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IMPERFECT COMPETITION, GENERAL EQUILIBRIUM AND UNEMPLOYMENT

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Abstract

We analyze whether different learning abilities of firms with respect to general equilibrium effects lead to different levels of unemployment. We consider a general equilibrium model where firms in one sector compete à la Cournot and a real wage rigidity leads to unemployment. If firms consider only partial equilibrium effects when choosing quantities, the observation of general equilibrium feedback effects will lead to repeated quantity adjustments until a steady state is reached. When labor is immobile across industries, unempolyment in the steady state is lower than when *all* general equilibrium effects are incorporated at once. The opposite result is true if labor is mobile.

Keywords: Product markets, Cournot competition, learning of general equilibrium effects, unemployment

JEL Classification: D58, E24, J60, L13

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1 Introduction

In this paper we examine whether the lack of recognition of general equilibrium effects leads to high unemployment as suggested by Gersbach and Sheldon [1996] and Saint-Paul [1993]. We first show that a canonical formulation of imperfect competition leads to a learning process by the agents until their maximization under a partial equilibrium view is consistent with their (general equilibrium) environment. We then apply our methodology to the hypothesis that neglecting general equilibrium effects leads to high unemployment. Our major conclusion is that the hypothesis is wrong if labor is immobile across industries and true if labor is mobile.

We examine a two sector model with imperfect competition in one sector and a real wage rigidity which creates unemployment. We compare two scenarios of Cournot Competition in the imperfectly competitive sector: In the first scenario, we analyze what happens when the firms incorporate all general equilibrium feedback effects of their quantity choice at once, so that the choice remains the best response to their competitors' best response when markets clear. We call this procedure General Equilibrium Cournot Competition, denoted by GEC and the resulting equilibrium shall be the GEC outcome.

In the second scenario, we assume that firms do not take general equilibrium feedbacks of their quantity choice into account. Firms select best responses against their competitors' best responses under the assumption that the rest of the economy stays the same. Then they encounter general equilibrium feedbacks and their profit estimation generally differs from realized profits. Firms revise their production plans until they are best responses against the plans of the competitors *and* no unexpected general equilibrium effects surprise the firms. As we will show, this learning procedure will converge to a steady state, where no further unexpected general equilibrium feedbacks will occur anymore. We call this process Partial Equilibrium Cournot Competition, denoted by PEC and the steady state we call PEC steady state.

We obtain the following results: First, the resulting equilibria under PEC and GEC generally differ. Second, unemployment in the PEC steady state is not always higher than in the GEC outcome. In particular, we show that the degree of labor mobility across sectors determines relative unemployment of GEC and PEC. High labor mobility favors GEC, whereas labor immobility favors PEC. To understand this result we will identify four effects that account for the difference between PEC and GEC. The major effect leading to create low output and low employment under PEC relative to GEC is the overestimation of the price reaction when the quantity is changed downwards by an individual firm, which has a negative impact on output choices and employment under PEC relative to GEC. The counteracting effect in our model is the underestimation of the change of high-skilled workers' wages, that are assumed to stay constant by firms. Since firms underestimate their wage costs when choosing a higher quantity, quantity choices and employment tend to be higher for PEC relative to GEC. The latter effect is large if labor is immobile and dominates all other effects. But when labor is mobile, the wage effect is rather small, so that the net effect of the PEC view relative to GEC in terms of output and employment is negative.

We proceed as follows in the paper: In section 2 we relate our paper to the literature of imperfect competition in a general equilibrium context. Section 3 develops the model. The simulation results are presented in section 4. Section 5 deals with the implications of an immobile labor force and section 6 concludes.

2 Relation to the Literature

In our paper we combine three strands of literature. Our starting point is the claim often brought forward in the discussion about remedies to the European unemployment problem, that insufficient recognition of general equilibrium effects by firms or unions contribute to the persistence of unemployment. Hence, we examine in this paper whether and how it makes a difference for unemployment (or output), if firms in oligopolistic industries act under a general or partial equilibrium view. To answer the question we need to address two conceptual problems. First, we have to incorporate imperfect (Cournot) competition in a general equilibrium framework, which raises some delicate conceptual issues. Comprehensive surveys of the state of the art in embedding imperfect competition in a general equilibrium are given by Ginsburgh and Keyzer [1997], Gabszewicz [1999] and d'Aspremont et al. [1999]. Dynamic macroeconomic models with imperfect competition are analyzed by Kaas [1999].

Second, while the general equilibrium view of firms can be formulated as a static problem, the partial equilibrium view is more challenging. Since the firms recognize at the market clearing stage, that realized prices, profits and other variables differ from those anticipated, it is natural to assume, that firms will react. This essentially leads to a learning process, where firms change their best responses under a partial equilibrium view, until they are not surprised anymore by general equilibrium effects at the market clearing stage. To formulate such a learning process, we draw on the recent work on learning in game theoretic situations (for recent surveys see Young [1997], Fudenberg and Levine [1998]). The learning process we employ for firms is similar to the best reply dynamics in game theoretic situations with one major difference: Given the partial equilibrium view of firms, the Nash equilibrium of firms competing in quantities is derived in the standard way and therefore firms do not learn about each other, but about effects resulting from other markets. In particular, they take realizations of output in other sectors and factor prices as given and adjust their best responses against the best responses of other firms to changes in other sectors and factor prices. The approach we suggest in this paper to model imperfect competition in a general equilibrium framework can also be applied to cooperative games (Gersbach and Schniewind [1999]).

3 Model

In this section, we develop a model to analyze the different Cournot competition processes associated with different degrees of sophistication about general equilibrium feedback effects.

There are two types of labor: skilled and unskilled. These are the only inputs into production. Since we focus on short term effects, capital is assumed to be fix.

There are two sectors producing good 1 and good 2. In both sectors low-skilled and high-skilled workers can be employed. The first sector is represented by an aggregate production function, whereas we assume sector 2 to consist of n identical firms competing in quantities. Aggregate production of sector 1 is given by

$$q_1 = A_1 L_1^{\ell^{\beta_1^\ell}} L_1^{h^{\beta_1^h}} \tag{1}$$

Production of a firm i in sector 2 is determined as follows:

$$q_{2i} = A_2 L_{2i}^{\ell^{\beta_2^\ell}} L_{2i}^{h^{\beta_2^h}} \tag{2}$$

Subscripts 1 and 2 denote the first and second sector, respectively. h and ℓ denote the skill levels of workers. We assume that low-skilled workers and high-skilled workers are mobile across industries, i.e. they can work in either sector. Later on we will analyze what happens when the labor force is immobile. Total labor input of low-skilled workers is $L_1^\ell + n \cdot L_{2i}^\ell$. $L_1^h + n \cdot L_{2i}^h$ is the labor input of high-skilled workers. Labor supply of both types of labor is given by $\overline{L}^\ell$ and $\overline{L}^h$. Overall labor supply amounts to $\overline{L} = \overline{L}^\ell + \overline{L}^h$. We assume that labor is supplied inelasticly.[1]

We assume that all types of households have the same CES-utility function:

$$u = \left(\alpha_1 \cdot c_1^{\frac{\sigma-1}{\sigma}} + \alpha_2 \cdot c_2^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}} \tag{3}$$

c_1 and c_2 denote the consumption levels of good 1 and good 2, whereas σ denotes the elasticity of substitution between the two goods. We assume that all profits accrue to the high-skilled workers, i.e. they own all firms. Each high-skilled worker owns the same share of ownership.[2]

1 Our model could be complemented by a labor/leisure tradeoff. Since we focus on employment rather than on aggregate output, adding a labor/leisure tradeoff would not affect our basic results.
2 If shares of firms are traded, each high-skilled worker would hold the market portfolio.

