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## Article

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# Fiscal Policy under Imperfect Competition with Flexible Prices: An Overview and Survey

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**Abstract** This paper surveys the link between imperfect competition and the effects of fiscal policy on output, employment and welfare. We examine static and dynamic models, with and without entry under a variety of assumptions using a common analytical framework. We find that in general there is a robust relationship between the fiscal multiplier and welfare, the tantalizing possibility of Pareto improving fiscal policy is much more elusive. In general, the mechanisms are supply side, and so welfare improving policy, whilst possible, is not a general result.

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## 1 Introduction

In a perfectly competitive economy without market imperfections, any competitive equilibrium will be Pareto optimal. Hence there can be no efficiency motive for macroeconomic policy. However, the presence of imperfect competition in the form of market power leads to an equilibrium which will in general be non-Pareto optimal, with levels of output and employment below competitive equilibrium. This leads to the tantalizing possibility that fiscal policy can be used to shift the economy to a new equilibrium which will Pareto dominate the initial equilibrium. In this paper we survey and explain the literature on imperfect competition and macroeconomics in the context of fiscal policy in a "real" model without money. This was one of the key pillars of New Keynesian macroeconomics in the 1980s and 1990s, alongside the nominal models with price and wage stickiness<sup>1</sup>.

The main contribution of New Keynesian economics was to set imperfect competition at the heart of Keynesian economics and its current incarnation as the "New Keynesian/Neoclassical Synthesis". This marked a major departure from the approach of Keynes himself, especially Keynes (1936), who used a perfectly competitive market structure to give microfoundations to the supply side of the economy. Perhaps the two main reasons were (i) that the theory of imperfect competition was relatively underdeveloped at that time and (ii) Keynes's conviction that he was generalizing the existing theory with perfect competition and market clearing being a special case (hence the title of his work). Still in the 1930's, imperfect competition and macroeconomics would be mixed in Kalecki (1938) and in the Dunlop (1938) critique to the real-wage counter-cyclicality implicit in the General Theory. However, despite this promising start, four decades would pass before we can find a significant piece of work using imperfectly competitive microfoundations in macroeconomics. During the 1960's and the beginning of the 1970's some of the concepts and techniques that would allow the integration of imperfect competition in general-equilibrium models were developed, in particular Negishi (1961). In the second half of the 1970's we find the first attempts

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<sup>1</sup> See Dixon (2008) which sets this strand of literature in the context of the wider New Keynesian approach.

to integrate these concepts in macroeconomic models. Nonetheless, their success was limited due to the "subjective-demand-curve" assumption<sup>2</sup>.

The theory of effective demand with monopolistic price-setting in general equilibrium was developed by Bénassy (1976), Bénassy (1978). However, Hart (1982), was the first model to operationalise the concept of the "'objective' demand curve" in a simple general-equilibrium model with imperfect competition (Cournot oligopoly for each good and monopoly unions), producing some "Keynesian" outcomes, namely equilibrium with under-employment (though not involuntary unemployment) and a multiplier mechanism for autonomous demand (a non-produced good in this case) that resembles the traditional Keynesian multiplier. Oliver Hart's work gives rise to a new generation of New Keynesian models<sup>3</sup> characterised by the use of imperfect competition in general-equilibrium macroeconomic models. A few notable examples are Akerlof and Yellen (1985), Bénassy (1987), Blanchard and Kiyotaki (1987), Hall (1986), Mankiw (1985), Snower (1983), and Weitzman (1982). These and other papers were analysed in surveys of the literature written at the time: Dixon and Rankin (1994) or Silvestre (1993).

Despite the fact that we can find references to fiscal policy effectiveness under imperfect competition in all the above-mentioned papers, the systematic and focussed treatment of the problem, can only be found in the second half of the 1980's. In this survey, we analyse the effectiveness of fiscal policy in general-equilibrium models with the following features, along with the standard assumptions of fully rational agents, no uncertainty, and a closed economy: (1) there is imperfect competition in goods markets; (2) labour markets are perfectly competitive; (3) prices of goods and factors are perfectly flexible<sup>4</sup>; (4) public consump-

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<sup>2</sup>A subjective demand curve is simply one that is "perceived" by the firm. It can be subject to constraint that it passes through the actual price-quantity pair that occurs in equilibrium. However, this led to endemic multiplicity of equilibria. For a short survey of the literature see Dixon and Rankin (1995).

<sup>3</sup>The first generation refers to contributions such as Fischer (1977) and Taylor (1979), especially interested in price- and wage-setting rules for relatively long periods (short-run *ad hoc* nominal rigidity).

<sup>4</sup>Of course the issue of fiscal policy in models with sticky prices has been the subject of much recent research, e.g. Correia et al. (2008), Linneman and Schabert (2003), Schmitt-Grohé and Uribe (2004).

tion has no direct effects on utilities and technologies of private agents<sup>5</sup>; (5) there is no agent heterogeneity.

These assumptions allow us to study the effect of imperfect competition in goods markets on fiscal policy, isolating it from other factors. Therefore, we can present a set of theoretical models using the same framework in order to study the effects of changing a particular basic assumption. We will concentrate on the effects of fiscal policy in two main objectives: aggregate output and representative-household welfare. The choice for these two objectives, especially the first one, is the usual one in the literature, but it is justified by the assumptions considered, as we will see throughout the survey. Section 2 is dedicated to simple static models and section 3 covers the dynamic models. Section 4 concludes.

## 2 Static Models

In this section we develop a class of static general equilibrium models that nests most of the relevant literature on the topic.

### 2.1 The Microeconomic Foundations

#### 2.1.1 Households

There is a large number of identical households that maximise a utility function depending on the consumption of a basket of goods ( $C$ ) and leisure ( $Z$ ):

$$\max_{C,Z} U = u(C, Z), \quad (1)$$

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<sup>5</sup>Additionally we assume a benevolent government, so we can abstract from political-economy issues.

which is a continuously twice-differentiable function, with<sup>6</sup>  $u_C > 0$ ,  $u_Z > 0$ ,  $u_{CC} < 0$ ,  $u_{ZZ} > 0$ , and  $u_{CZ} = u_{ZC} > 0$ . The sub-utility is constant elasticity of substitution (CES):

$$C = n^{\frac{1-\lambda}{1-\sigma}} \cdot \left( \int_0^n c(j)^{\frac{\sigma-1}{\sigma}} \cdot dj \right)^{\frac{\sigma}{\sigma-1}}, \quad (2)$$

where  $c(j)$ , with  $j \in [0, n]$ , represents the consumption of variety  $j$ ,  $\sigma > 1$  stands for the (absolute value of the) elasticity of substitution between goods, and  $\lambda \in [0, 1]$  controls the consumers' level of love for variety: if  $\lambda = 0$ , then there is no love for variety, when  $\lambda = 1$  we have the Dixit and Stiglitz (1977) case. Leisure is defined as what is left over from the unit endowment after working ( $L$ ):

$$Z = 1 - L. \quad (3)$$

The budget constraint is given by

$$w.L + \Pi - T = \int_0^n c(j) \cdot p(j) \cdot dj, \quad (4)$$

where  $w$  represents the nominal wage,  $\Pi$  profits,  $T$  is tax, and  $p(j)$  is the price of good  $j$ . Taxes are a linear function of primary income:

$$T = T_0 + t \cdot (w.L + \Pi), \quad (5)$$

where  $t \in [0, 1)$  and  $T_0 < (1 - t) \cdot (w.L + \Pi)$ .

Since the CES function is homothetic, the representative household problem given by equations (1) to (5) can be solved in two steps:

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<sup>6</sup>For sake of simplicity we use the following notation for partial derivatives:

$$f_x = \frac{\partial f}{\partial x}(x, y) \quad f_{xy} = \frac{\partial^2 f}{\partial x \partial y}(x, y) \quad .$$

1) minimising total expenditure, given the optimal choice for the quantity of private-consumption baskets ( $C$ )<sup>7</sup>;

2) maximising utility, given the optimal expenditure function.

From the first step we obtain the following demand function for each good:

$$c(j) = \left( \frac{p(j)}{P} \right)^{-\sigma} \cdot \frac{C}{n^{1-\lambda}}, \quad (6)$$

where  $P$  represents the relevant price (or cost-of-living) index for the household given by

$$P = \left( \frac{1}{n^{1-\lambda}} \cdot \int_0^n p(j)^{1-\sigma} \cdot dj \right)^{\frac{1}{1-\sigma}}, \quad (7)$$

and the optimal (minimal) expenditure function is given by  $P \cdot C$ .

Notice the demand for good  $j$  is decreasing with a constant price elasticity given by (in absolute value)  $\sigma$ , on the relative price of this good compared to the average ( $p(j)/P$ ), it is increasing on aggregate consumption intentions ( $C$ ), and it is not increasing on the mass of available goods ( $n$ ), with an elasticity given by  $1 - \lambda$ .

From the second step we obtain:

$$C = \mathfrak{C}(\omega_N, \pi_N), \quad (8)$$

$$L = \mathfrak{L}(\omega_N, \pi_N), \quad (9)$$

where  $\omega_N \equiv w \cdot (1 - t) / P$  represents the real net wage,  $\pi_N \equiv (\Pi \cdot (1 - t) - T_0) / P \equiv \pi \cdot (1 - t) - \tau_0$  stands for net profits, equation (8) is the private consumption function where  $\mathfrak{C}_{\omega_N} > 0$  and  $\mathfrak{C}_{\pi_N} > 0$ , and equation (9) represents the labour-supply

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<sup>7</sup>This problem could be solved with a general sub-utility function  $C = C(n, [c(j)]_0^n)$ , as long as it still represents homothetic preferences over goods. However, for sake of simplicity we will keep CES preferences here, as they clearly dominate the literature.

function where  $\mathfrak{L}_{\omega_N} \gtrless 0$  and  $\mathfrak{L}_{\pi_N} < 0$ .<sup>8</sup> Household consumption intentions are an increasing function of the real net wage ( $\mathfrak{C}_{\omega_N} > 0$ ) and also of the real non-wage income ( $\mathfrak{C}_{\pi_N} > 0$ ), both taken as given by households. The net real non-wage income has a negative impact on labour supply ( $\mathfrak{L}_{\pi_N} < 0$ ), but the effect of the real net wage ( $\mathfrak{L}_{\omega_N}$ ) cannot be determined ex ante, as it depends on both the substitution effect ( $> 0$ ) and on the income effect ( $< 0$ ).

### 2.1.2 Government

We first assume that the government controls real public expenditure ( $G$ ). To avoid composition effects, we assume the government-consumption basket has exactly the same CES composition the households' in (2). To minimise total expenditure in all goods for a given level of  $G$ , the demand function of each variety for public consumption,  $g(j)$  with  $j \in [0, n]$ , is given by an equation identical to (6). The relevant price index is still given by  $P$  and public consumption expenditure is  $P.G$ .

The government budget constraint is given by

$$P.G = T_0 + t.(w.L + \Pi). \quad (10)$$

This equation nests two cases, each corresponding to a type of financing<sup>9</sup>:

I. The case when government intends to keep the control over the marginal tax rate ( $t \geq 0$ ), so that the (net) lump-sum tax becomes the endogenous variable:

$$T_0 = P.G - t.(w.L + \Pi); \quad (10.I)$$

II. The case when government decides not to raise a lump-sum tax ( $T_0 = 0$ ), so that the marginal tax rate becomes:

$$t = \frac{P.G}{w.L + \Pi}. \quad (10.II)$$

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<sup>8</sup>For more detailed explanations and derivations see the appendices in Costa and Dixon (2009). In this case, please refer to section 5.1.

<sup>9</sup>In Costa and Dixon (2009) we also consider "unproductive labour" expenditure, as in Mankiw (1985). This gives rise to a third type of financing.



For sake of simplicity, we will concentrate on the study of the effects of changing public consumption on the economy, ignoring the effects of changing other fiscal variables as (net) lump-sum taxes ( $T_0$ ) and the marginal tax rate ( $t$ ), when these variables are exogenous.

