase in $z$. To summarize:

*Proposition 3* (Neutrality). Let $\lambda > 0$. If $(P^{0*}, z^*)$ is an equilibrium for $M^0$, then $(\lambda P^{0*}, \lambda z^*)$ is an equilibrium for $\lambda M^0$.

*Proof* Both eqs (19) are Hod0 in ($P^0$, $z$, $Y^0$), and from (4) $Y$ is proportionate to $M^0$. □

An alternative proof of neutrality comes directly from (18). When there is no fix-price sector $A_f = 0$, and furthermore since both $\alpha$ and $\mu$ are Hod0 in ($P^0$, $z$) $m_0 = -m_z$ and $\eta_0 = -\eta_z$: hence in (18) the elasticities of both $P^0$ and $z$ with respect to $Y$ are unity, which is equivalent to neutrality.

The macroeconomic neutrality result Proposition 3 is stated in the very classical terms of homogeneity of the system. However, in this case, the homogeneity stems from the feedbacks between two sectors with different mechanisms of price determination. Unlike the Keynesian case where nominal prices become pegged to the fix-price sector price, in the classical case the combination of a competitive sector with a fixed output and an oligopolistic sector in which price is a markup over the marginal disutility of labour leads to prices being flexible with output being fixed in both sectors.

This result is more surprising than it at first seems. From the partial-equilibrium perspective, there is no reason at all why the output of the oligopolistic sector should be fixed: indeed, from the Keynesian case it is quite possible for oligopolistic output to increase. It is the general-equilibrium interactions implicit in (19) which result in the 'natural rate' property of the competitive sector spilling over to the oligopolistic sector.

An immediate implication of this neutrality result is that there are no welfare effects of increasing the money supply, in contrast to Proposition 2. We need to be a little careful here. Since we have assumed that utility depends on real money balances $M/b(P)$, there is no effect. If we had rather interpreted $M$ as a non-produced good, then of course there would be an increase in utility. However, even in this case there is no effect over and above the initial increase in the non-produced good: the outputs of produced goods remain constant.

The Keynesian and Classical economies have provided us with useful benchmarks. They give opposite answers to the question of how an increase in nominal demand is divided between output and inflation. In the Keynesian case, changes in demand lead to pure output responses; in the classical case, there is a pure price response. Since both tableaux were special cases of the general model, it will be immediately clear that almost any division of demand changes into price and output is possible, depending on the precise structure of the economy.

*Case 3: Cobb-Douglas Preferences* To derive the Keynesian and Classical cases, we placed restrictions on the structure of the economy (the relative sizes of the sectors) and the technology in the competitive sector ($r$). We will conclude this section by analyzing the general model, but under the particular assumption that households have a Cobb-Douglas subutility function $u$. With Cobb-Douglas preferences the elasticity of demand in each sector is unity and budget shares are constant, hence $m_0 = m_z = 0$ and $\eta_0 = \eta_f = \eta_z = 0$. In this case (18) simplifies to

$$\frac{\mathrm{d}\log P^0}{\mathrm{d}\log Y} = \frac{A_z}{A_z + (1+r)A_f} \leqslant 1 \tag{20a}$$

$$\frac{\mathrm{d}\log z}{\mathrm{d}\log Y} = \frac{A_z + A_f}{A_z + (1+r)A_f} \leqslant 1 \tag{20b}$$

The elasticity of supply is crucial here, as we would expect from the fact that in the classical case $r = 0$, and in the Keynesian case $r = \infty$. As the elasticity of supply gets larger, the elasticities of $P^0$ and $z$ with respect to $Y$ decrease, so long as there is a fix-price sector ($A_f > 0$). Recall that with Cobb-Douglas preferences $A_z = (1-d)(1-\psi)$ and $A_f = (1-d)\psi$ irrespective of prices $\mathbf{P}$. Clearly in the limit when $r$ is infinite ($\rho = 1$) we have the Keynesian case. However, even if the competitive sector has a perfectly inelastic supply, the presence of a fix-price sector will lead to some output response in the oligopolistic sector. If there is no fix-price sector then (irrespective of parameters $r$ and $A_z$) we are back to the classical case. It is interesting to note that, for given $r$, what determines the responsiveness of $P^0$ and $z$ to changes in nominal demand is the relative sizes of the competitive and fix-price sectors, not their absolute size. This confirms the finding from the Keynesian case that even small sectors of the economy can have a significant influence on the overall behaviour of the economy.