3.1 Real Wage Rigidity and Unemployment Insurance

In this section we introduce the labor markets. The institution in the labor market we focus upon is a real reservation wage for low-skilled workers that is above the market clearing level. The real reservation wage, denoted by $\overline{rw}$, is defined as a percentage of the market clearing real wage $\frac{w^\ell}{p}$ for low-skilled workers, if no frictions are present (all markets perfectly competitive). If $\overline{rw}$ exceeds $\frac{w^\ell}{p}$, it becomes binding and unemployment occurs. w^ℓ is then $p \cdot \overline{rw}$. A variety of regulations can cause a real wage floor: explicit minimum wages, an unemployment benefit system or institutional wage settings. Labor is taxed at flat rate, denoted by τ, to finance benefits for the unemployed workers.[3]

We assume that the unemployed obtain a fixed percentage of the wage earned by their working counterparts, denoted by ub. Let us denote the share of unemployed workers by Δ, given by:

$$\Delta = \overline{L}^\ell - L_1^\ell - n \cdot L_{2i}^\ell \tag{4}$$

The government's budget constraint implies that

$$(w^\ell(L_1^\ell + n \cdot L_{2i}^\ell) + w^h(L_1^h + n \cdot L_{2i}^h)) \cdot \tau = ub \cdot \Delta \tag{5}$$

3.2 The System of Equations

The equilibrium with wage rigidities is determined by the following system of equations. Throughout the paper we normalize the price of the first good to 1, i.e.

$$p_1 = 1 \tag{6}$$

By utility maximization we receive the following demand functions for consumption:

$$c_1 = \frac{b}{p_1 + p_2(\frac{p_1}{p_2}\frac{\alpha_2}{\alpha_1})^\sigma} \tag{7}$$

$$c_2 = \frac{b}{p_2 + p_1(\frac{p_2 \alpha_1}{p_1 \alpha_2})^\sigma} \tag{8}$$

3 If taxation were not distortionary, full employment and any distributional goal could be achieved by an appropriate tax scheme. Hence, the impossibility to eliminate real wage rigidities can either be explained by tax distortions or by political factors.

b denotes the budget of the households. We have three different budgets. The low-skilled worker's budget consists entirely of wages. The budget of the high-skilled includes their wages and profits. The unemployed obtain benefits ub. Hence we have six demand functions for consumption. The three different budgets, leading to six demand functions for consumption, are given as follows:

$$b^\ell = w^\ell \Rightarrow c_1^\ell, c_2^\ell \tag{9}$$

c_1^ℓ denotes the demand of a low-skilled worker for good 1.

$$b^h = w^h + (\pi_1 + \pi_2)/(L_1^h + nL_{2i}^h) \Rightarrow c_1^h, c_2^h \tag{10}$$

$$b^u = ub \Rightarrow c_1^u, c_2^u \tag{11}$$

The upper index u stands for the unemployed. The firms' profit functions are sales minus costs, augmented by the tax wedge. Total labor costs for a firm consist of the wage bill and the tax expenditures. Therefore:

$$\pi_1 = p_1 q_1 - w^\ell(1+\tau)L_1^\ell - w^h(1+\tau)L_1^h \tag{12}$$

$$\pi_{2i} = p_2 q_{2i} - w^\ell(1+\tau)L_{2i}^\ell - w^h(1+\tau)L_{2i}^h \tag{13}$$

We assume Sector 1 to be perfectly competitive, i.e. firms are price takers. We obtain the following first order conditions for profit maximization in sector 1:

$$w^\ell(1+\tau) = p_1 A_1 L_1^h \beta_1^\ell L_1^{\ell^{\beta_1^\ell - 1}} \tag{14}$$

$$w^h(1+\tau) = p_1 A_1 L_1^{\ell^{\beta_1^\ell}} \beta_1^h L_1^{h^{\beta_1^h - 1}} \tag{15}$$

Firms in sector 2 minimize costs and then choose quantities to maximize profits. How they choose quantities will be the focus of our examinations and is discussed in the next section. From cost minimization we obtain the cost function of firm i, denoted by E_{2i}:

$$E_{2i} = A_2^{-\frac{1}{\beta_2^\ell+\beta_2^h}} \left[\left(\frac{\beta_2^\ell}{\beta_2^h}\right)^{\frac{\beta_2^h}{\beta_2^\ell+\beta_2^h}} + \left(\frac{\beta_2^\ell}{\beta_2^h}\right)^{-\frac{\beta_2^\ell}{\beta_2^\ell+\beta_2^h}} \right] \tag{16}$$

$$\Big(w^\ell(1+\tau)\Big)^{\frac{\beta_2^\ell}{\beta_2^\ell+\beta_2^h}} \Big(w^h(1+\tau)\Big)^{\frac{\beta_2^h}{\beta_2^\ell+\beta_2^h}} \cdot q_{2i}^{\frac{1}{\beta_2^\ell+\beta_2^h}}$$

This leads to the cost minimizing factor demand equations:

$$L_{2i}^\ell = A_2^{\frac{-1}{b_2^\ell+b_2^h}} \cdot \left(\frac{b_2^\ell w^h(1+\tau)}{b_2^h w^\ell(1+\tau)}\right)^{\frac{b_2^h}{b_2^\ell+b_2^h}} \cdot q_{2i}^{\frac{1}{b_2^\ell+b_2^h}} \tag{17}$$

$$L_{2i}^h = A_2^{\frac{-1}{b_2^\ell+b_2^h}} \cdot \left(\frac{b_2^\ell w^h(1+\tau)}{b_2^h w^\ell(1+\tau)}\right)^{\frac{-b_2^\ell}{b_2^\ell+b_2^h}} \cdot q_{2i}^{\frac{1}{b_2^\ell+b_2^h}} \tag{18}$$

Market clearing for good 1 implies:

$$(L_1^\ell + nL_{2i}^\ell) \cdot c_1^\ell + (L_1^h + nL_{2i}^h) \cdot c_1^h + \Delta \cdot c_1^u = q_1 \tag{19}$$

We will choose our parameters so that the real reservation wage will be binding and thus the labor market for low-skilled workers will not clear. This mirrors the fact that there are non competitive wages in many industries. Labor market clearing for high skilled workers holds and is given by:

$$\overline{L}^h = L_1^h + nL_{2i}^h \tag{20}$$

The appropriate consumer price index is defined by (see e.g. Dixon [1995])

$$p = \left[\left(\frac{\alpha_1^\sigma}{\alpha_1^\sigma + \alpha_2^\sigma}\right) \cdot p_1^{(1-\sigma)} + \left(\frac{\alpha_2^\sigma}{\alpha_1^\sigma + \alpha_2^\sigma}\right) p_2^{(1-\sigma)} \right]^{\left(\frac{1}{1-\sigma}\right)} \tag{21}$$

This price index guarantees that changes in prices do not affect households' utility as long as real incomes are kept constant. Nominal wages for low-skilled workers in both sectors are given by:

$$w^\ell = \overline{rw} \cdot p \tag{22}$$

Unemployment benefits ub are defined as a fraction s of the minimum wages for the low-skilled, $0 < s \leq 1$:

$$ub = s \cdot \overline{rw} \cdot p \tag{23}$$

Unemployment is given by:

$$\Delta = \overline{L}^{\ell} - L_1^{\ell} - nL_{2i}^{\ell} \tag{24}$$

Labor is taxed at a flat rate in order to finance a transfer to the unemployed. The tax rate is determined by the condition that the government's budget must be balanced:

$$(w^{\ell}(L_1^{\ell} + nL_{2i}^{\ell}) + w^h(L_1^h + nL_{2i}^h)) \cdot \tau = ub \cdot \Delta \tag{25}$$

Left over are the quantities q_{2i}, that the firms in sector 2 choose under Cournot competition.

3.3 Cournot Competition in Sector 2

We assume that firms in sector 2 compete in quantities. The objective of the firms is to maximize profits which are given by

$$\pi_{2i} = p_2(q_2) \cdot q_{2i} - E_{2i}(w^{\ell}, \tau, w^h, q_{2i}) \tag{26}$$

where $q_2 = \sum_{i=1}^{n} q_{2i}$ [4].

The key issue is which feedback loops firms will take into account when they choose quantities. We consider two different levels of sophistication of the firms.