### 2.1.3 Industries

The productive sector is composed by a continuum of industries with mass  $n > 0$  and each industry is dedicated to producing a differentiated good  $j$  and has  $h$  firms<sup>10</sup>. The industry that produces good  $j$ , denoted  $\mathfrak{S}(j)$ , is the set of firms that produce it. Market demand directed to industry  $\mathfrak{S}(j)$  ( $d(j)$ ) is given by the sum of private and government demands, i.e.

$$d(j) \equiv c(j) + g(j) = \left( \frac{p(j)}{P} \right)^{-\sigma} \cdot \frac{D}{n^{1-\lambda}}, \quad (11)$$

where  $D \equiv C + G$  represents aggregate demand. Market clearing in the market for good  $j$  requires demand to equal supply:

$$d(j) = \sum_{i=1}^h y_i(j), \quad (12)$$

where  $y_i(j)$  represents the output of firm  $i$  in industry  $\mathfrak{S}(j)$ .

### 2.1.4 Firms

Firm  $i$  in industry  $\mathfrak{S}(j)$ , has the following strategic behaviour<sup>11</sup>:

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<sup>10</sup>For simplicity, we assume that  $h$  is the same across all industries and is greater than or equal to 1.

<sup>11</sup>Had we not considered a continuum of goods, but a finite number of varieties instead, an individual producer could be sufficiently large to consider the effects of its own actions on macroeconomic variables. In this case, we would observe a feedback effect from the macro into the microeconomic level. For a few examples of models that consider the possibility of large firms at the economy level see Costa (2001), D'Aspremont et al. (1989), or Wu and Zhang (2000), amongst other.

- it competes with other firms in its industry ( $q \neq i$ ) using quantities produced as a strategic variable which determines the industry price - intra-industrial Cournot competition;
- it treats the aggregate price-level as given.

This is called *Cournotian Monopolistic Competition*<sup>12</sup> (CMC) and has the limiting case of perfect competition (when the number of firms per industry is very large ( $h \rightarrow \infty$ ) or if varieties are close substitutes ( $\sigma \rightarrow \infty$ ), and Dixit and Stiglitz (1977) monopolistic competition when all industries have a single producer ( $h = 1$ ).

Firm  $i$  maximises its profits ( $\Pi_i(j)$ ):

$$\max_{y_i(j)} \Pi_i(j) = p(j) \cdot y_i(j) - TC_i(j), \quad (13)$$

where  $TC_i(j)$  represents total cost for this firm and  $p(j)$  is seen as a function of  $y_i(j)$ , as we will see below. The production technology of this good is

$$y_i(j) = \begin{cases} A \cdot N_i(j) - \Phi & \iff N_i(j) > \frac{\Phi}{A}; \\ 0 & \iff 0 \leq N_i(j) \leq \frac{\Phi}{A}; \end{cases} \quad (14)$$

where  $N_i(j)$  represents the labour quantity hired by firm  $i$ ,  $A > 0$  is the (constant) marginal productivity of labour which for simplicity we normalise to  $A = 1$ , and  $\Phi \geq 0$  is overhead or administrative labour<sup>13</sup>. Production exhibits increasing returns to scale if  $\Phi > 0$  and constant returns to scale if  $\Phi = 0$ .<sup>14</sup> The labour market is perfectly competitive with an economy-wide market wage  $w$ , so that total costs of firm  $i$  are

$$TC_i(j) = w \cdot N_i(j). \quad (15)$$

<sup>12</sup>See D'Aspremont et al. (1997). In effect, the firm is "big" in its own industry, but "small" in the economy as a whole.

<sup>13</sup>This can be interpreted in the following way: there is a minimum quantity of labour ( $\Phi/A$ ) necessary for firms to work at all.

<sup>14</sup>See Costa and Dixon (2009), section 5.2.

The firm acts in a Cournot manner given industry demand in equations (11) and (12), treating the outputs of other firms in the industry ( $q \neq i$ ) and macroeconomic variables  $\{P, D\}$  as given, with "inverse" demand

$$p(j) = \left( \frac{D}{n^{1-\lambda}} \right)^{\frac{1}{\sigma}} \left( y_i(j) + \sum_{q \neq i} y_q(j) \right)^{-\frac{1}{\sigma}} P. \quad (16)$$

From solving the profit maximisation problem given by equations (13) to (16), we obtain the optimal price-setting rule for firms in industry  $\mathfrak{I}(j)$  that corresponds to equalising the marginal revenue to the marginal cost ( $MC$ ):

$$p(j) \cdot \left( 1 - \frac{S_i(j)}{\sigma} \right) = w, \quad (17)$$

where  $S_i(j) \equiv y_i(j)/d(j)$  is the market share of firm  $i$ . Since all firms are identical, we have  $S_i(j) = 1/h$  in all industries, so the optimal price-setting rule for all goods  $j$ , given by (17) becomes for all  $p(j) = p$ :

$$p \cdot (1 - \mu) = w, \quad (17.a)$$

where  $\mu \equiv (p - MC)/p = 1/(\sigma \cdot h) \in [0, 1)$  is the Lerner index that represents market power of each firm in each industry. Note this index gives us the reciprocal of the (absolute value of the) price-elasticity of demand faced by each producer in a symmetric equilibrium. In the perfect competition case ( $h \rightarrow \infty$  or  $\sigma \rightarrow \infty$ )<sup>15</sup> we have  $\mu = 0$ , i.e.  $p = MC$ . In an extreme case of monopoly ( $h = 1$  and  $\sigma = 1$ ), we would have  $\mu = 1$ , where the firm posts an infinitely high price relative to the marginal cost. The higher the value of  $\mu$ , the higher the representative firm's market power.

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<sup>15</sup>In order for perfect competition in goods and inputs markets to subsist in the long run, there can be no increasing returns to scale. Thus, we also have to assume that  $\Phi = 0$  in this case.

### 2.1.5 Macroeconomic Constraints

For labour-market equilibrium<sup>16</sup>, the (ex-post) equality of labour supplied and demanded is

$$L = N \equiv \int_0^n N(j) \cdot dj. \quad (18)$$

where  $N(j) = \sum_{i=1}^h N_i(j)$  is employment in industry  $\mathfrak{S}(j)$ . Notice that  $N$  gives us total labour demand (both productive and "administrative"). Taking into account equilibrium symmetry, labour demand is given by  $n \cdot h \cdot (y + \Phi)$ , where  $y$  stands for the equilibrium output of each firm. Real aggregate output is given by<sup>17</sup>

$$Y = \frac{1}{P} \int_0^n p(j) \cdot d(j) \cdot dj. \quad (19)$$

In a symmetric equilibrium  $Y = n \cdot h \cdot p \cdot y / P$ . Note that, taking into account equation (7) and equilibrium symmetry, we obtain  $P = n^{\lambda/(1-\sigma)} \cdot p$ . By substituting it in equation (16), we finally obtain the fundamental identity of national accounting  $Y = D$ .<sup>18</sup>

We have also the value of non-wage income given by the sum of the profits of all firms in the economy:

$$\Pi = \int_0^n \Pi(j) \cdot dj. \quad (20)$$

where  $\Pi(j) = \sum_{i=1}^h \Pi_i(j)$ .

We choose the CES basket to be the *numéraire*,  $P = 1$ , so that from (7), we can obtain the price posted in each industry:

$$p = n^{\frac{\lambda}{\sigma-1}}. \quad (21)$$

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<sup>16</sup>Imperfect competition cannot, by itself, generate unemployment equilibria in our model.

<sup>17</sup>Since there are no intermediate outputs, revenue equals value added, gross output equals net output.

<sup>18</sup>This result does not depend upon microeconomic equilibrium symmetry, but it is more easily obtained under this assumption.

Note this price diverges from the general level when there is some taste for variety ( $\lambda > 0$ )<sup>19</sup>. Using equation (17.a), we can obtain the equilibrium (real) wage rate that is represented by the following expression, given the mark-up level:

$$w = (1 - \mu) \cdot n^{\frac{\lambda}{\sigma-1}}. \quad (22)$$

Here, besides the love-for-variety effect, we can observe that a larger market power implies a smaller wage, as it contracts labour demand. The corresponding aggregate labour demand can be written as a function of aggregate output, the mass of industries, and the number of firms per industry:

$$L = Y + n \cdot h \cdot \Phi, \quad (23)$$

where the first term on the right-hand side corresponds to the directly productive labour input and the second one represents "administrative" labour (the overhead fixed cost for the economy).

Aggregate profits can also be re-written as

$$\Pi = \mu \cdot Y - (1 - \mu) \cdot n^{1+\frac{\lambda}{\sigma-1}} \cdot h \cdot \Phi, \quad (20.a)$$

i.e. it is an increasing function of both the aggregate output and the mark-up level, and a decreasing function of both the mass of industries and the number of firms per industry.

### 2.1.6 A General Formulation for the Equilibrium

In order to deal with the various models that are nested in this general framework, we will write down the equilibrium values for the wage rate, employment, and non-wage income as functions of the government-consumption level<sup>20</sup>. We

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<sup>19</sup>See Costa and Dixon (2009), section 5.3.

<sup>20</sup>To simplify notation we ignore other exogenous variables and parameters.

will not have to explicitly define these functions given the fact that we are only interested on the effects of fiscal policy:

$$\begin{aligned} w^* &= w(G); \\ L^* &= L(G); \\ \Pi^* &= \Pi(G); \end{aligned} \tag{24}$$

where asterisks identify the macroeconomic-equilibrium values for these variables.

Given both fiscal-policy behaviour types considered in equations (10.I and II), have still to consider that:

$$\begin{aligned} T_0^* &= T_0(G) && \text{in case I;} \\ t^* &= t(G) && \text{in case II } (T_0 = 0). \end{aligned} \tag{25}$$

Using the fundamental identity of national accounting, the aggregate-demand definition, the consumption function, and the government budget constraint given above, we can write an equation that gives us the equilibrium value for aggregate output  $Y = D$ :

$$Y = \mathfrak{C}(w(G) \cdot (1 - t(G)), \Pi(G) \cdot (1 - t(G)) - T_0(G)) + G. \tag{26}$$

Output equals consumption, which depends on after-tax wages and profits, plus  $G$ . From this equation we can easily see that the equilibrium value of output is a function of  $G$ :  $Y^* = Y(G)$ . Once we have found the value of  $Y^*$ , we can obtain all the additional equilibrium values that depend on it, namely  $C^*$  and  $U^*$ , the latter representing the equilibrium value for households' utility (welfare).

## 2.2 Fiscal Policy Effectiveness

From equation (26) we can obtain the value of the output government-consumption multiplier,  $m^* = dY^*/dG$ , using a first-order Taylor approximation and the implicit-function theorem:

$$dY = (1 + (1 - t^*) \cdot (\mathfrak{C}_{\omega_N}^* \cdot w_G^* + \mathfrak{C}_{\pi_N}^* \cdot \Pi_G^*)) \cdot dG - (w^* + \Pi^*) \cdot dt^* - \mathfrak{C}_{\pi_N}^* \cdot dT_0^*, \tag{27}$$

where we have  $dT_0^* = (1 - t^* \cdot m^*) \cdot dG$ ,

$$dt^* = \begin{cases} 0 & \text{in case I;} \\ \frac{1-g^* \cdot m^*}{Y^*} \cdot dG & \text{in case II;} \end{cases}$$

and  $g^* = G/Y^* \in [0, 1)$  is the weight of public consumption in aggregate expenditure.

We can expect  $m^*$  to be positive in most cases, but the main goal of this section is analysing it in specific situations, according to the various hypothesis advanced by many authors from the middle 1980's onwards. Furthermore, we are especially interested in the effect of the market power on fiscal policy effectiveness, i.e. we will analyse the sign of

$$\frac{\partial m^*}{\partial \mu}. \tag{28}$$

Finally, the analysis of fiscal policy effectiveness on households welfare can simply be done in the following way: if  $m^* > 0$ , then an expansionary fiscal policy will imply a leisure loss, as labour is the only input. Thus, welfare will only increase if private consumption positively reacts to an increase in public consumption and so that it more than offsets the previous leisure reduction. In the next sub-section we will survey the main results of this strand of literature.