## 4. The Keynesian case with a bounded labour supply elasticity

The benchmark Keynesian case was derived under the assumption of a perfectly elastic aggregate labour supply at real-wage $\bar{\theta}$. How is this result altered under the assumption that the labour-supply is not perfectly elastic? The result that an increase in nominal demand has no effect on prices (Proposition 1) depended upon workers willing to supply more labour (in aggregate) at $\bar{\theta}$ as output and employment increased. Without a perfectly elastic labour-supply, the real-wage will also have to rise as output and employment rise. This will happen through nominal wages rising. The rise in nominal wages will, however, cause the oligopolistic price to rise. To explore this effect in detail we will assume for simplicity that there is no competitive sector ($\psi = 0$). Real wages are then

$$\frac{W}{b(P^0,f)} = \frac{P^0}{b(P^0,f)} \frac{1}{\mu(P^0,f)} \tag{21}$$

so that

$$\frac{\mathrm{d}\log(W/b)}{\mathrm{d}\log P^0} = 1 - A_0 - m_0$$

where $m_0$ is the elasticity of $\mu$ with respect to $P^0$, $m_0 \leqslant 0$ (gross substitution). Since the oligopolistic sector price $P^0$ rises with $W$, the larger is $A_0$, the more nominal wages need to rise relative to $f$ to attain a given increase in real wages. This implies a crowding-out mechanism that will reduce the multiplier below the 'extreme' Keynesian case. This section addresses the crucial question of what happens to output and employment both in aggregate, and in the oligopolistic sector, as the elasticity of labour-supply varies. If there were a completely inelastic labour-supply, then total output (employment) could not change; the increase in the output in the fix-price case would be exactly offset by a decrease in the oligopolistic sector. This would be a pseudo-classical result: money would not affect total output and employment, although it would still be non-neutral due to the fix-price sector and changing structural composition of outputs between sectors.

Consider the relationship between the oligopolistic price level $P^0$ and the demand for labour. From (14) and (15) we have

$$N^d = N^0(P^0, f, Y) + N^f(P^0, f, Y) \tag{22a}$$

so that

$$\frac{\mathrm{d}\log N^d}{\mathrm{d}\log P^0} \equiv \varepsilon_{0N} = \frac{N^0}{N}\varepsilon_0 + \frac{N_f}{N}\varepsilon_{f0} < 0 \tag{22b}$$

where $\varepsilon_{0N}$ is the elasticity of total employment with respect to $P^0$, $\varepsilon_0$ and $\varepsilon_{f0}$ are the elasticities of employment in the oligopolistic and fix-price sectors w.r.t. $P^0$. Note that $\varepsilon_0$ is the elasticity of total oligopolistic employment as all oligopolistic prices rise ($\varepsilon_i$ in the markup eq. (9) is the own price elasticity of a single industry), and with gross-substitution $\varepsilon_{f0} \geqslant 0$.

The relationship between $P^0$ and the labour supply is derived by substituting the real wage (21) into (6)

$$N^s\left(\frac{w}{b}\right) = N^s\left(\frac{P^0}{b(P^0, f)} \cdot \frac{1}{\mu(P^0, f)}\right) \tag{23}$$

so that the elasticity of the labour supply with respect to $P^0$ is given by

$$\frac{\mathrm{d}\log N^s}{\mathrm{d}\log P^0} = \sigma(1 - A_0 - m_0)$$

In Fig. 2 we put together the demand relation (22a) and supply relation (23). Equilibrium in the economy occurs at that $P_A^0$ (and the corresponding $W$ implicit in (23)) where labour demand equals supply at $A$. An increase in nominal national income $Y$ will shift the labour curve to the right, equiproportionally to the increase in $Y$. As $Y$ increases to $Y^1$ in Fig. 2, the equilibrium output and employment rise to $N^1$ as the equilibrium moves from $A$ to $B$. As one would expect, the slopes of the labour demand and supply curves will determine the eventual increase in output. If the labour-supply is perfectly elastic, then $P^0$ (and $W$) will not need to change as $N$ increases, so that there is a pure output response as $Y$ rises, equilibrium moving from $A$ to $C$ (this is in effect Proposition 1). If the labour supply is inelastic with respect to $P^0$ (due to a low $\sigma$ or high $A_0$), then there will be crowding out.