3.3.1 Partial Equilibrium Cournot Competition (PEC)

In the first case firms only consider partial equilibrium effects when they choose their quantities. This is the main feature of the industrial organization literature. This means that with a change in quantities, only the price reaction along the demand schedule with constant household income is considered. All other variables are assumed to stay constant. But after the firms have realized their quantities, in equilibrium not only the price adjusts to the (new) quantities, but also all other variables in the

4 While we will assume profit maximization, it is questionable whether such an assumption is reasonable when imperfectly competitive sectors are embedded in a general equilibrium framework (see Gabszewicz and Vial [1972] and the discussion in Ginsburgh and Keyzer [1997]). In our model, since only high-skilled workers benefit from firm profits, profit maximization will also maximize shareholder's utility as long as the share of high-skilled workers is not too large.

system, and so do the budgets of the households and the factor prices, which in turn enter the underlying demand and cost functions. This means that the cost and the demand functions change, which implies that firms adjust their best response quantity to the new situation, again leading to a change in the price but also to a change in the budget and the costs, implying a new quantity adjustment and so on. This means that we obtain no static solution but a dynamic adjustment process with a starting point and an endpoint. We call this dynamic process Partial Equilibrium Cournot competition (PEC) process. An endpoint is a constellation of quantities, prices, output, employment etc., such that firms do not want to adjust quantities anymore and goods markets are in equilibrium. If the system converges to such a steady state in the dynamic process we call it PEC steady state equilibrium.

We examine now in more detail the demand function of a household for good 2 as expressed in equation (27):

$$c_2 = q_2 = \frac{b}{p_2 + p_1(\frac{p_2\alpha_1}{p_1\alpha_2})^{\sigma}} \tag{27}$$

The demand functions are the same for all households. We have three different types of households which differ in their income b. If we aggregate the demand functions, we have to replace the budget b by the aggregate income of the whole economy (the CES demand functions are unit elastic to income). The starting point of the PEC process is an arbitrary feasible level of quantities produced by the firms in sector 2. Then the first order condition of the profit equation (26) and the demand equation (27) are to be solved simultaneously for the q_{2i} (and p_2), that maximize profits.

3.3.2 General Equilibrium Cournot Competition (GEC)

The second case is that *all* general equilibrium effects are taken into account by the agents at once when choosing quantities. Hence, changes in output, prices in all sectors, changes in taxes etc. are calculated and enter the profit function. Given the standard assumptions about demand and cost functions, the solution of this problem must be symmetric because all firms in sector 2 are identical. Mathematically we have to calculate the market equilibria for different quantities q_{2i} chosen by all firms. Then we calculate the market equilibrium, including the profits, when one firm j changes its quantity whereas all other firms still choose q_{2i}. The q_{2i}, where it is not profitable *in equilibrium* for a certain firm j to deviate, given that all other firms $i \neq j$ choose q_{2i}, is the Cournot Nash solution. Note that the resulting equilibrium is the one that *really* maximizes π_{2i}, given that all other firms in sector 2 choose the same quantity, since these equilibrium values will actually be realized. Under this Cournot competition procedure agents take all general equilibrium effects into account that occur when a quantity is changed. We call this static Cournot competition process General Equilibrium Cournot competition (GEC) process.

4 Simulation Results

4.1 Calibration

The preceding section outlined the general equilibrium relationships between quantities and other variables for both PEC and GEC. In this section we calibrate the model and examine how the PEC and the GEC results differ in terms of aggregate employment. Given the model's simplicity, it is not easy to estimate what the parameter values should be. However, as we will discuss later, the results are robust across a wide range of variations of the parameters. We consider the following parameter constellation (see table (1)):

Table 1:

Parameters	Values
σ	0.5
A_1	1
β_1^ℓ	$\frac{1}{3}$
β_1^h	$\frac{2}{3}$
A_2	1
β_2^ℓ	$\frac{1}{3}$
β_2^h	$\frac{2}{3}$
$\overline{L}^\ell$	60
$\overline{L}^h$	40
$rwfactor$	1.1
s	0.8

$rwfactor$ denotes the factor, the low-skilled real wage in the benchmark model without frictions (all markets perfectly competitive) is multiplied with, for the model with rigidities. In this benchmark solution, the proportion of skilled to unskilled workers is 2 to 3. Although there is no clear-cut way to calibrate skill proportions in a two skill level economy, an estimate of around 1/2 is an average of wage or education considerations (see Saint-Paul [1994]). The production function parameters were calibrated so as to imply $\frac{w^\ell}{w^h}$ to be around 1/2 (1/3 if no frictions are present in the economy). Note that the overall income differences are larger since the high-skilled people are owners of the firms. The parameters α_1 and α_2 in the utility function are chosen to imply that sector 2 has a percentage of 10 % of the economy. This means that a household spends 10 % of his budget for good 2 when the prices of good 1 and good 2 are equal. Later on we will analyze what happens when sector 2 has a percentage of 20 % of the economy. Moreover, we focus on an elasticity of substitution of 1/2 between the two goods in the utility function. We will also analyze what happens, when the elasticity of substitution between the consumption goods decreases to 1/4.

4.2 Calculations for PEC and GEC

We first analyze PEC. Because we have to calculate a fix point in this case, we need a starting point for PEC, that is we need a market equilibrium of initial values of quantities in sector 2. The dynamics runs as follows: The economy starts with the market equilibrium for an arbitrary feasible initial value of quantities q_{2i}. Feasibility means that the aggregate quantity q_2 can be produced by using the available labor. Building on that equilibrium, the firms in sector 2 choose quantities à la Cournot by considering all variables as constant except the price of good 2. The chosen quantities are produced and based on the resulting new Cournot Nash equilibrium, general equilibrium feedbacks take place, and a new market equilibrium is determined. In the next step, PEC based on this new market equilibrium takes place, leading to new quantities, followed by a new market equilibrium and so on.

The question arises, if this procedure converges and if so, where does it converge to? To answer this question, look at figure 1: On the horizontal and vertical axes quantity levels q_{2i} are shown. For this and the next figures the number of firms in sector 2 shall be 5. The two curves in figure 1 represent the following relationships: The first line takes a specific quantity of a firm in the non-competitive sector 2 on the abscissa, calculates the market equilibrium (prices, output, employment ...), and then derives the PEC quantity for a firm i (which is the same for all firms in sector 2) building on the calculated equilibrium values as starting point. The curve represents all combinations of quantities generating equilibrium values as starting points and PEC quantities. The other curve is the identity (Id). Since the identity has a steeper slope than the other curve, the point of intersection is a stable fix point. This means that repeated PEC, i.e. the PEC process, approaches the quantity q_{2i} belonging to the intersection of the two curves. The fix point is the PEC steady state equilibrium quantity q_{2i}. Note that all firms in sector 2 choose the same quantity q_{2i} because being identical.

As already mentioned, the (static) GEC solution is symmetrical as well because all firms are identical. So if we take the GEC solution q_{2i} for all firms $i \neq j$, vary the quantity of firm j, calculate the market equilibrium (including profits), the q_{2j} that maximizes profits of firm j, must exactly be equal to q_{2i} (see figure 2).

4.3 Results

If we compare figure 1 and figure 2, we see that the profit maximizing quantity in figure 2 (GEC) lies above the PEC steady state equilibrium quantity. Correspondingly, unemployment associated with PEC will be higher than under GEC. Why do firms tend to choose fewer quantities than optimal and thereby create less employment when they fail to consider all general equilibrium effects at once?

To find out the reason for the behavior under PEC compared with GEC, we first illustrate quantity choices under PEC if firms take the GEC equilibrium values as starting point. In figure 3 we have plotted the profit functions against the quantities. One curve is the profit function of a firm j under GEC as in the figure before (all firms $i \neq j$ staying at their GEC solution quantities). The other curve is the profit function of a firm j under PEC based on the equilibrium that corresponds to the GEC solution (this means we take the values of this equilibrium as the starting point for PEC and then vary only q_{2j} of firm j). As we see, firm j tends to choose a smaller quantity under PEC starting from the optimal point of GEC. Note that the curves intersect at the true optimal point (the maximum of the GEC profit function of firm j). This happens because at this point all the variables considered to be constant under PEC have the values also realized under GEC. So when these variables are inserted into the profit function, the value of the profit function is of course the same as under GEC, where these values occur just in the equilibrium corresponding to the profit maximizing quantity of firm j.