## 2.3 A Brief Survey of the Literature

### 2.3.1 The Initiators: Dixon and Mankiw

The first works exclusively dedicated to this topic are Dixon (1987) and Mankiw (1988), which share the following assumptions:

1. A Cobb-Douglas utility function

$$U = C^\alpha \cdot Z^{1-\alpha} \quad \text{with } 0 < \alpha < 1. \tag{1.A}$$

2. Absence of income-dependent taxes ( $t^* = 0$ ).

3. Absence of love for variety ( $\lambda = 0$ ).
4. A fixed number of firms per industry ( $h = 1$ ), i.e. a constant mark-up given by  $\mu = 1/\sigma$ .
5. A fixed mass of industries ( $n$ ).

Considering these assumptions, we have a consumption function given by

$$C = \alpha \cdot \frac{w + \Pi - T_0}{P}, \quad (\text{unrecognized8.A})$$

i.e. the marginal propensity to consume is constant and identical for all types of income ( $\mathfrak{C}_{\omega_N}^* = \mathfrak{C}_{\pi_N}^* = \alpha$ ). With a constant mark-up and no love for variety, the equilibrium wage rate is also constant and given by<sup>21</sup>  $w^* = 1 - \mu$ . Thus, we know this equilibrium wage will not react to fiscal policy, i.e.  $w_G^* = 0$ . From equation (20.a) the reaction of non-wage income to fiscal policy is given by  $\Pi_G^* = \mu \cdot m^*$ .

Considering case I ( $dT_0^* = dG$ ), we conclude that

$$m^*|_{dT_0^*=dG} = \frac{1 - \alpha}{1 - \alpha \cdot \mu} > 0, \quad (\text{unrecognized27.A})$$

i.e. a unit increase in  $G$  induces an equilibrium output increase of  $0 < 1 - \alpha < (1 - \alpha)/(1 - \alpha \cdot \mu) < 1$ .

Figure 1 pictures the multiplier mechanism in the following way. First, consider that in the initial equilibrium government expenditure is zero ( $G = 0$ ) and profits are also zero ( $\Pi^* = 0$ ). On the left-hand panel we can depict the microeconomic decision in the leisure-consumption space using two simple graphical tools: the upward-sloping income-expansion path and the downward-sloping budget constraint. The former corresponds to equating the marginal rate of substitution between leisure and consumption ( $MRS_{Z,C} \equiv U_Z/U_C = (1 - \alpha) \cdot C / (\alpha \cdot Z)$  in this model) to the real net wage ( $\omega_N^* = 1 - \mu$  here). The later is just taken from equation (4), given the equilibrium values for the wages, profits, and taxes.

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<sup>21</sup> See equation (22).



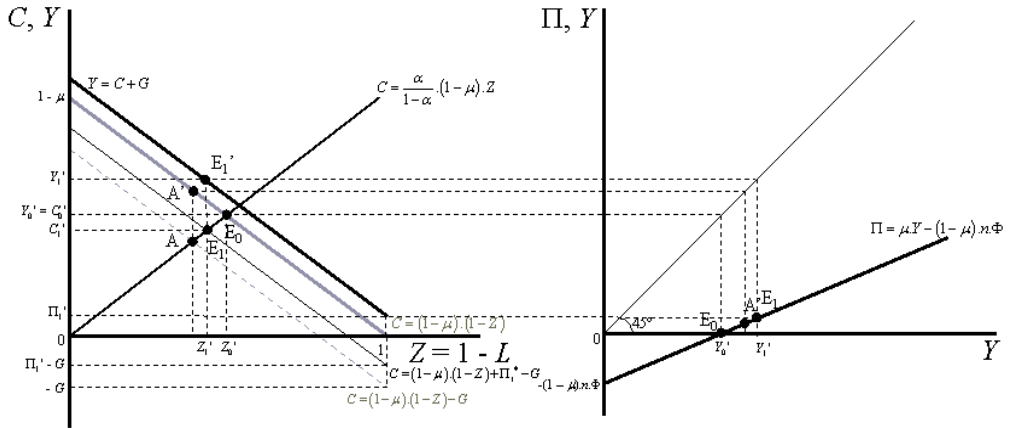


Figure 1: The Multiplier in the Dixon-Mankiw Model - Case I

Thus, the microeconomic equilibrium for the representative household is given by point  $E_0$  where it chooses an amount of leisure equal to  $Z_0^*$  and an amount of consumption given by  $C_0^*$ . Since there is no government consumption, the macroeconomic equilibrium in this space is represented by a "production possibilities frontier" between output and leisure that is given by the  $Y = C$  schedule, the same as the household budget constraint. On the right-hand panel, we can represent the increasing relationship between total income and profits that corresponds to equation (20.a)

Now, let us introduce government consumption given by  $G > 0$ . The first effect on the left-hand panel is that the macroeconomic-equilibrium representation is now different from the microeconomic one, i.e. the  $Y = C + G$  curve stands above households budget constraint. However, the initial demand stimulus is also perceived by households as a tax increase, since  $dT_0^* = dG$ . Thus, the microeconomic budget constraint shifts down by the amount of lump-sum taxes ( $G$ ). The negative income effect moves the optimal decision of households from  $E_0$  to  $A$ , reducing both consumption and leisure. Nonetheless, the macroeconomic  $Y = C + G$  curve does not move, and that means output increases to point  $A'$ . Consequently, due

to the demand expansion, profits increase, as shown by point A' in the right-hand panel. Thus, the microeconomic budget constraint shifts upwards and households increase both leisure and consumption. But then, the macroeconomic constraint also shifts upwards, profits increase and so on until the process ends in a new equilibrium represented by points  $E_1$  (in both panels) and  $E_1'$  (in the left-hand panel).

In a nutshell, the "initial" demand stimulus of one unit of government consumption is partially crowded out, leading to a output increase of  $0 < 1 - \alpha < 1$  and then to a profits increase of  $\mu \cdot (1 - \alpha)$ , before the second "round" starts. Notice the output increase can be easily explained by the labour-supply side: more government expenditure means more taxes and these have a positive effect on labour supply that more than offsets the negative effect of profits<sup>22</sup>. Thus, households are willing to work longer hours as their disposable income decreases, the same reason that makes them consume less.

We observe that fiscal policy effectiveness on output is an increasing function of the degree of monopoly that exists in the economy:

$$\left. \frac{\partial m^*}{\partial \mu} \right|_{dT_0^* = dG} = \alpha \cdot \frac{1 - \alpha}{(1 - \alpha \cdot \mu)^2} > 0. \quad (28.A)$$

In order to explain what happens, let us use Figure 2. This figure is very similar to Figure 1, but it assumes a larger mark-up level ( $\mu_1 > \mu_0$ ), i.e. a smaller elasticity of substitution amongst goods. To keep zero profits in the initial equilibrium, we also assume a larger fixed cost ( $\Phi_1 > \Phi_0$ ). As we can see in the left-hand-side panel, the larger mark-up level induces a smaller equilibrium wage rate, inducing a downward rotation on the income expansion path around the origin and also a downward rotation of the budget constraint about point (1,0). On the right-hand side, a larger mark-up rotates the profit function up, but the larger fixed costs shifts it down in a parallel way.

Since the mechanism is similar to the one described in Figure 1, we can notice the output increase ( $Y_1^* - Y_0^*$ ) is larger here than before, with a weaker monopoly

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<sup>22</sup>Remember that  $\mu < 1$ .

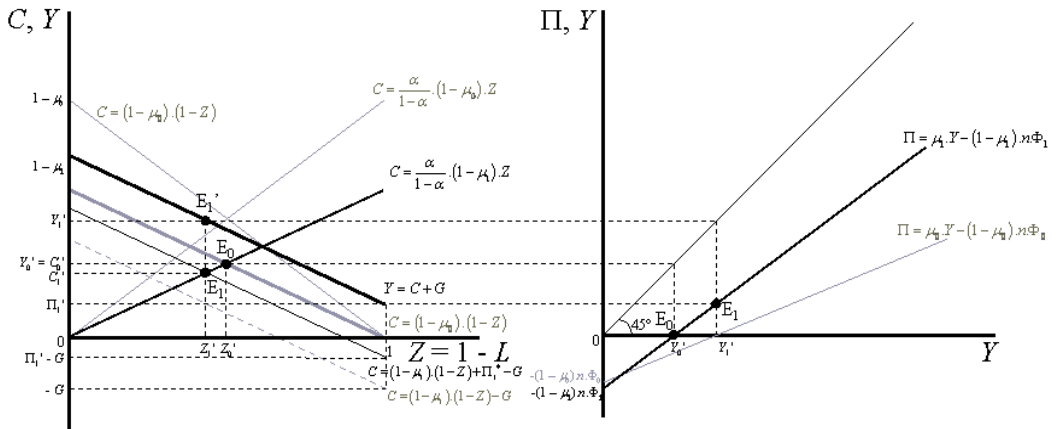


Figure 2: The Multiplier and the Mark-up in the Dixon-Mankiw Model - Case I

power. So why does this happen? The answer lies on the combination of three effects: i) there is a negative substitution effect on labour supply due to the lower wage rate; ii) but the income effect of the lower wage rate is positive; and iii) there is a negative effect on labour supply due to larger profits. The net effect on labour supply is clear-cut: people want to increase hours worked by more than in the case depicted in Figure 1. This is due to the reinforced negative effect of taxes when the wage rate is lower. However, the crucial effect is the last one: a higher mark-up induces a larger profit windfall that will lead to a larger consumption by households, reinforcing the second-round effect of the multiplier.

Given the similarity of this mechanism to the basic Keynesian model, some authors (e.g. Mankiw) identified it with the traditional Keynesian spirit. However, Dixon (1987) draws our attention to the fact that the economic mechanism that supports this outcome has much more to do with the Walrasian spirit than with the Keynesian one<sup>23</sup>. In fact, the consumption-leisure choices made by households are basically the same under an expansionary fiscal policy either we face perfect or imperfect competition. The main difference has to do with the division

<sup>23</sup>This was a point also made by Bénassy (1995).

of income between wage and non-wage income which is affected by the degree of imperfect competition. The effect of fiscal policy on welfare is clear: output increases by less than public consumption. Thus, private consumption decreases due to the effect of higher taxes. Therefore, households work harder and their welfare decreases as a consequence of both effects.

### 2.3.2 Taxation

One extension of Dixon (1987) and Mankiw (1988) is to allow a more realistic income tax ( $T_0^* = 0$  and  $0 < t^* < 1$ ) to finance government expenditure, as in Molana and Moutos (1991).

In what concerns to households, their behavioural functions are now given by

$$C = \alpha \cdot (1 - t) \cdot \frac{w + \Pi}{P}, \quad (8.B)$$

$$L = 1 - (1 - \alpha) \cdot (1 - t) \cdot \frac{w + \Pi}{w \cdot (1 - t)}. \quad (9.B)$$

Here, considering there are no (net) lump-sum taxes, we are in case II, i.e. we have  $dt^* = (1 - m^* \cdot g^*) \cdot dG/Y^*$  to substitute in equation (27). Thus, we obtain an equilibrium multiplier given by

$$m^* \Big|_{dt^*=(1-m^* \cdot g^*) \cdot dG/Y^*} = \frac{Y^* - \alpha \cdot (1 - \mu + \Pi^*)}{\Delta_B}, \quad (27.B)$$

where  $\Delta_B = Y^* - \alpha \cdot (1 - \mu + \Pi^*) + \alpha \cdot (1 - g^*) \cdot (1 - \mu + \Pi^* - \mu \cdot Y^*)$ .<sup>24</sup> At first sight, the numerator, and also the denominator, appears to be either positive or negative. However, since we know that  $C^* = (1 - g^*) \cdot Y^*$  and using equation (8.B) in addition, we have  $C^* = \alpha \cdot (1 - t^*) \cdot (1 - \mu + \Pi^*)$ . If we also consider

<sup>24</sup>Since we know that, in equilibrium, we have  $-(1 - \mu) < \Pi^* - \mu \cdot Y^* = -(1 - \mu) \cdot n \cdot \Phi < 0$ , then we obtain  $\Delta_B = Y^* - \alpha \cdot (1 - \mu + \Pi^*) + \alpha \cdot (1 - g^*) \cdot (1 - \mu) \cdot (1 - n \cdot \Phi)$ . The constraint  $n \cdot \Phi < 1$  is a consequence of having  $1 \geq L \geq N \geq n \cdot m \cdot \Phi \geq 0$ .