The precise effect of $Y$ on $N$ can be determined by totally differentiating the

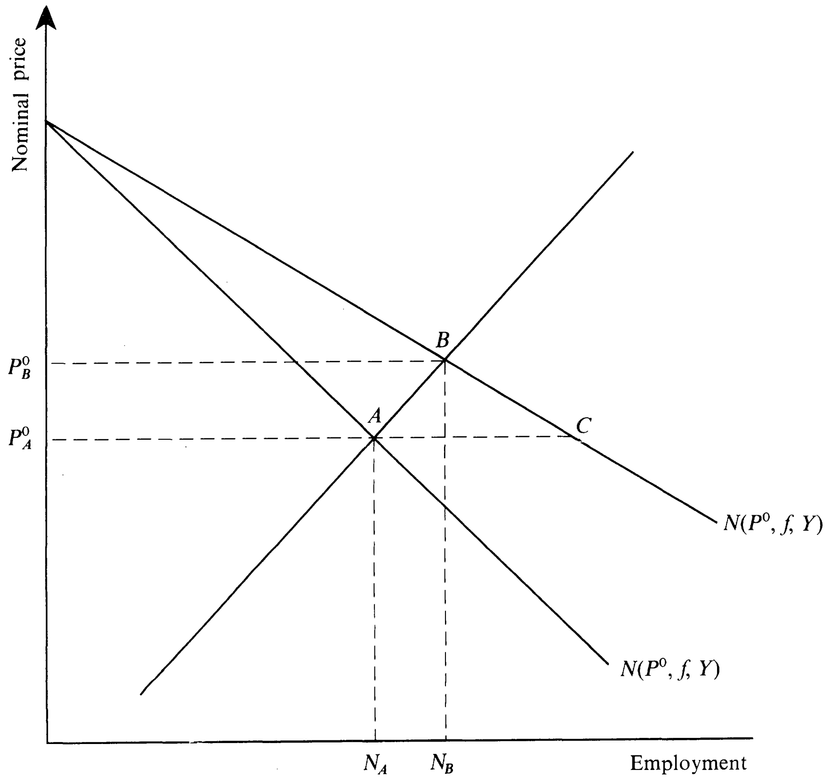


FIG. 2. Monetary Expansion with Bounded Labour Supply Elasticity

equilibrium system

$$N^d(P^0, f, Y) = N^s\left(\frac{P^0}{b(P^0, f)} \cdot \frac{1}{\mu(P^0, f)}\right) \tag{24}$$

which yields

$$\frac{\mathrm{d}\log N}{\mathrm{d}\log Y} = \frac{\sigma(1 - A_0 - m_0)}{\sigma(1 - A_0 - m_0) - \varepsilon_{0N}} \tag{25a}$$

$$\frac{\mathrm{d}\log P^0}{\mathrm{d}\log Y} = \frac{1}{\sigma(1 - A_0 - m_0) - \varepsilon_{0N}} \tag{25b}$$

Clearly, $0 < \dfrac{\mathrm{d}\log N}{\mathrm{d}\log Y} < 1$ (since $\sigma > 0$, $0 < A_0 < 1$, $m_0 \leqslant 0$, $\varepsilon_{0N} < 0$). In order to evaluate (25) more clearly, let us take as a reference point the case where (a) $\bar{N} = 0$ (i.e. constant returns) and (b) preferences are Cobb-Douglas, so that $A_0$ is a parameter ($A_0 = d$), $m_0 = 0$, and $\varepsilon_{0N} = N^0/N$ (since $\varepsilon_0 = -1$ and $\varepsilon_{0f} = 0$). First, recall that Proposition 1 held however small the fix-price sector. This is clearly no longer true for $\sigma$ bounded: the effect of $Y$ on $N$ is decreasing

TABLE 1

| $\sigma$ | 0.5 | 1 | 2 | 5 | 10 |
|---|---|---|---|---|---|
| $\frac{d \log N}{d \log Y}$ | $\frac{1}{9}$ | $\frac{5}{14}$ | $\frac{5}{9}$ | $\frac{25}{34}$ | $\frac{25}{19}$ |

in $A_0$, the size of the fix-price sector matters. Secondly, we can turn to the elasticity of labour supply $\sigma$. In the table we compute $d \log N/d \log Y$ for different values of $\sigma$, setting $A_0 = 0.8$, $N^0/N = 0.8$. Clearly the elasticity of labour supply is crucial. In general, without the restriction of Cobb-Douglas preferences and constant returns the analysis of (25) is not so straightforward (all the variables $\sigma$, $A_0$, $\varepsilon_{0N}$, $m_0$ are endogenous and may vary), but intuition suggests that the same conclusions will hold.