To explain the wrong profit estimation by firms that lead to a lower quantity choice under PEC than under GEC, we identify four effects. The profit function faced by the firms (see equation (28)) depends on 5 arguments. Table (2) shows which arguments in the profit function are overestimated by a firm j and which are underestimated, when the firm deviates *downwards* from the GEC solution quantity with the other firms staying at their GEC quantity.

$$\pi_{2j} = p_2(q_2) \cdot q_{2j} - E_{2j}(w^\ell, \tau, w^h, q_{2j}) \tag{28}$$

To understand table 2, we have plotted in figure 4 one of the important variables, namely the price p_2 of good 2. In the figure, one of the curves shows the price that will actually be realized associated with a certain quantity q_{2j} in market equilibrium. This is what a firm j would see under GEC, where it has the whole picture of the economy in mind (the other firms always choosing the GEC-optimal q_{2i}). The other curve is the price expected by a firm j deviating from the GEC solution as starting point (with the other firms staying at their GEC quantities) with its PEC view, considering only the interactions between q_{2i} and p_2. If we compare the two curves, we observe that with a

Table 2:

Revenue	Estimation under PEC relative to GEC	Impact on output and employment under PEC relative to GEC
p_2	overestimated	negative
q_{2j}	-	-
Costs		
w^ℓ	underestimated	negative
τ	underestimated	negative
w^h	overestimated	positive

decreasing quantity q_{2j}, the price p_2 rises less in market equilibrium than firm j *thinks* with its PEC view. The reason for this phenomenon is as follows: Under PEC, a firm j recognizes the first increase of p_2 associated with a lower quantity. But what it does not realize is that with a lower quantity real income of the economy decreases. This in turn implies a decline in demand for good 2 *and* good 1. Because of the real wage rigidity employment decreases not only in sector 2 but also in sector 1. This implies a declining production of good 1, which tends to raise the price p_1 relative to p_2. So the rise of p_2 (relative to p_1) is not as big as expected under PEC. The overestimation of the price effect (and therefore the revenue) leads to a lower quantity choice and has therefore a negative impact on employment.

Regarding the cost effects, w^ℓ is assumed to be constant by firm j, but in reality it increases, i.e. it is underestimated. This happens because when q_2 decreases due to the downward deviation of firm j, the price p_2 increases (but overestimated), leading to a higher price index p ($p_1 \equiv 1$). For a constant minimum real wage the nominal wage w^ℓ must increase therefore. Actually this negative cost effect would be an argument for the firm to produce more, but it is not seen, and this leads to a lower production than optimal and therefore more unemployment. For a similar reason the tax rate τ does not stay constant, but increases: With q_2 declining, less people are employed, which means more unemployment, calling for a higher tax rate to finance it. The above effects all lead to an overestimation of the profits, and therefore to a low quantity choice and low employment. The only variable, that can be counteracting is w^h. When firm j reduces its output, less low skilled workers are employed, implying a lower marginal productivity of the high-skilled, leading to a declining wage. On the other hand, the high-skilled wage can increase because of the increasing p_2. Of course the high-skilled wage differential between sector 1 and sector 2 diminishes because high-skilled workers can move between sectors. In our simulations the net effect is a bit negative, i.e. w^h decreases a little, when q_{2j} decreases. The overestimated high-skilled wage when deviating downwards would lead to a *higher* production than optimal, but this counteracting effect is overcompensated by the other effects.

4.4 Robustness

In this section we examine the impact of three parameters on the employment outcomes under GEC and PEC: the number of firms in the non-competitive sector 2, the elasticity of substitution between the consumption goods 1 and 2, and the size of the sector 2, where PEC or GEC take place.

To illustrate the effect of the myopic PEC view compared with the case, where all general equilibrium effects are incorporated by the the firms (GEC view), we have plotted aggregate employment against the number of firms in sector 2. Since in this section we analyse the case, where all labor force is mobile across industries, the figures are labeled with Mob. One curve in figure 5 is the PEC equilibrium employment outcome, i.e. aggregate employment in the steady state of the dynamic PEC process. The other curve (marked in figure 5) is aggregate employment resulting in the GEC equilibrium. The third curve is employment resulting under perfect competition, which we take as a benchmark. The fact, that employment under GEC is always higher than under PEC is the consequence of the lower quantity choice under PEC than under GEC. The less firms there are in the market, the stronger the price effect of choosing a low quantity is, but also the overestimation of this effect, so that PEC performs particularly bad relative to GEC for a small number of firms. When the number of firms increases, the price effect becomes smaller and smaller, so that the outcomes converge to the result under perfect competition. The distance between the PEC curve and the GEC curve decreases as well, because not only the price effect per se, but also the bias under PEC looses importance.

Figure 6 shows the same curves as figure 5, but now with a (lower) elasticity of substitution of 1/4. The pattern of the curves remains the same except for the distance between the curves. With a lower elasticity of substitution the (positive) price effect of producing low quantities becomes stronger, so that the distance of the PEC and GEC curve to the benchmark curve (perfect competition) increases. But with the lower elasticity of substitution the bias of the price effect increases as well, so that the distance between the PEC and the GEC curve increases too.

In Figure 7 the curves are plotted again for an elasticity of substitution of 1/2, but now we consider a sector size of 20 % instead of 10 %. This means that α_1 and α_2 in the utility function are chosen to imply that households spend 20 % of their budgets for good 2 and 80 % for good 1 when prices of good 1 and good 2 are equal. Obviously, the employment difference between GEC and PEC increases. The consequence of the overestimation of the price effect becomes more important when the sector size increases. The distances to the perfect competition employment outcome increase as well.

5 Immobility of the Labor Force

In this section we extend our analysis to the case, where the labor is immobile. Low-skilled workers are now divided into two groups $\overline{L}_1^\ell$ and $\overline{L}_2^\ell$. Labor force $\overline{L}_1^\ell$ is only able to work in sector 1, whereas labor force $\overline{L}_2^\ell$ can only work in sector 2. Total low-skilled labor supply is $\overline{L}^\ell = \overline{L}_1^\ell + \overline{L}_2^\ell$. High-skilled labor force is also divided into two groups $\overline{L}_1^h$, which can only be employed in sector 1 and $\overline{L}_2^h$, which can only work in sector 2. Total high-skilled labor supply amounts to $\overline{L}^h = \overline{L}_1^h + \overline{L}_2^h$.

5.1 The Model

The model remains the same as before for the most part. Labor market clearings for low-skilled workers will still not hold because of the real wage rigidity, whereas high skilled labor market clearings hold and are defined as

$$\overline{L}_1^h = L_1^h \tag{29}$$

$$\overline{L}_2^h = nL_{2i}^h \tag{30}$$

The real reservation wage $\overline{rw}$ is now defined as a percentage of the minimum of the market clearing real wages $\frac{w_1^\ell}{p}$ and $\frac{w_2^\ell}{p}$ when no frictions are present. Then

$$w_1^\ell = \overline{rw}\, p \tag{31}$$

$$w_2^\ell = \overline{rw}\, p \tag{32}$$

If the real wage $\overline{rw}$ exceeds the market clearing level, unemployment occurs (at least in one of the two sectors) and is defined as

$$\Delta = \overline{L}_1^\ell - L_1^\ell + \overline{L}_2^\ell - nL_{2i}^\ell \tag{33}$$

Again we analyze the effects of PEC and GEC in sector 2.

5.2 Simulation Results

The parameters for the following simulations are the same as in the mobility case. Low-skilled workers are now divided into two groups: 54 can work in sector 1 and 6 can work in sector 2. High-skilled labor force is also divided into two groups of 36 working in sector 1 and 4 in sector 2, so that production of good 2 makes 10 % of total production (we have constant returns to scale).

The calculations for PEC and GEC are similar to the mobile labor force case. Figure 8 shows the PEC steady state equilibrium and figure 9 demonstrates the GEC solution.

5.3 Results

If we compare figure 8 and figure 9, we see that the profit maximizing quantity in figure 9 (GEC) lies *below* the PEC equilibrium quantity now. Correspondingly, unemployment associated with PEC will be lower than under GEC. Why do firms tend to choose higher quantities than optimal and thereby create more employment when they fail to consider all general equilibrium effects at once?

The major difference is now that wages of high-skilled people react much stronger to quantity changes in the immobility case. Its neglect under PEC overcompensates all other effects. To illustrate this point, we examine again quantity choices under GEC and PEC with the GEC equilibrium values as starting point. Figure 10 is analogous to figure 3. As we see, firm j now tends to choose a higher quantity under PEC starting from the optimal point of GEC.

Table (3) shows again, which arguments in the profit function are overestimated by a firm j and which are underestimated, when the firm deviates *upwards* from the GEC solution quantity with the other firms staying at their GEC quantity. Note that we now examine an *upward* deviation of a firm's quantity choice since we want to understand why PEC yields output choices bigger than GEC (starting from the GEC solution).