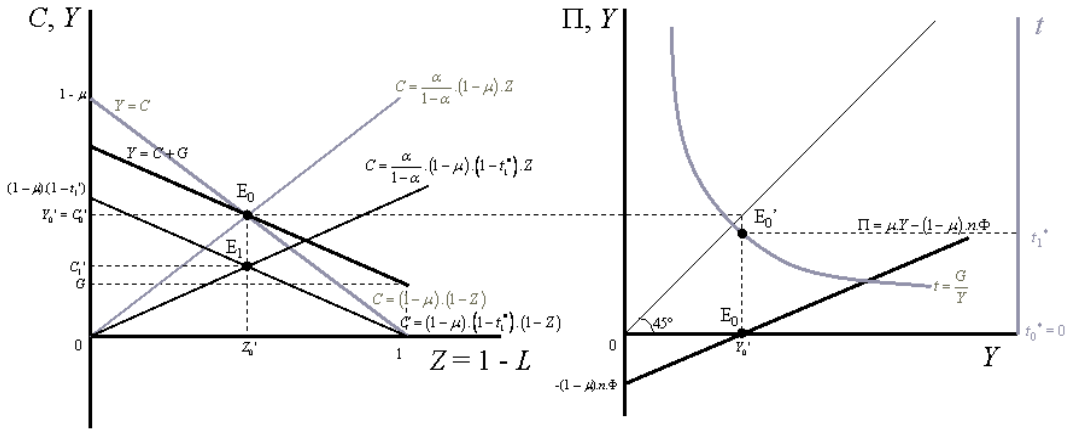


Figure 3: The Multiplier with Proportional Taxes - Case II

that the government budget constraint implies that  $t^* = g^*$ , it is simple to see that  $Y^* = \alpha \cdot (1 - \mu + \Pi^*)$ . Therefore,  $m^*|_{dt^*=(1-m^* \cdot g^*) \cdot dG/Y^*} = 0$ , i.e. fiscal policy is absolutely ineffective in this case  $\Pi^{25}$ .

In Figure 3 we can observe what happens, starting from an initial equilibrium  $E_0$  with  $G = 0$ ,  $t^* = 0$ , and  $\Pi^* = 0$ . On the left-hand-side panel we now have a secondary axis to represent the tax rate, a decreasing function of output given  $G > 0$ . Thus, when positive government consumption is introduced, the tax rate increases from zero to  $t_1^* > 0$ . This implies a downward rotation of both the income expansion path and the budget constraint. In the new equilibrium  $E_1$ , private consumption was completely crowded out by government consumption and output, leisure, and profits remain unchanged, given the functionals assumed. Since there is no effect on output, consumption decreases hence welfare falls after an increase in government expenditure.

<sup>25</sup>With the information obtained for the numerator, we know now that  $\Delta_B = \alpha \cdot (1 - g^*) \cdot (1 - \mu) \cdot (1 - n \cdot \Phi) > 0$ .

So, why is there such a dramatic loss of effectiveness? Contrary to case II, here an increase in public consumption only presents a potential substitution effect on labour supply, as it implies a tax-rate increase. However, this tax-rate increase has identical consequences on profits and wages, as they are both taxed at the same rate. Thus, the incentive to work more ceases to exist, unless profits decrease. But to have a decrease in profits, we would need an output fall and that is not compatible with an increase in employment in this case. Molana and Moutos (1991) also demonstrate that, when taxes are levied only on wage income, we may even obtain a negative multiplier.

### 2.3.3 Entry

Dixon (1987) and Mankiw (1988) models assume the economy is in a "short-run" situation, i.e. firms are not allowed to enter or leave the productive sector. However, in the Marshallian "long run," entry and exit will occur until profits are zero. Startz (1989) presents a "long-run" model using the basic assumptions in both Dixon (1987) and Mankiw (1988)<sup>26</sup>. This framework has been called the Dixon-Mankiw-Startz (DMS) model. Since there is no uncertainty, dynamics, or cost of creating a new firm (or shutting down and existing one), the zero-profit condition is  $\Pi^* = 0$ .

Therefore, non-wage income ceases to respond to fiscal-policy impulses, as  $\Pi_G^* = 0$ . This feature cuts the transmission mechanism through profits into consumption and from consumption to aggregate demand again. Then, the multiplier is given by

$$m^* \Big|_{\substack{dT_0^*=dG \\ \Pi_G^*=0}} = 1 - \alpha > 0. \quad (27.C)$$

This multiplier is still positive, in the  $(0, 1)$  interval, but it does not depend on the degree of monopoly power: fiscal policy effectiveness would be identical in the Walrasian case ( $\mu = 0$ ) and in all imperfectly competitive cases ( $0 < \mu < 1$ ).

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<sup>26</sup>In fact, Startz (1989) uses a Stone-Geary utility function instead of a Cobb-Douglas. However, the latter can be seen as a particular case of the former and the crucial property for the results obtained (i.e. constant marginal utility shares) is kept with a much simpler Cobb-Douglas function.

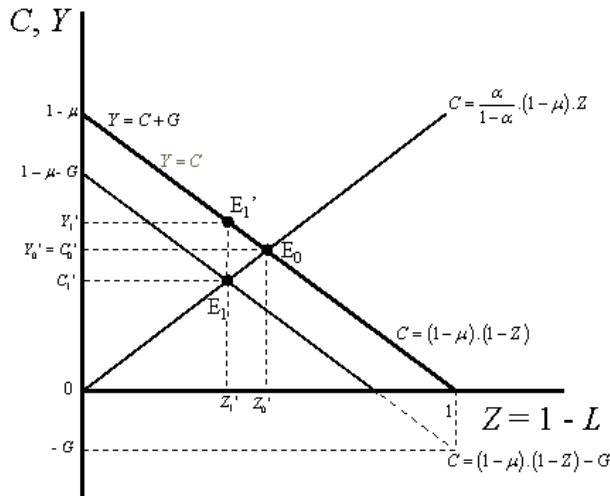


Figure 4: The Free-entry Multiplier of Startz

Figure 4 shows us what is happening in the free-entry model. There is no need for the right-hand-side panel as profits are compressed to zero by entry and exit. Thus, an increase in  $G$  shifts the microeconomic budget constraint down and the income effect of higher taxes induce an increase in labour supply and a decrease in consumption. Therefore, aggregate output increases, but there is a partial crowding out of private consumption of  $\alpha$  units for each unit of government consumption.

We can also notice that a change in  $\mu$  moves the income expansion path and the budget constraint, but it does not alter the result in terms of fiscal policy effectiveness as they both rotate in the same proportion like in the flat-rate-tax case. Furthermore, we can observe the free-entry (or "long-run") multiplier, given by equation (27.C), is smaller than the no-entry ("short-run") multiplier given by equation (27.A):

$$\Gamma_{A(C)}^* \equiv \frac{m^*|_{dT_0^*=dG}}{m^*|_{dT_0^*=dG}} = 1 - \alpha \cdot \mu < 1.$$

As we saw when comparing both models with the same lump-sum tax financing public expenditure, the main difference between these two types of model is the way profits distribution affects private consumption. Once this mechanism is shut down, only the income effect in labour supply leads to increased output.

### 2.3.4 Preferences

The main result of Startz (1989) is extremely appealing, as it eliminates the profit-multiplier mechanism. Dixon and Lawler (1996) consider what happens when we generalise the assumption on preferences<sup>27</sup>. If we keep the assumptions of the DMS framework, but allow for general preferences, the no-entry multiplier is given by

$$m^*|_{dT_0^*=dG} = \frac{1 - \mathfrak{C}_{\pi_N}}{1 - \mathfrak{C}_{\pi_N} \cdot \mu} > 0, \quad (27.D1)$$

which is positive and less than one if we assume the marginal propensity to consume of net non-wage income is restricted to the  $(0, 1)$  interval, as in the particular case of the DMS framework where  $\mathfrak{C}_{\pi_N} = \alpha$ .

Considering free entry, we obtain the "long-run" multiplier given by

$$m^*|_{dT_0^*=dG} = 1 - \mathfrak{C}_{\pi_N} > 0, \quad (27.D2)$$

which was constant and equal to  $1 - \alpha$  in the particular case of Startz (1989).

Assuming  $u(\cdot)$  still represents homothetic preferences, the graphical representations are similar to Figures 1 and 4 and the only difference is that the income

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<sup>27</sup>In fact, that article also demonstrates Startz's result also depends upon the production technology. However, we will not analyse that side of the story here.



expansion path is now given by  $C = \Sigma(1 - \mu) \cdot Z$ , where  $\Sigma(\cdot)$  is a general increasing function. If we assume preferences are not homothetic, the income expansion path becomes non-linear, but the outcomes are identical. Furthermore, it is easy to observe the no-entry multiplier is larger than the free-entry one:

$$\Gamma_D^* \equiv \frac{m^*|_{dT_0^*=dG}}{\Pi_G^*=0} = 1 - \mathfrak{C}_{\pi_N} \cdot \mu < 1,$$

and this result is also easily explained by the neutralisation of the profit effect<sup>28</sup>.

Thus, the previous results are similar to the DMS framework and we only have to substitute  $\alpha$  by  $\mathfrak{C}_{\pi_N}$ . However, in general, the marginal propensity to consume of profits depends upon the mark-up. Therefore, the "long-run" fiscal multiplier is the larger (smaller) the larger (smaller) the market power in the economy, when  $\mathfrak{C}_{\pi_N}$  is decreasing (increasing) with  $\mu$ .<sup>29</sup>

### 2.3.5 Increasing Returns to Variety

Let us now return to the functionals assumed in the DMS model. However, we assume there is some taste for variety, i.e.  $\lambda > 0$ . In this case, equation (22) tells us that, for a given mark-up level, the real wage is an increasing function of the mass of goods existing in the economy.

This love-for-variety assumption is explored in Heijdra and van der Ploeg (1996). Devereux et al. (1996) present a (dynamic) model where there is a love-for-variety technology, known as increasing returns to specialisation, with intermediate inputs in the production function.

When the mass of firms and goods ( $n$ ) is fixed, i.e. when there is no entry or exit, the fiscal multiplier is still given by equation (27.A). However, if firms

<sup>28</sup>Dixon and Lawler (1996) also demonstrate this is not always the case when production technology does not exhibit constant marginal returns.

<sup>29</sup>Costa and Dixon (2009) provide a useful example using the CES preferences in Heijdra and van der Ploeg (1996).

are free to enter or leave the market, their mass becomes an endogenous variable given by

$$n^* = \left( \frac{\mu \cdot Y^*}{(1-\mu) \cdot \Phi} \right)^{1-\gamma}; \quad \gamma = \frac{\lambda}{\lambda + \sigma - 1} \in [0, \mu], \quad (29)$$

from the free-entry condition  $\Pi^* = 0$ .

Thus, an aggregate-demand increase induces an increase in real wages that will affect fiscal policy effectiveness as<sup>30</sup>

$$w_G^* = \gamma \cdot \frac{w^*}{Y^*} \cdot m^* = \frac{\gamma}{\alpha} \cdot (1 - (1 - \alpha) \cdot g^*) \cdot m^* > 0,$$

i.e. entry of firms, a consequence of the aggregate demand stimulus, leads to a real-wage increase and consequently to a consumption increase, opening a transmission channel similar to the profit one in the no-entry model. In this case, the multiplier is given by

$$m^* \Big|_{\substack{dT_0^* = dG \\ \Pi_G^* = 0}} = \frac{1 - \alpha}{1 - \gamma \cdot (1 - (1 - \alpha) \cdot g^*)} \geq 0. \quad (27.E)$$

Notice that, due to  $\lambda > 0$  we have  $\gamma > 0$  and consequently a larger multiplier than in the free-entry constant-returns case  $(1 - \alpha)$ .

On the left-hand-side panel of Figure 5 we can observe that fiscal policy would change the equilibrium from point  $E_0$  to point A. That is the situation depicted in Figure 4, corresponding to a fixed-wage environment. However, point A is not an equilibrium in this model, as the real wage is a function of the aggregate output  $w^* = \Omega(Y)$  with  $\Omega'(\cdot) > 0$ . This fact can easily be observed by combining equations (22) and (29). Therefore, a higher output induce new firms to enter and that stimulates aggregate demand via private consumption in the case of love for

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<sup>30</sup>See Costa and Dixon (2009), section 5.4.