The plausible empirical magnitude of $\sigma$ is a matter of much dispute. There is general agreement that individual labour supply elasticities are small (between 0 and 0.5). What this implies for the aggregate elasticity is not so clear. In this paper individual labour supplies are completely inelastic unless the real wage equals their reservation wage, when it is infinite. The aggregate elasticity depends on the distribution of reservation wages. The lumpiness of the 'to work or not to work' decision can thus lead to a high aggregate labour-supply elasticity despite apparently low individual elasticities. This line of argument has been made by Hansen (1985), and Rogerson (1988).

How important, then, is the effect of the fix-price sector in determining the real impact of changes in nominal demand? Even if the elasticity in (25a) is low (due to low $\sigma$ or small fix-price sector), this can still represent a significant policy relevant magnitude. This arises because unemployment is small relative to employment, so that small proportional changes in employment lead to big proportional changes in unemployment. In the UK, the labour-force in the later 1980s was about 22m, and unemployment about 2.5m. A 1% rise in total employment would thus represent a reduction of about 200,000 in unemployment, or about 10%. Hence even quite small elasticities of $N$ with respect to $Y$ can be of considerable policy interest.

Having looked at the response of aggregate employment $N$ to changes in nominal demand $Y$, let us now focus on its specific effect on employment and output in the oligopolistic sector. In the case of constant disutility of labour (perfectly elastic supply), the fact that prices were fixed in the fix-price sector tied down the oligopolistic price, and led to oligopolistic output responding equi-proportionally to increases in nominal demand. What happens to output and employment in the oligopolistic sector with a bounded labour-supply elasticity? There are two counteracting forces at work here. On the other hand, as total employment $N$ rises, this raises the nominal wage costs of oligopolistic firms, which is passed on in terms of a higher $P^0$, and lower output. On the other hand, the fact that the price $f$ is fixed acts as a restraint on the increase in $P^0$, which (in the face of an increase in $Y$) tends to boost oligopolistic output. Which of these two effects dominates determines whether or not oligopolistic output/employment or decreases, and will clearly depend on the elasticity of labour supply and the size of the fix-price sector. From (14) and (25b) we have

$$\frac{\mathrm{d}\log N^0}{\mathrm{d}\log Y} = \frac{\sigma(1 - A_0 - m_0) - \varepsilon_{0N} + \varepsilon_0}{\sigma(1 - A_0 - m_0) - \varepsilon_{0N}} < 1 \tag{26}$$

If $\sigma$ is bounded, (26) is less than unity. It will be negative when (recalling the breakdown of $\varepsilon_{0N}$ in (22b))

$$\sigma(1 - A_0 - m_0)(N/N_f) \leqslant \varepsilon_{f0} - \varepsilon_0 \tag{27}$$

In the case of Cobb-Douglas preferences, so that $m_0 = \varepsilon_{f0} = 0$, $\varepsilon_0 = -1$, so that (27) is satisfied and output in the oligopolistic sector falls if

$$\sigma(1 - A_0) \leqslant N_f/N$$

Hence, for $\sigma$ small enough, the 'crowding out' effect of rises in real and nominal wages as employment rises will dominate the expansionary effect of greater nominal demand. If we make the further approximation that $(1 - A_0) \simeq N_f/N$ (this will be strictly true when we start from an initial position where $P^0 = f$), then for $\sigma \leqslant 1$ oligopolistic output will be non-increasing in $Y$. Conversely, for $\sigma > 1$ oligopolistic employment will be increasing in $Y$, and there is hence a net 'crowding in' effect from the fix-price sector, with output in both sectors increasing with nominal demand.

There is thus an important spillover effect from the fix-price sector to the oligopolistic sector, which can be either positive or negative depending on the size of the fix price sector and $\sigma$. The important point is that a positive spillover is still possible even though the labour supply is not perfectly elastic.

## 5. Conclusion

In this paper, we have shown that a whole continuum of behaviour is possible, from the Keynesian to the classical, depending on the precise structure of markets, and the nature of the underlying preferences and technology in the economy. The main innovation of the paper is to depart from the more usual 'representative sector' methodology, and to follow a structuralist approach allowing for markets to function in differing ways. We have focused on the impact of heterogeneous types of product market competition on the macroeconomic properties of the economy.

The results of the paper vindicate the view that the behaviour of the economy depends on complex interactions between markets, and that with heterogeneous markets there is no simple relation between the behaviour of the parts and the whole. We believe that the issue of heterogeneity goes far beyond the simple notion of 'aggregation'. In particular, the behaviour of a small sector of the economy can have significant effects on the behaviour of the macroeconomic whole. In our opinion this paper points to a new focus for future research, a more structuralist macroeconomics. Whilst this is relevant for all economies, it is perhaps even more relevant for developing and transforming economies where heterogeneity is part of their very nature.


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