Note that the second column in table (3) is the mirror image of the second column of table (2) because we consider an *upward* deviation in quantities. To review table (3) we have plotted in figure 11 one of the important variables, namely the wage w_2^h of high-skilled people working in sector 2. In the figure one of the curves shows the wage that will actually be realized associated with a certain quantity q_{2j} in market equilibrium (GEC). The other curve is the wage expected by a firm j deviating from the GEC solution (with the other firms staying at their GEC quantities) with its PEC view, considering only the interactions between q_{2i} and p_2. Comparing the two curves, we observe that with an increasing quantity q_{2j} the wage w_2^h rises more in market

Table 3:

Revenue	Estimation under PEC relative to GEC	Impact on output and employment under PEC relative to GEC
p_2 q_{2j}	underestimated -	negative -
Costs		
w_2^ℓ τ w_2^h	overestimated overestimated underestimated	negative negative positive

equilibrium than firm j *thinks* under its PEC view. The reason for this phenomenon is as follows: Under PEC, a firm j takes the factor costs as given and does not expect a change of factor costs when changing the quantity (only interactions between quantity and price are considered by the firms). But with a higher quantity, more low-skilled are employed in the sector, raising the marginal product of high-skilled. This in turn implies a rise of the high-skilled wage. The underestimation of the wage (and therefore the costs) leads to a higher quantity choice and has therefore a positive impact on employment. This effect is very strong and overcompensates all other (counteracting) effects.

Regarding the price effect, p_2 is underestimated. The argumentation is analogous to the mobile case: With an increasing production of q_2, p_2 falls. But the higher generated income leads to higher demand and production of good 1 as well, leading to a fall in the price of good 1, or to a less strong fall of p_2 relative to p_1. Because of the underestimated price p_2, the firms tend to chose fewer quantities than optimal, which creates less employment. The wage of low-skilled workers is still assumed to be constant by firm j, but in reality it decreases, i.e. it is overestimated. This happens because when q_2 increases owing to the upward deviation of firm j, the price p_2 falls (but is underestimated), leading to a lower price index p ($p_1 \equiv 1$). For a constant minimum real wage the nominal wage w^ℓ must therefore decrease. The tax rate τ does not stay constant either, but decreases for a similar reason: With q_2 increasing, more people are employed, allowing for a lower tax rate to finance unemployment. But all these effects are overcompensated by the high-skilled wage effect, which leads to a higher quantity choice than optimal.

5.4 Robustness

In this section we examine again the impact of three parameters on the employment outcomes under GEC and PEC: the number of firms in the sector, the elasticity of substitution between consumption goods 1 and 2, and the size of the sector 2, where PEC or GEC take place.

To illustrate the effects of PEC compared with GEC, we have plotted aggregate employment against the number of firms in sector 2 again. As all the labor force is immobile now, this is denoted by *Imall* in the figures. One curve in figure 12 is the PEC steady state equilibrium employment outcome, the other curve is aggregate employment resulting in the GEC equilibrium. The third curve is employment resulting under perfect competition, i.e. the benchmark. The fact, that employment under PEC is always higher than under GEC, is the result of the higher quantity choice under PEC than under GEC. The less firms are in the market, the stronger the price effect of choosing a low quantity is, but the stronger the overestimation of this effect compared to the wage effect also is, so that the distance of the PEC curve and the GEC curve disappears. When the number of firms increases, the price effect becomes smaller and smaller, so that the outcomes converge to the result under perfect competition. The distance between the PEC curve and the GEC curve increases at the beginning, because now the wage effect dominates clearly the price effect.

Figure 13 shows the same curves as figure 12, but now again with a lower elasticity of substitution of 1/4. The pattern of the curves changes now. With a low elasticity of substitution in the utility function, the price effect of a certain quantity choice becomes more important and so does the overestimation of this effect. This implies that the distance between the perfect competition curve and the other curves increases. Additionally the price effect (together with the low-skilled wage effect and the tax effect) now overcompensates the high-skilled wage effect for a small number of firms, so that the GEC outcome is better than the PEC outcome. With the number of firms in sector 2 increasing, the wrong estimation of the wage effect becomes more important relative to the wrong estimation of the price effect, so that the curves intersect and the PEC result is getting better for many firms in the sector.

In Figure 14 the curves are plotted again for an elasticity of substitution of 1/2, but now we consider a sector size of 20 %. Again the result is, that the distance between the benchmark curve (perfect competition) and the other curves increases. The reason for this phenomenon is simply, that the negative employment effect of imperfect competition is bigger when the sector with imperfect competition is bigger. In addition, the consequence of the overestimation of the price effect of course becomes more important when the sector size increases. This leads to an intersection of the PEC curve and the GEC curve and a better outcome in the GEC case for a small number of firms, whereas for a large number of firms the PEC outcome is still better.

6 Conclusions and Extensions

We have developed a general equilibrium model with Cournot Competition in one sector and perfect competition in the other sector in order to study how different learning abilities of agents affect economic outcomes, especially unemployment. We have shown that a partial equilibrium view of the economy by competing firms leads to low unemployment compared with a general equilibrium view, when the production factors are immobile. In contrast, if the production factors are mobile, the opposite result holds.

We hope that our analysis offers some avenues for further research. One of the most important feature on this agenda is to examine other types of product market competition in order to improve our understanding in which way imperfect competition in a general equilibrium environment works and affects outcomes. An interesting feature in this context is the analysis of firms competing à la Bertand with homogenous goods (and constant marginal costs) instead of Cournot. The following argument demonstrates that in this case the outcome must be equal to the outcome under perfect competition: If the price setting process, where at every stage prices equal marginal costs, converges to a stable steady state under PEC, which means that the function from p_2 to p_2 contracts (analogous to figure 1 and 8 in this paper), one can apply the fix point theorem of Banach to this situation. It states the existence and uniqueness of a fix point for contracting functions. Since the general equilibrium with *perfect competition* in all goods markets fulfills the claim that prices equalize marginal costs, the steady state of PEC reduces (like GEC) to *this* outcome. Hence, with Bertrand competition, differences in the recognition of general equilibrium effects can be irrelevant. In which way other types of product market competition affect the relative comparison of PEC and GEC is left for future research.

Figure 1: Convergence of Cournot Quantities

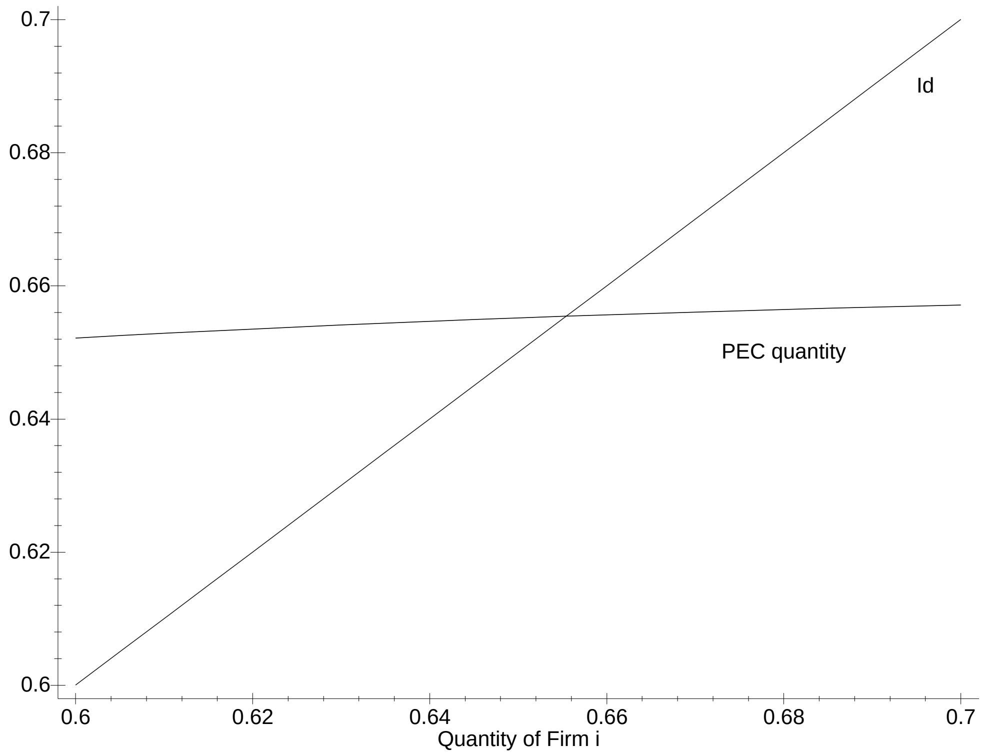


Figure 2: Profits of Firm j (GEC)