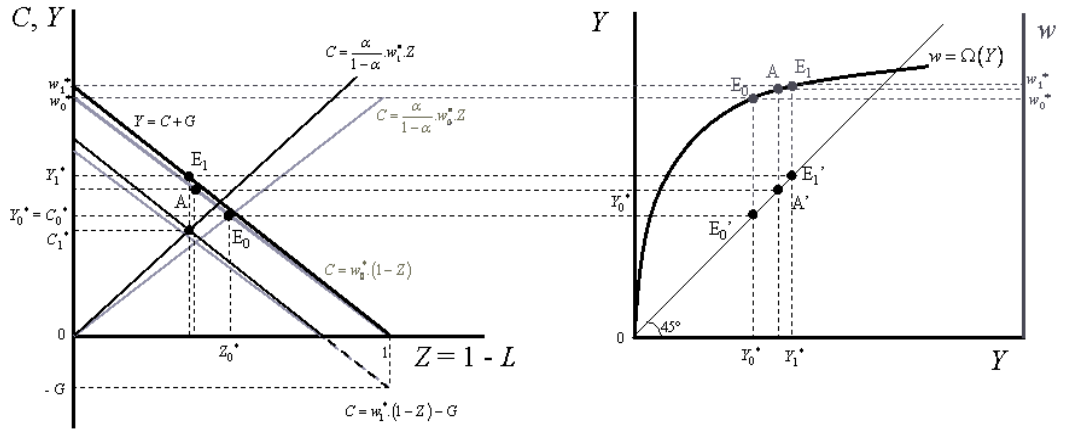


Figure 5: The Multiplier with a Varying Real Wage

variety and labour demand in the case of increasing returns to specialisation. In any case, the equilibrium wage rate goes up, as we can observe on the secondary axis of the right-hand-side panel of Figure 5. The wage increase rotates the income expansion path, the household budget constraint, and the macroeconomic constraint up in the left-hand-side panel. The new equilibrium is finally reached in point  $E_1$  with a larger output and a smaller decrease in private consumption.

Despite the fact that we are using a consumption function with constant marginal propensities to consume, this multiplier depends upon the monopoly power level in the economy through  $g^*$  and  $\gamma = \mu \cdot \lambda / (\mu \cdot \lambda + 1 - \mu)$ . It is simple to demonstrate that  $\gamma$  is increasing with the mark-up<sup>31</sup>, but it is not so easy to show how does  $g^*$  depends on  $\mu$ . At first glance, one could think the weight of public consumption in output should be increasing with the monopoly degree, as it means more inefficiency, thus less output. However, taking into account net profits are zero, the macroeconomic production function can be represented as

<sup>31</sup>  $\frac{\partial \gamma}{\partial \mu} = \frac{\gamma^2}{\lambda \cdot \mu^2} \geq 0$ .

$$Y = (1 - \mu) \cdot n^{\frac{\lambda}{\sigma-1}} \cdot L.$$

In the equation above we can observe that, for the same employment level, an increase in  $\mu$  leads to a reduction in the term  $(1 - \mu)$ , but it also increases the exponent, as it corresponds to a reduction in  $\sigma$ . This means that the monopoly degree under monopolistic competition reinforces the effect of increasing returns. There is also an indirect effect that acts through  $n$ , since an increase in  $\mu$  stimulates entry.

Therefore, we can easily determine what is the effect on the multiplier when we start from a zero-government-consumption steady state

$$\frac{\partial m^*}{\partial \mu} \Big|_{\substack{dT_0^*=dG \\ \Pi_G^*=0 \\ g^*=0}} = \frac{1 - \alpha}{(1 - \gamma)^2} \cdot \frac{\lambda}{(1 - \mu \cdot (1 - \lambda))^2} \geq 0.$$

In this particular case, the larger is the market power, the larger is the entry effect on the real wage, increasing the effectiveness of the initial fiscal stimulus. An identical outcome can be obtained for situations where  $g^*$  does not react dramatically to changes in the mark-up. Using numerical simulations with plausible values for the parameters, we also obtain a multiplier that is an increasing function of  $\mu$ .

Now comparing the "short-" and "long-run" multipliers, we observe that

$$\Gamma_E^* \equiv \frac{m^* \Big|_{\substack{dT_0^*=dG \\ \Pi_G^*=0}}}{m^* \Big|_{dT_0^*=dG}} = \frac{1 - \alpha \cdot \mu}{1 - \gamma \cdot (1 - (1 - \alpha) \cdot g^*)}.$$

Considering that  $\gamma$  and  $g^*$  depend upon the values of other parameters in the model, it is not possible to say *a priori* if this value is larger or smaller than one. Thus, we know that for  $\mu < \frac{\gamma \cdot [1 - (1 - \alpha) \cdot g^*]}{\alpha}$  the free-entry ("long-run") multiplier is larger than the multiplier with a fixed mass of firms, given the positive externality caused by the entry of new firms. The opposite result is obtained when the mark-up is high.

### 2.3.6 Endogenous Mark-ups

The assumption that entry of firms is done through the creation of new monopolies associated to new products hides an additional assumption that product innovation is cheaper than copying an existing good or creating a close substitute. When facing significant costs associated with creating a differentiated product, the incentive to create a new industry may be smaller than the incentive to enter an existing industry. Thus,  $h$  may be the endogenous variable in our free-entry model instead of  $n$ .<sup>32</sup>

Up to this point, we considered that  $\mu$  was a constant, as we assumed that both  $h$  was fixed (and equal to one, a basic assumption in monopolistically competitive models) and also that  $\sigma$  was fixed due to CES preferences<sup>33</sup>. When we alter the endogenous variable in the entry process, we also endogenise  $\mu = 1/(\sigma \cdot h)$ . This value can be obtained through the zero-profit condition, assuming once again there is no love for variety ( $\lambda = 0$ ):

$$\mu^* = \frac{\phi^*}{1 + \phi^*}, \quad (30)$$

where  $\phi^* = n \cdot \Phi / Y^*$  is an increasing returns to scale indicator for the production function and it represents the weight of total fixed costs in aggregate output. We can notice its equilibrium value is a decreasing function of the equilibrium output. Note that, in this case, the market power has a negative correlation with aggregate output, which is consistent with counter-cyclical mark-ups as documented in the empirical literature<sup>34</sup>.

Despite the fact this hypothesis is considered in Dixon and Lawler (1996), the treatment of fiscal-policy effectiveness in an endogenous-mark-up framework is done in Costa (2004). However, there are other endogenous-mark-ups models,

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<sup>32</sup>For a more detailed analysis of the underlying process and its fundamentals see Costa and Dixon (2007).

<sup>33</sup>Throughout the text we loosely use the expression "endogenous mark-ups," as widely used in the literature, to signify "varying mark-ups," as  $\mu$  is always endogenous even when it is equal to  $1/\sigma$ . We thank an anonymous referee for highlighting this point.

<sup>34</sup>E.g. see Martins et al. (1996) or Martins and Scarpetta (2002).

though not specifically dedicated to fiscal-policy effectiveness, that are surveyed in Rotemberg and Woodford (1999).

In the case treated here, it is the real wage that reacts to fiscal policy, as we have  $w^* = 1 - \mu^*$ . Nonetheless, considering the reduced-form macroeconomic production function with free entry  $Y = (1 - \mu) \cdot L$ , the endogenous mark-up may work as a productivity shock, but it originates in the aggregate-demand side in the case of fiscal policy<sup>35</sup>.

Thus, an increase in public consumption translates into a mark-up reduction, i.e. a real-wage increase  $w_G^* = (\mu^*)^2 \cdot m^* / (n \cdot \Phi) > 0$ . Therefore, the increase in intra-industrial competition induced by an expansionary fiscal policy leads to a second stimulus in private consumption, via real wages, reinforcing the multiplier mechanism and acting as a positive externality:

$$m^* \Big|_{\substack{dT_0^* = dG \\ \Pi_G^* = 0}} = \frac{1 - \alpha}{1 - \frac{(\mu^*)^2}{n \cdot \Phi}} \geq 0. \quad (27.F)$$

The graphical representation of this mechanism is also given by Figure 5, where  $w^* = \Omega(Y)$  is obtained from equation (30). Despite the difference in the economic mechanism, the real-wage transmission mechanism is similar to the previous model.

Considering that  $\mu$  is now an endogenous variable, it makes no sense to calculate the derivative of this multiplier in order to the mark-up. However, any change in the parameter values or exogenous variables that leads to a higher mark-up (e.g. a smaller public consumption or a higher fixed cost) induces an increase in fiscal policy effectiveness.

Finally, considering the no-entry mechanism is the same as in the previous case, we have

$$\Gamma_F^* \equiv \frac{m^* \Big|_{\substack{dT_0^* = dG \\ \Pi_G^* = 0}}}{m^* \Big|_{dT_0^* = dG}} = \frac{1 - \alpha \cdot \mu}{1 - \frac{(\mu^*)^2}{n \cdot \Phi}}.$$

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<sup>35</sup>There is a recent interest in this subject in the business-cycle literature. For an example, see Barro and Tenreyro (2006), *inter alia*.

Thus, near the initial equilibrium where  $\mu = \mu^*$ , the "long-run" multiplier is larger than the "short-run" one, as long as the monopoly power indicator is sufficiently large, i.e. as long as  $\mu^* > \alpha.n.\Phi$ .

D'Aspremont et al. (1995) provide an earlier analysis of fiscal policy in a Cournotian framework for an overlapping-generations economy with a single produced good.

Molana and Zhang (2001) study the steady-state effects in an intertemporal model similar to Costa (2004), where they assume that  $\mu = \mu(n)$  with  $\mu'(n) < 0$ . In a way similar to Galí (1995), these authors assume that there is imperfect competition in intermediate goods markets used to produce final goods and where a larger mass of varieties increases the elasticity of substitution amongst them. Despite the different endogenous mark-up generation mechanism, the qualitative results are similar<sup>36</sup>.

In both the endogenous mark-up and the taste for variety (or increasing returns to specialisation) cases, fiscal policy (or aggregate demand management policy in general) has a positive effect on the efficiency level in the economy. This allows the balanced-budget multiplier to be greater than one and simultaneously, for a given employment level, the output to be larger. Consequently, taking into account the multiplier effect of public over private consumption is given by  $m^* - 1$ , it is possible to obtain a positive final effect on households consumption. For the same reason, leisure will not decrease so much as in the previous cases.

Therefore, it is possible that fiscal policy, without any direct externalities, has a positive effect on households welfare as long as: i) the effect of the efficiency gain is large enough to guarantee that  $m^* > 1$  and ii) the increase in private consumption is sufficiently important to offset the reduction in leisure.

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<sup>36</sup>Chen et al. (2005) present a model that intends to extend the DMS framework to an endogenous-mark-up situation. However, as Costa and Palma (2007) notice, their model does not hold an endogenous mark-up mechanism, only a public-consumption externality in the production function.

### 2.3.7 Extensions and Generalisations

Many additional works try to analyse the relationship between market power and fiscal policy effectiveness, but we cannot go through all of them here. However, some of the most interesting results can be briefly described in this section.

Molana and Montagna (2000) introduce heterogeneity in the marginal product of labour in a DMS-style framework, also keeping love for variety. There, the zero-profit condition only applies to the "marginal firm (industry)," the reason why its more efficient competitors present positive profits. In their model, the absence of taste for variety leads to the entry of less efficient firms, so it reduces the average efficiency of the economy and also fiscal policy effectiveness. Love for variety tends to oppose this effect.

Torregrosa (1998) supplies a demonstration for the conjecture in Molana and Moutos (1991) stating that a negative multiplier can be obtained when there exist only proportional taxes on labour income. Reinhorn (1998) studies optimal fiscal policy in a framework where public consumption directly affects consumers utility.

Finally, Censolo and Colombo (2008) study the way fiscal policy effectiveness is influenced by differences between the composition of private and public expenditures, when different market structures (perfect and monopolistic competition) exist simultaneously in the same economy.

## 3 Intertemporal Models

In the following section, we will develop a dynamic general equilibrium model which corresponds most closely to the static models considered in the previous section.

### 3.1 Intertemporal Household

In particular, the instantaneous household utility follows as before: equations (1) and (2) with  $\lambda = 0$ . The infinitely-lived household has a discount rate of  $\rho > 0$



and, instead of (1), it maximises lifetime utility:

$$\max_{C,Z} U = \int_0^{\infty} u((C(\tau), Z(\tau)) \cdot e^{-\rho \cdot \tau} \cdot d\tau. \quad (31)$$

In the dynamic model the household owns capital  $K(\tau)$  at moment  $\tau$  which it rents out to firms at price  $R(\tau)$ : hence its total income at time  $\tau$  is as before, labour income  $w(\tau) \cdot L(\tau)$  and equity profits  $\Pi(\tau)$ , plus the income from capital  $R(\tau) \cdot K(\tau)$ .<sup>37</sup>

Notice that, with an infinitely-living household, Ricardian equivalence holds. Thus, since we are not interested in studying how public debt evolves overtime, nothing is lost if we assume government follows a balanced-budget rule at each moment  $\tau$ . Also, for simplicity, in this section we will assume that the government finances expenditure by a lump-sum tax  $P(\tau) \cdot G(\tau) = T_0(\tau)$ , i.e. we have  $t(\tau) = 0$ .

We still consider the preferences for varieties given by equation (2) and the resource constraint in equation (3). Therefore, the intertemporal budget constraint can be simply expressed in terms of aggregate variables. The household can choose to allocate its income between consumption or accumulating capital, given the tax to be paid. The accumulation of capital is thus:

$$\dot{K}(\tau) = \frac{w(\tau) \cdot L(\tau) + R(\tau) \cdot K(\tau) + \Pi(\tau)}{P(\tau)} - C(\tau) - G(\tau). \quad (32)$$

For simplicity we ignore time indices ( $\tau$ ) from this point onwards. Also, we continue to choose the composite good as numéraire, so  $P(\tau) = 1$ .

### 3.2 Firm and Production

For simplicity, we assume that there is one firm per industry:  $h = 1$  (monopolistic competition)<sup>38</sup>. Each instant  $\tau$ , the representative firm  $j \in [0, n]$  employs labour

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<sup>37</sup>We ignore depreciation of capital in order to keep the presentation simple. Considering a positive depreciation rate,  $\delta > 0$ , does not change the quality of results.

<sup>38</sup>Therefore, we do not need the subscript  $i$  to identify a firm, as we can use the good  $j$  it produces for the same purpose.

and capital to produce output:

$$y(j) = \max \{F(K(j), N(j)) - \Phi, 0\}. \quad (33)$$

where we assume that  $F_K > 0$ ,  $F_N > 0$ ,  $F_{KK} < 0$ ,  $F_{NN} < 0$ ,  $F_{KN} > 0$ , also that function  $F(\bullet)$  is homogeneous to degree 1 (HoD1), i.e. the technology would present constant returns to scale (CRtS) if  $\Phi$  was equal to zero, and the Inada conditions hold. The firm faces the demand curve (16) with  $h = 1$ . Given the real wage and rental on capital, the first-order conditions for profit maximization imply (in a symmetric industry equilibrium):

$$(1 - \mu) \cdot F_K(j) = R; \quad (1 - \mu) \cdot F_N(j) = w. \quad (34)$$

with the mark-up  $\mu = \sigma^{-1}$ . Since the marginal products of labour and capital are the same across all firms (this is ensured by competitive factor markets), we can rewrite the household's accumulation equation using (34) as

$$\dot{K} = (1 - \mu) \cdot (F_N \cdot N + F_K \cdot K) + \Pi - C - G.$$

Since function  $F(\bullet)$  HoD1 in  $(K, N)$ , by Euler's Theorem<sup>39</sup> we have

$$\dot{K} = (1 - \mu) \cdot F(K, N) + \Pi - C + G.$$

Furthermore, in a symmetric equilibrium where  $p(j) = P = 1$ , the profits of each firm are simply<sup>40</sup>:

$$\Pi(j) = p(j) \cdot y(j) - TC(j) = \mu \cdot F(K(j), N(j)) - \Phi,$$

so that aggregating across all firms with equilibrium in the capital market, i.e.  $K = \int_0^n K(j) \cdot dj$ , we have

$$\Pi = \mu \cdot F(K, N) - n \cdot \Phi. \quad (35)$$

Again, equilibrium in the labour market implies that  $N = L$ .

<sup>39</sup>When  $F(\bullet)$  is HoD1,  $F(K, N) = F_K \cdot K + F_N \cdot N$ .

<sup>40</sup>This follows from the homogeneity of  $F(\bullet)$ , and the relation between the marginal products, the mark-up, and the factor payments.

Under imperfect competition, a wedge is driven between the marginal product of each factor and the factor return: this leads to each additional unit of output yielding a marginal profit of  $\mu$ , since only a proportion  $(1 - \mu)$  is used to pay for labour and capital. There is also the overhead fixed cost, which may make the profit per firm negative or positive, depending upon the level of output.

### 3.3 The Household's Intertemporal Optimization

The household chooses  $(C(\tau), L(\tau))$  to maximize lifetime utility (31) subject to the accumulation equation (32), in effect a dynamic budget constraint. The current-value Hamiltonian for this intertemporal optimisation problem is

$$\mathcal{H} = u(C, 1 - L) + \xi \cdot (w.L + R.K + \Pi - C - G),$$

and the first-order conditions for this are

$$\begin{aligned} \mathcal{H}_C &\equiv u_C - \xi = 0; \\ \mathcal{H}_L &\equiv -u_Z + \xi \cdot w = 0; \\ \mathcal{H}_K &\equiv \xi \cdot R = -\dot{\xi} + \rho \cdot \xi; \\ \lim_{\tau \rightarrow \infty} [e^{-\rho \cdot \tau} \cdot \xi(\tau) \cdot K(\tau)] &= 0. \end{aligned}$$

Using (34) we can express  $(w, R)$  in terms of the marginal products. Hence, we derive two basic optimality conditions:

**Intra-temporal optimality** Once again<sup>41</sup>,  $M(C, Z)$ , the marginal rate of substitution between consumption and leisure equals the net real wage rate

$$M(C, Z) \equiv \frac{u_Z}{u_C} = (1 - \mu) \cdot F_N.$$

**Inter-temporal optimality** The *Euler condition*. Assuming that  $u_{CZ} = 0$ , i.e. assuming the felicity function is additively separable, this can be written as

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<sup>41</sup>See Costa and Dixon (2009), section 5.1.

$$\frac{\dot{C}}{C} = \theta \cdot [(1 - \mu) \cdot F_K - \rho],$$

where  $\theta \equiv -u_C / (C \cdot u_{CC})$  is the elasticity of intertemporal substitution in consumption.

### 3.4 Steady State

In the steady state, we have the condition that  $\dot{C} = 0$ . Hence the Euler condition implies that

$$(1 - \mu) \cdot F_K^* = \rho,$$

where asterisks stand for steady-state values. In the Walrasian case ( $\mu = 0$ ) this is just the modified golden rule. What imperfect competition does is to discourage investment, since the returns on investment are depressed (there is a wedge between the marginal product and the rental on capital).

Now, under the assumption that function  $F(\bullet)$  is HoD1, we can write it in factor intensive form  $F(K, L) = L \cdot F\left(\frac{K}{L}, 1\right) = L \cdot f(k)$ , where  $k \equiv K/L$ . Hence the steady-state Euler condition is

$$f'(k^*) = \frac{\rho}{1 - \mu}, \quad (36)$$

where  $f'(k) = F_K\left(\frac{K}{L}, 1\right) > 0$  and  $f''(k) = F_{KK}\left(\frac{K}{L}, 1\right) < 0$ .

With this particular market structure we can write the solution to this as  $k^* = k^*(\mu)$  with  $k^{*\prime}(\mu) < 0$ . With  $F(\bullet)$  HoD1, the steady-state Euler condition is very powerful: not only is the marginal product of capital determined, but so is the steady-state wage rate

$$w^*(\mu) = f(k^*(\mu)) - \frac{\rho \cdot k^*(\mu)}{1 - \mu}. \quad (37)$$

With this we have the income expansion path (IEP) for consumption and leisure, defined by the intertemporal optimality condition and the steady-state wage

$$\frac{u_Z^*}{u_C^*} = (1 - \mu) \cdot F_N^* = w^*(\mu). \quad (38)$$

As in the static model, the IEP will be upward sloping in  $(Z, C)$ , since both consumption and leisure are normal, it will be a straight line if preferences are quasi-homothetic and it will be a linear ray through the origin if preferences are homothetic.

There is a steady-state relationship between income and consumption given by<sup>42</sup>

$$C^* = L^* \cdot f(k^*(\mu)) - n^* \cdot \Phi - G^* . \quad (39)$$

We will call this the Euler frontier (EF).

Note that the EF *is not the household's budget constraint* (BC). Let us take the case where  $n$  is fixed. The household receives profit income  $\Pi^*$ , which it sees as a lump-sum payment and also the rental income on capital. The household thus only sees the variation in labour income as it considers varying  $L^*$ : the slope of the actual budget constraint is thus  $w^*(\mu)$ . The actual budget constraint is given by the grey dotted line in Figure 6: if the household is at point E, it is flatter than the EF. Also, at the intercept there is all of the non-labour income (rental on capital, profits less tax).

The unique steady-state equilibrium is found at the intersection of the IEP and EF at point E, as depicted in the same figure<sup>43</sup>. Here we can see the equilibrium level of  $C^*$  and  $L^* = 1 - Z^*$ . The optimal capital stock is then simply  $K^* = L^* \cdot k^*(\mu)$ .

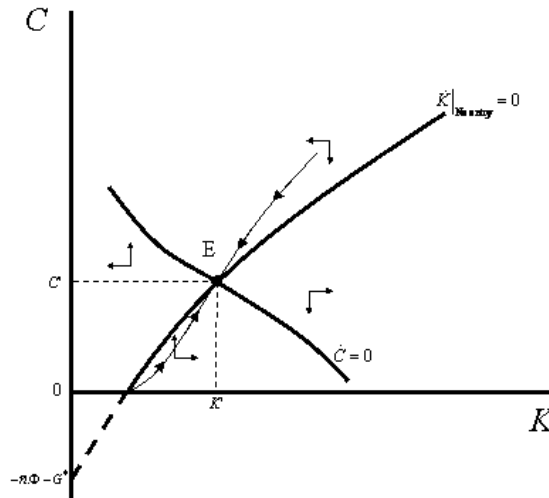
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<sup>42</sup>This can be derived from the budget constraint:

$$\begin{aligned} C^* &= w^*(\mu) \cdot L^* + R^* \cdot K^* + \Pi^* - G^* = \\ &= w^*(\mu) \cdot L^* + \frac{\rho}{1-\mu} L \cdot k^*(\mu) + \mu \cdot L^* \cdot f(k^*) - n^* \cdot \Phi - G^* = \\ &= L^* \cdot f(k^*(\mu)) - n^* \cdot \Phi - G^* . \end{aligned}$$

<sup>43</sup>Uniqueness is not guaranteed when we have a significant taste for variety, i.e.  $\lambda$  is large, when the mark-up is endogenous, i.e.  $\mu^* = \mu(k^*)$ , or when there are increasing returns to scale at the aggregate level.





**Figure 7:** The Saddle-Point Stable Equilibrium

$(1 - \mu) \cdot F_K < \rho$ ; to the left it is increasing. The capital isocline has the standard upward-sloping shape<sup>45</sup>: it need not be globally concave due to the effect of  $K$  on the labour supply. The phase diagram thus has a unique saddle-path solution as depicted in Figure 7.

### 3.5 The Effect of Imperfect Competition on the Long-run Equilibrium

In this section we illustrate the effect of a change in  $\mu$  on the steady-state equilibrium from both  $(1 - L, C)$  space and  $(K, C)$  space. First, let us analyse the consequences of imperfect competition in leisure-consumption space. We have two effects of an increase in the degree of imperfect competition:

<sup>45</sup>See Costa and Dixon (2009), section 5.7. Notice that with  $\delta > 0$  the capital isocline would present the usual hump shape: increasing before the modified golden-rule capital stock and decreasing afterwards.