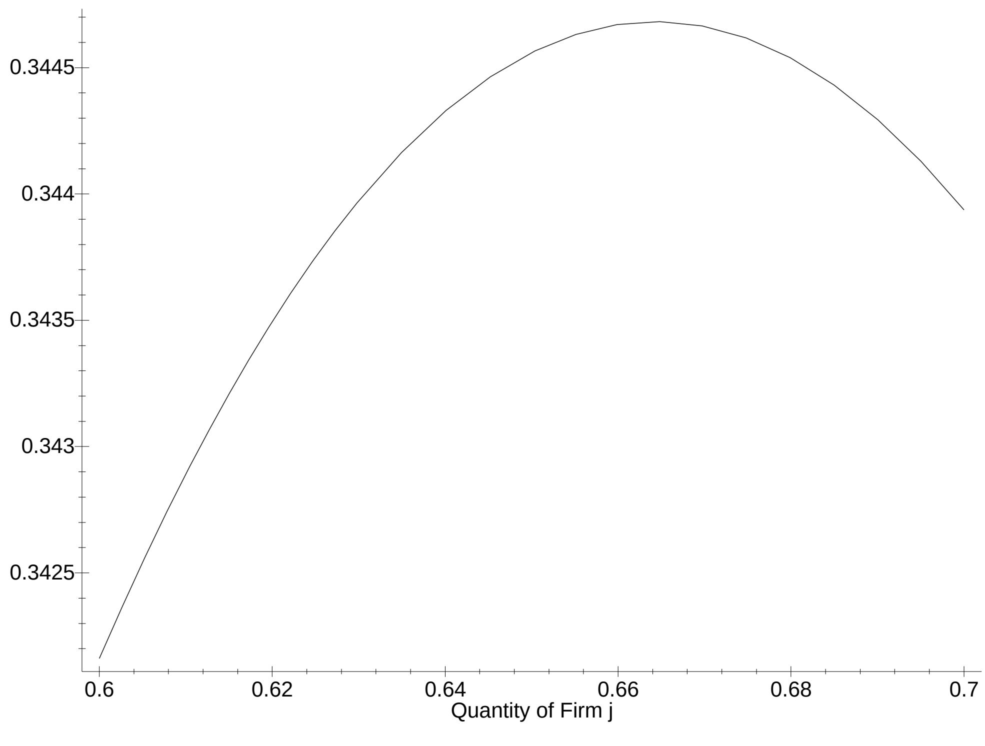


Figure 3: Profits Firm j (PEC/ GEC)

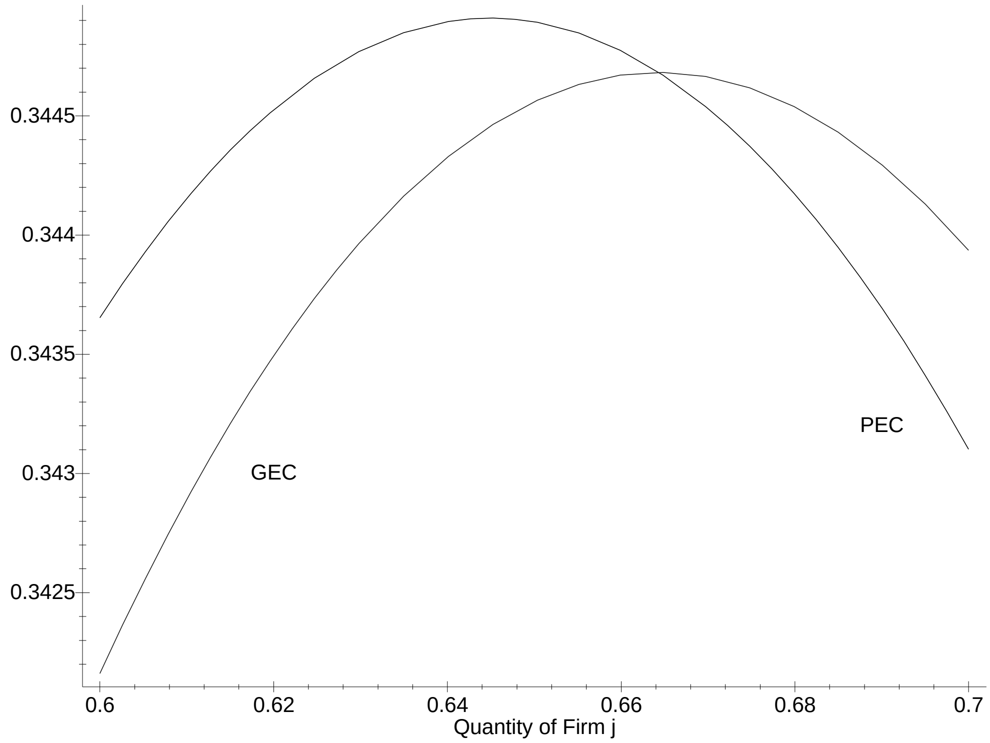


Figure 4: Price 2 (PEC/ GEC)

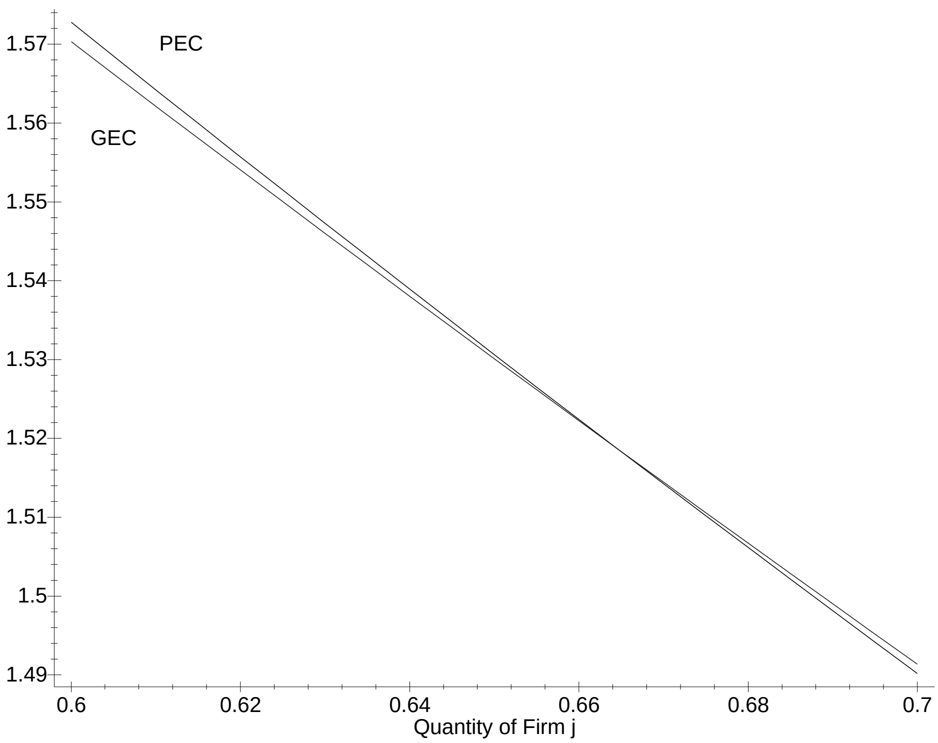


Figure 5: Competition and Employment (Mob)