- The EF curve rotates anti-clockwise. Since we have

$$f'(k^*) = \frac{\rho}{1-\mu};$$

$$\frac{dk^*}{d\mu} = \frac{f'(k^*)}{(1-\mu) \cdot f''(k^*)} = \frac{\rho}{(1-\mu)^2 \cdot f''(k^*)} < 0.$$

- The real wage falls, so that the IEP moves to the right. Since from (37)

$$w^*(\mu) = f[k^*(\mu)] - \frac{\rho \cdot k^*(\mu)}{1-\mu};$$

$$\frac{dw^*}{d\mu} = -\frac{\rho \cdot k^*(\mu)}{(1-\mu)^2} < 0.$$

These two effects are depicted in Figure 8, where the equilibrium moves from  $E_0$  to  $E_1$  when we compare a low-mark-up steady-state ( $\mu = \mu_0$ ) with a large-mark-up one ( $\mu = \mu_1 > \mu_0$ ).

Clearly, the shift in the IEP represents a pure substitution effect. As the wage falls, the household substitutes leisure for consumption. The EF rotation, however, marks a counterbalancing income effect: income is lower for any  $L$  when  $\mu$  is higher. This operates to increase labour supply and decrease consumption. So, both income and substitution effects operate to reduce consumption: they operate in opposite ways on the labour supply. In Figure 8 leisure increases, which means that the income effect dominates for that specific example.

Turning to capital-consumption space and the phase diagram, the way to understand the effect of  $\mu$  is via the effect on  $L$ : for given  $(K, C)$ , an increase in  $\mu$  increases the wedge between the marginal product of labour and the wage, hence leading to a reduction in the labour supply. Less labour means that both total output and the marginal product of capital fall. Hence we have two effects of an increase in  $\mu$ : (i) the consumption isocline shifts to the left (since  $F_K$  falls as  $L$  decreases) and (ii) the capital isocline shifts downwards, as there is less output given  $(K, C)$ .



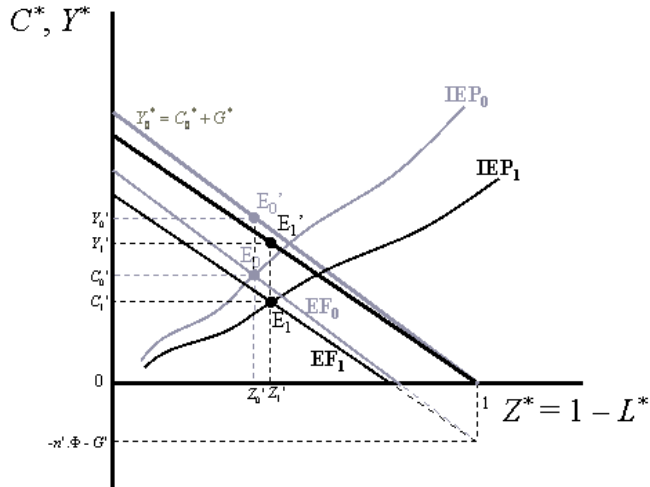


Figure 8: Market Power and the Steady-State Equilibrium (I)

The shift from equilibrium  $E_0$  to  $E_1$  in Figure 8 is represented in  $(K, C)$  in Figure 9. Note that whilst steady-state consumption falls, the effect on capital is potentially ambiguous. This is because the effect of  $\mu$  on labour supply is ambiguous. Here capital decreases, which is compatible with the reduction in employment observed in Figure 8.

### 3.6 Free Entry

Until now, we have assumed that the mass of firms/goods is fixed across time, so that  $n(\tau) = n$ . In this case, aggregate output is given by

$$Y(\tau) = L(\tau) \cdot f(k(\tau)) - n \cdot \Phi. \quad (42)$$

If there is instantaneous free entry which drives profits to zero, from (35), for given  $(K, L)$ , profits are zero when

$$n(\tau) = \frac{\mu \cdot F(K(\tau), L(\tau))}{\Phi} = \frac{\mu}{\Phi} \cdot L(\tau) \cdot f(k(\tau)). \quad (43)$$

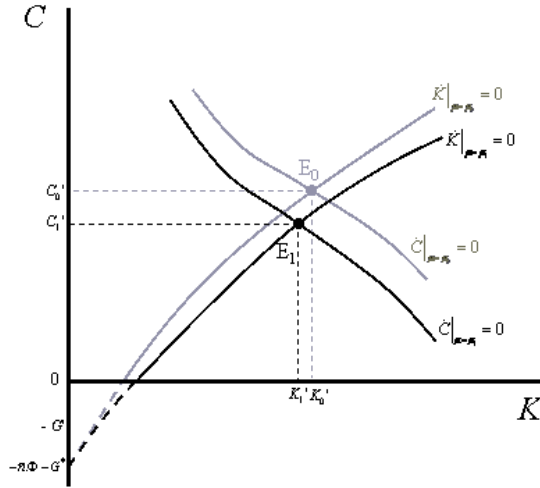


Figure 9: Market Power and the Steady-State Equilibrium (II)

In this case, aggregate output is given by

$$Y(\tau) = (1 - \mu) \cdot F(K(\tau), L(\tau)) = (1 - \mu) \cdot L(\tau) \cdot f(k(\tau)). \quad (44)$$

Let us turn to leisure-income space. Free entry does not affect the IEP, which just depends on the real wage  $w^*(\mu)$  which is not influenced by entry. However, entry does affect the Euler frontier (39) since the level of aggregate overheads  $n^* \cdot \Phi$  varies according to (43). In factor-intensive notation, we have the "Free Entry Euler Frontier" (FEEF) that simplifies to

$$C^* = L^* \cdot (1 - \mu) \cdot f(k^*(\mu)) - G^*. \quad (45)$$

The FEEF is steeper than the EF: a higher labour supply means that the mass of firms is larger which increases the socially wasteful overhead  $n^* \cdot \Phi$  thus reducing consumption by more than if  $n$  is fixed. The two lines meet at the labour supply where the free-entry mass of firms happens to be equal to the exogenously given

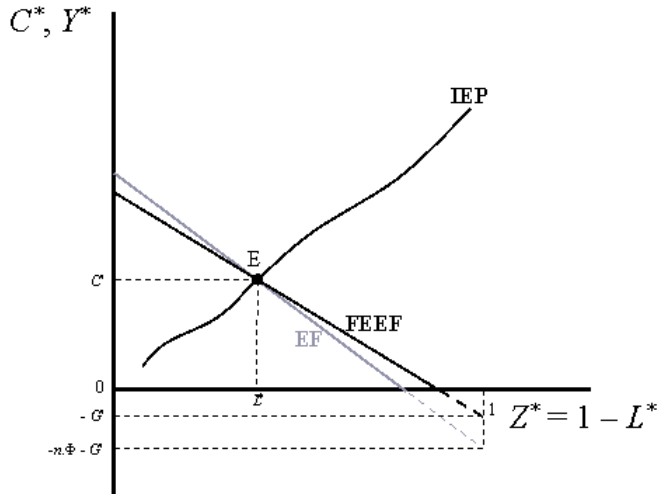


Figure 10: Steady-State Equilibrium with Free Entry (I)

mass of firms<sup>46</sup>: for labour supplies below this the FEEF lies above the EF (since there are less firms); for labour supplies above this the FEEF lies below the EF. This is depicted in Figure 10, where EF and FEEF intersect at point E.

If we turn to  $(K, C)$  space, free entry does not influence the consumption isocline (since overheads do not influence the marginal product of capital). The capital isocline becomes

$$\dot{K} = 0 : (1 - \mu) \cdot F(K, L(C, K, \mu)) - C - G = 0. \quad (46)$$

The capital isocline is affected: the fixed- $n$  isocline is steeper and intersects the free-entry isocline at the capital stock where the mass of firms under free entry

<sup>46</sup>From (43), for given  $n$ , the critical level of labour supply is

$$\bar{L}^* = \frac{n \cdot \Phi}{\mu \cdot f(k^*(\mu))}.$$

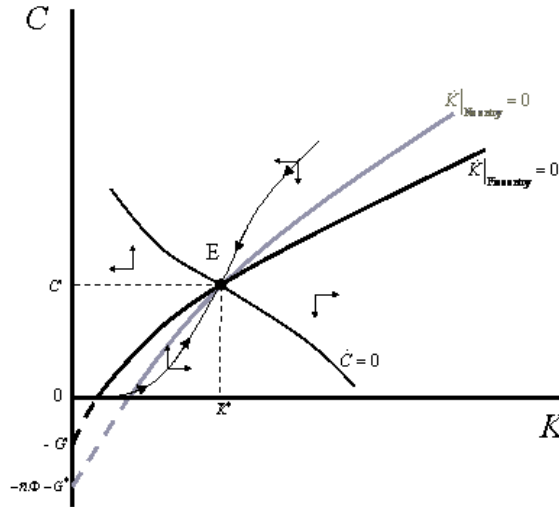


Figure 11: Steady-State Equilibrium with Free Entry (II)

equals the fixed  $n$  (which is  $\bar{K}^*$ ). For capital stocks below that, the free-entry isocline implies less overheads and lies above the fixed- $n$  isocline, and for capital above that level, it lies below the fixed- $n$  case. We depict this in Figure 11.

Also, we can easily see entry does not affect the dynamics of the steady-state equilibrium<sup>47</sup>. Notice the fixed-mark-up monopolistically competitive model with free entry is formally equivalent to a Ramsey model with more inefficient production function given by  $(1 - \mu) \cdot F$ .

### 3.7 Fiscal Policy, Entry, and Imperfect Competition

We will explore the effects of an increase in government expenditure funded by a lump-sum tax. This will divide into the long-run steady-state effects and the short-run impact effects, as well as the transition towards the steady state. We will

<sup>47</sup>See Costa and Dixon (2009), section 5.6.

assume that in the initial position we start off with zero profits, even in the case of a fixed mass of firms. That means that the EF and FEEF both pass through the same point in steady state, i.e. point  $E_0$  in Figure 12.

Turning first to the long-run steady-state effects of an increase in government expenditure. In leisure-consumption space, the IEP is unaffected by the change in  $G$ . The EF and FEEF are both shifted down by a vertical distance equal to the increase in government expenditure. The new steady states are  $E_{NE}$  for a fixed number of firms, and  $E_{FE}$  with free entry. As in the static case, the multiplier is "Walrasian" in the sense of being less than one and greater than zero. The drop in consumption is less than the increase in government expenditure<sup>48</sup>. How much less is determined by the slope of the EF and FEEF: a steeper slope results in more crowding out of consumption in steady state. This leads us to three simple conclusions:

- The multiplier with free-entry is smaller than the multiplier with a fixed mass of firms, since FEEF is steeper than EF. This result is found in Coto-Martinez and Dixon (2003) for an open-economy context.
- Employment increases (leisure decreases) as  $G$  increases and the increase in the labour supply is greater when there is free entry.
- An increase in imperfect competition makes both the FEEF and the EF flatter, leading to less crowding out and to a larger output multiplier in each case.

None of these results requires that the initial steady-state is the same (where the FEEF and EF intersect) if there are homothetic preferences (and hence a linear IEP). If the IEP is non-linear, the result will hold if the initial position is the same. The intuition behind these results is the following: an increase in government spending financed by a lump-sum tax makes the household worse off, so it cuts back on the good things in life, consumption and leisure. Because the economy is less efficient (at the margin) with free entry, the required effort to supply the

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<sup>48</sup>See Costa and Dixon (2009), section 5.8.