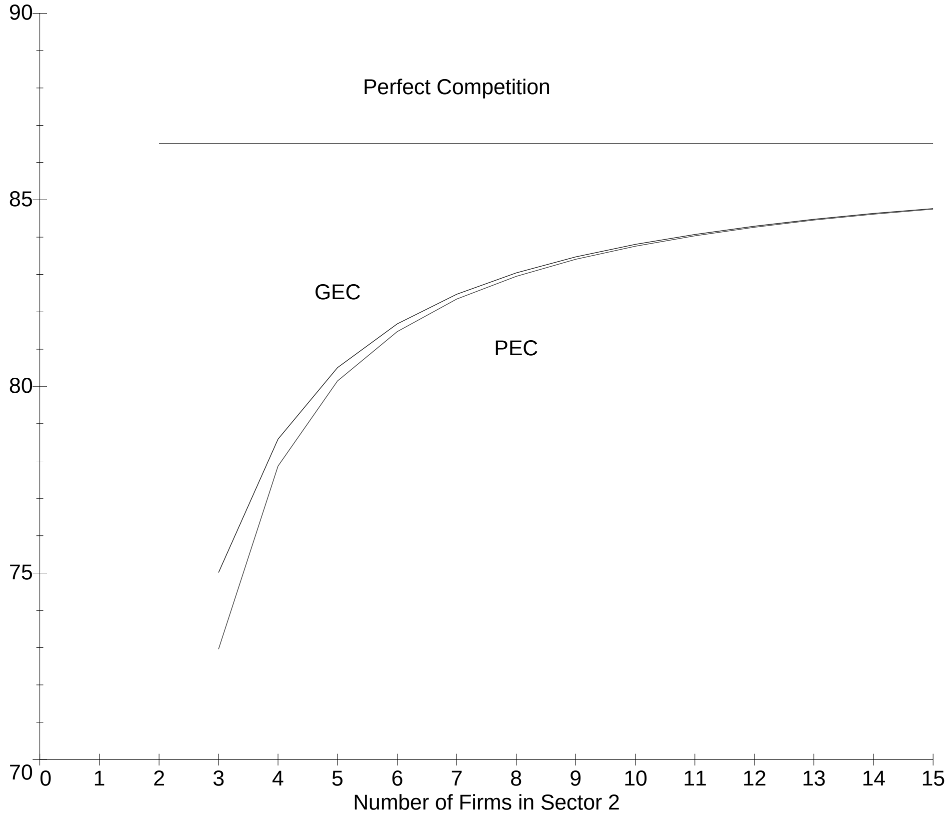


Figure 6: Competition and Employment (Mob)

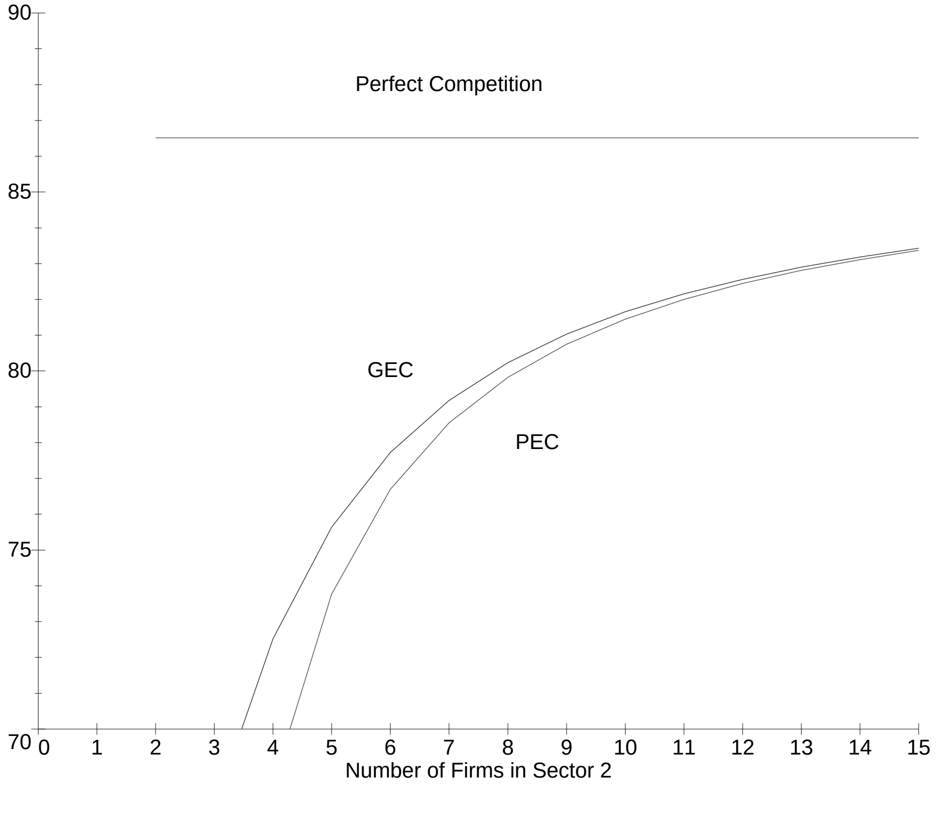


Figure 7: Competition and Employment (Mob)