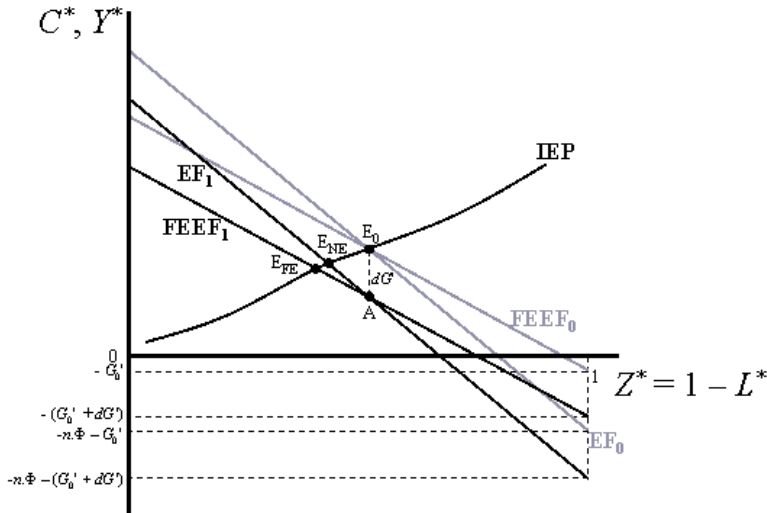


Figure 12: Long-Run Effects of Fiscal Policy

extra output to the government is greater than with fixed  $n$ , so that consumption and leisure decline more under free entry. An increase in imperfect competition means that whether there is a fixed mass of firms or free entry, the weight of the tax burden falls more heavily on leisure so that the crowding out of consumption is less.

If we compare the steady states in  $(1 - L, C)$  space, there is a striking similarity between static and dynamic models. Now, let us turn to the dynamics of the model with imperfect competition. In Coto-Martinez and Dixon (2003) these results are generalised to a small open economy setting.

### 3.8 Fiscal Policy: Short-run Dynamics

In Figure 13, using the  $(K, C)$  space, we have the two accumulation equations which we assume intersect at the initial steady-state. In this case, the fixed- $n$  capital accumulation schedule is steeper than the free-entry curve, as seen above. The effect of a permanent increase in  $G$  is to shift both curves down vertically in

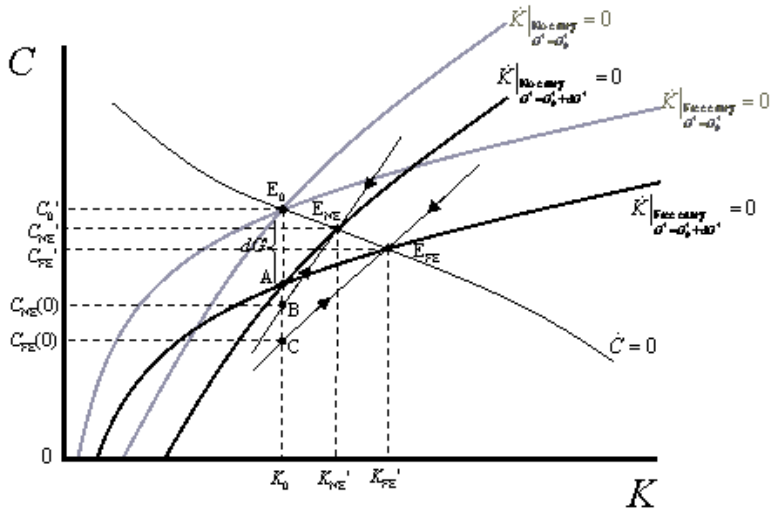


Figure 13: Short-Run Effects of Fiscal Policy

$(K, C)$  space. The new steady-state equilibria are  $E_{NE}$  for fixed  $n$  and  $E_{FE}$  with free entry (these two correspond exactly to the points with identical notations in Figure 12). We can see that the steady-state capital stock increases by more when there is free entry: this reflects the increase in the labour supply (decline in leisure) with the same capital/labour ratio in both cases. Since both  $E_{NE}$  and  $E_{FE}$  are saddle-point stable, consumption will drop down and follow an upward-sloping path to the new steady state.

Let us compare what happens along the paths in both cases. Considering  $\beta > 0$  is the slope of the stable manifold<sup>49</sup>, we can approximate the consumption value using the first-order Taylor expansion:

$$C(\tau) = C^* + \beta \cdot (K(\tau) - K^*). \tag{47}$$

<sup>49</sup>See Costa and Dixon (2009), section 5.7. for an algebraic expression.

We are especially interested in what happens at time  $\tau = 0$ , when the fiscal shock occurs. In both cases we observe a decrease in  $C(0)$  due to the combination of two effects: (i) the long-run consumption level decreases as described before and (ii) the capital stock is below its long-run optimal level (i.e.  $K(0) < K^*$ )<sup>50</sup>. However, if we want to compare the no-entry to the free-entry versions of the model, we can notice that

$$\Delta C(0) = \Delta C^* - \beta_{NE} \cdot \Delta K^* + \Lambda \beta \cdot (K(0) - K_{NE}^*), \quad (48)$$

where  $\Delta X \equiv X_{NE} - X_{FE}$ , with  $X_{NE} = X|_{\text{No entry}}$  and  $X_{FE} = X|_{\text{Free entry}}$  is a measure of distance between the no-entry and the free-entry equilibrium values for variable  $X$ . We can see in Figure 13 that  $\Delta C^* > 0$ , i.e. the long-run drop in consumption is larger under free entry than in the fixed- $n$  model. We can also observe that  $\Delta K^* < 0$ , i.e. the long-run increase in the optimal capital stock is larger under free entry. Finally, we know that  $K(0) - K_{NE}^* < 0$  for the increase in government expenditure depicted in this example. Thus, we can expect a larger short-run decrease in private consumption in the free entry case ( $\Delta C(0) < 0$ ), unless the stable manifold is much steeper in the no-entry case, i.e.  $\Lambda \beta > \frac{\Delta C^* - \beta_{NE} \cdot \Delta K^*}{K_{NE}^* - K(0)} > 0$ .

Let us use a numerical illustration in order to see what can happen in specific models. First, we assume the felicity function is isoelastic in both consumption and leisure, i.e.

$$u((C(\tau), Z(\tau))) = \frac{C(\tau)^{1-\frac{1}{\theta}} - 1}{1 - \frac{1}{\theta}} + b \cdot \frac{Z(\tau)^{1-\frac{1}{\psi}} - 1}{1 - \frac{1}{\psi}},$$

where  $\theta, \psi, b > 0$ . Second, let us assume  $F(\cdot)$  is Cobb-Douglas, i.e.

$$F(K(\tau), N(\tau)) = A \cdot K(\tau)^\eta \cdot N(\tau)^{1-\eta},$$

where  $0 < \eta < 1$ . Now, we choose the following parameter values:

$\eta$	$\rho$	$\theta$	$\psi$	$\sigma$	$b$	$G_0$	$\Phi$
1/3	0.04	1	1	10	10/6	0.1643	0.0913

<sup>50</sup>See the values for the long-run multipliers in Costa and Dixon (2009), section 5.8.



The value of  $\eta$  was chosen in order to generate a long-run capital share in total income equal to one third. The value for  $\rho$  implies a 4 per cent return on capital per period. The values for  $\theta$  and  $\psi$  imply elasticities of intertemporal substitution equal to one for both consumption and leisure. The value of  $\sigma$  gives rise to a 11 per cent price-wedge over the marginal cost in the steady state. The value for  $b$  was chosen in order to generate  $L^* = 1/3$ , the value for  $G_0$  is the one that leads to a 20 per cent steady-state share of government consumption in output, and the value for  $\Phi$  is such that profits are zero in the initial equilibrium ( $E_0$  in Figure 13) when  $n = 1$ .

For this numerical illustration, a permanent one per cent increase in  $G$  leads to an immediate 1.3 per cent decrease in consumption in the no-entry case and to a 1.4 reduction in the free-entry case. Thus, in this example, despite the fact that the stable manifold is steeper in the no-entry case (i.e.  $\Delta\beta > 0$ ), the last term on the right-hand-side of equation (48) is smaller than the sum of the positive effects. This example corresponds to Figure 13: in the no-entry case the equilibrium response of households leads to the short-run equilibrium represented by point B, whilst point C represents its free-entry counterpart.

We also varied all the parameters in their ranges and obtained similar results, i.e. for these functionals we could not numerically generate a situation where  $\Delta C(0) < 0$ . Of course we cannot guarantee such an event would not occur with different felicity or production functions, but we can expect this result to hold in most of the real policy experiments.

### 3.9 Extensions and generalisations

As we saw, dynamic models allow us to study not only the long-run (steady-state) effects, but also the short-run effects that occur due to the fact that agents may use a part of their resources presently available to obtain better future outcomes, according to a discounted optimisation problem (either utility or profits). Amongst these models, Heijdra (1998) is an inevitable reference where a continuous-time dynamic model with monopolistic competition is presented, including love for variety and Ethier effects (i.e. increasing returns from diversity in the investment-goods sector). Costa (2007) (the effect of capital depreciation), Devereux et al. (1996) (increasing returns to specialisation), Harms (2002) (persistence of fiscal

shocks), Heijdra et al. (1998) (distortionary taxation and useful public expenditure), Linneman and Schabert (2003) (price stickiness and fiscal-monetary policies interaction), Molana (1998) (intertemporal substitution between current leisure and future consumption), or Ravn et al. (2006) (endogenous mark-ups due to deep habits) are also examples of important references in this line of research. We can also observe a recent revival of interest in the effects of fiscal policy in imperfectly competitive economies with sticky prices where complementarity between private consumption and leisure may generate consumption crowding in - see Bilbiie (2011) - and additionally the zero lower bound for the interest rate provides increased effectiveness - see Christiano et al. (2009) and Hall (2009).

On the empirical front, the recent interest on the quantitative effects of fiscal shocks, especially when mark-ups respond counter-cyclically to them, can be observed in Afonso and Costa (2010), Hall (2009), or Monacelli and Perotti (2009).

#### **4 Concluding Remarks**

In this paper we studied fiscal policy effectiveness in static general equilibrium models where there is imperfect competition in goods markets. We observed this effectiveness, both over output and households welfare, and its relation with the degree of monopoly depend upon a large number of factors, namely the ones analysed here: i) the type of taxes used; ii) the possibility of free entry; iii) consumers preferences; iv) the existence of increasing returns on the mass of varieties; and v) the existence of endogenous mark-ups. Overall we find that the effectiveness of fiscal policy does indeed depend on the degree of imperfect competition. This is because the mark-up distorts the relative price of consumption and leisure (the latter becomes cheaper). For a broad range of results (with many caveats), we find that the multiplier is increasing in the degree of imperfect competition. However, the effect on welfare will still tend to be negative: the reason output increases is that households are induced to work harder by being taxed. In order to obtain the "Keynesian" welfare effect, you need to have some extra ingredient: for example increasing returns, love for variety, or an endogenous mark-up.

One of the main achievements of these models was to reintroduce the wealth effect on labour supply into the analysis of fiscal policy. Since Patinkin (1965),

the wealth effect on the labour supply had been suppressed in macroeconomics, resulting in the vertical long-run aggregate-supply curve and zero long-run fiscal multiplier<sup>51</sup>. The DMS papers made the wealth effect on the labour supply of an increase in taxation resulting from an increase in government expenditure central to the analysis of fiscal policy. This was a theme taken up later by Real Business Cycle theorists, e.g. Baxter and King (1993), and later the New Keynesian synthesis, e.g. Woodford (2003).

In dynamic models, many of the same issues arise, particularly if we focus on the steady-state results. However, we have an additional dimension of the real-time dynamics and in particular the comparison of short- and long-run effects. In both static and dynamic models, the role of entry is crucial, as was argued by Startz (1989). With a fixed mass of varieties, extra output is produced in a marginally efficient way. With free entry, extra output sucks in additional firms and overheads. In many models this leads to a lower multiplier and lower welfare.

From the point of view of the history of economic thought it is rather strange that John Maynard Keynes, Joan Robinson the founder of monopolistic competition theory, and Richard Khan, who invented the multiplier, coexisted in the same time and place (Cambridge, England in the 1930s). Despite the space-time and intellectual proximity between them, the link was not made between imperfect competition and macroeconomics until much later<sup>52</sup>. In this survey, we have traced through general equilibrium macroeconomic models how this "tantalizing possibility" was realised in the ensuing 60 years. As we have seen, the simple fact that the imperfectly competitive equilibrium is not Pareto optimal does not imply that Pareto-improving fiscal policy is generally possible. However, it does have important and more-or-less Keynesian features as regards the multiplier.

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<sup>51</sup>For an historical perspective see Dixon (1995) - also available on <http://www.huwdixon.org/SurfingEconomics/chapter3.pdf>.

<sup>52</sup>See Marris (1991) for more details, especially pp. 181-187.

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