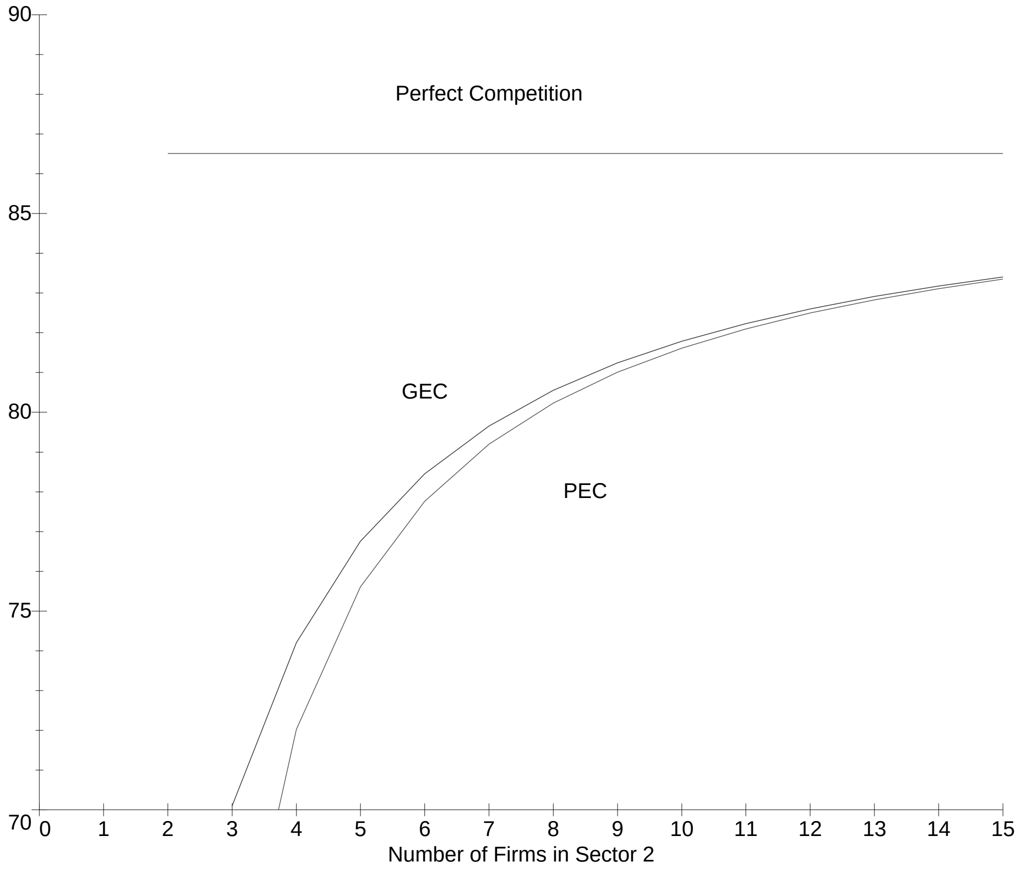


Figure 8: Convergence of Cournot Quantities

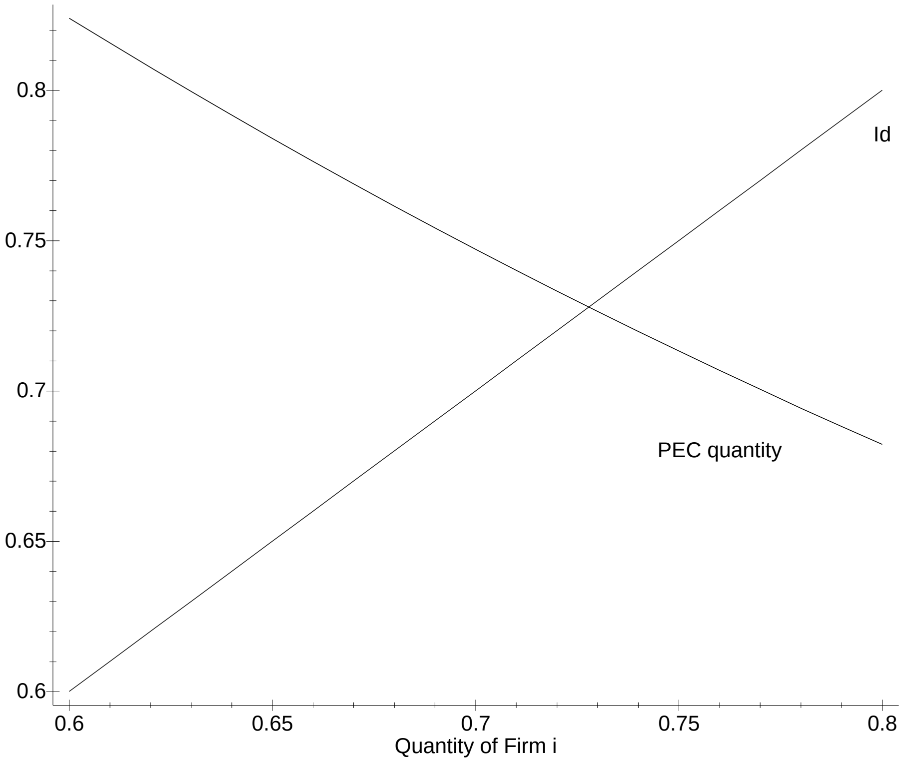


Figure 9: Profits of Firm j (GEC)

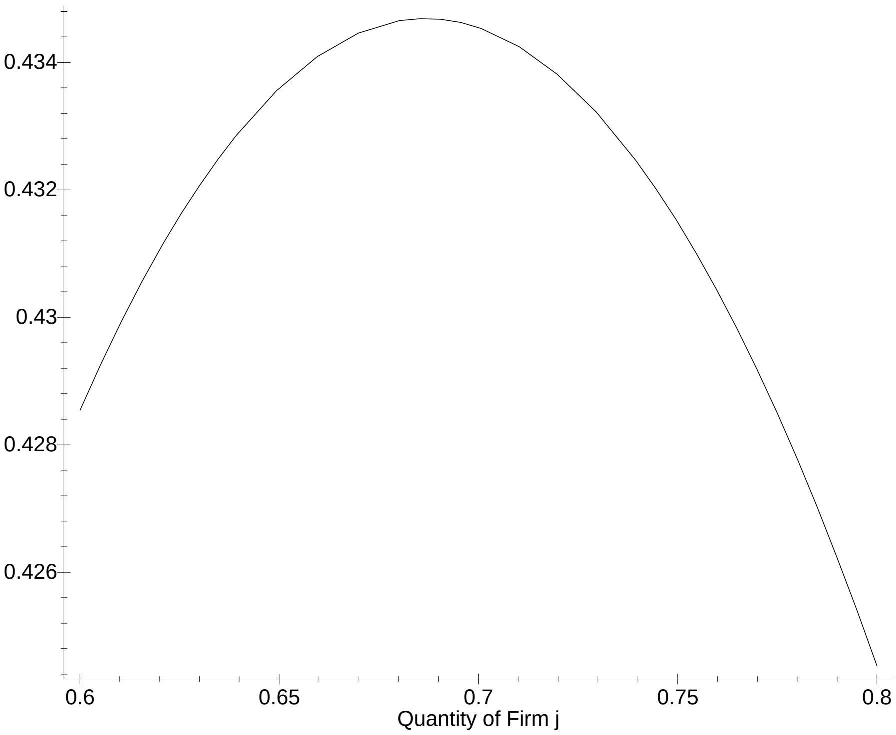


Figure 10: Profits Firm j (PEC/ GEC)

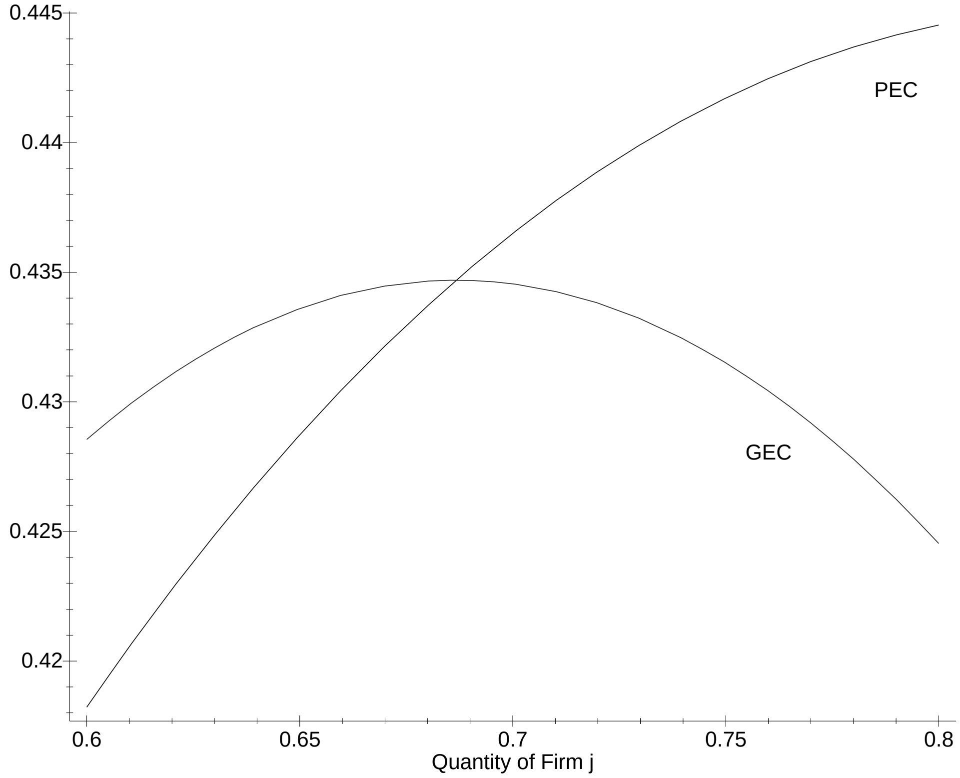


Figure 11: Wage High-Skilled (PEC/ GEC)

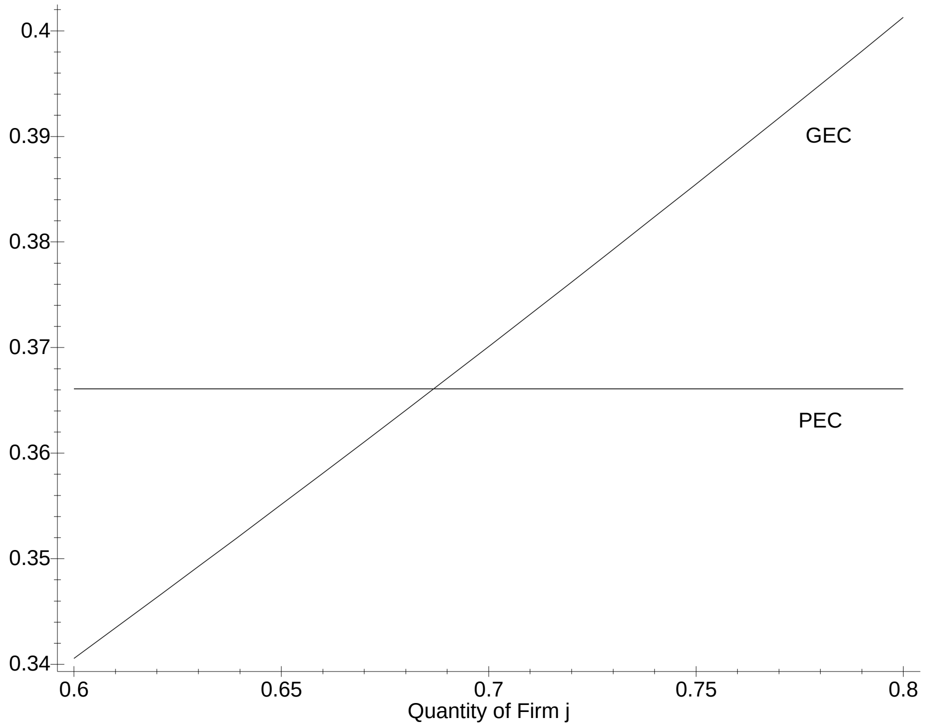


Figure 12: Competition and Employment (Imall)

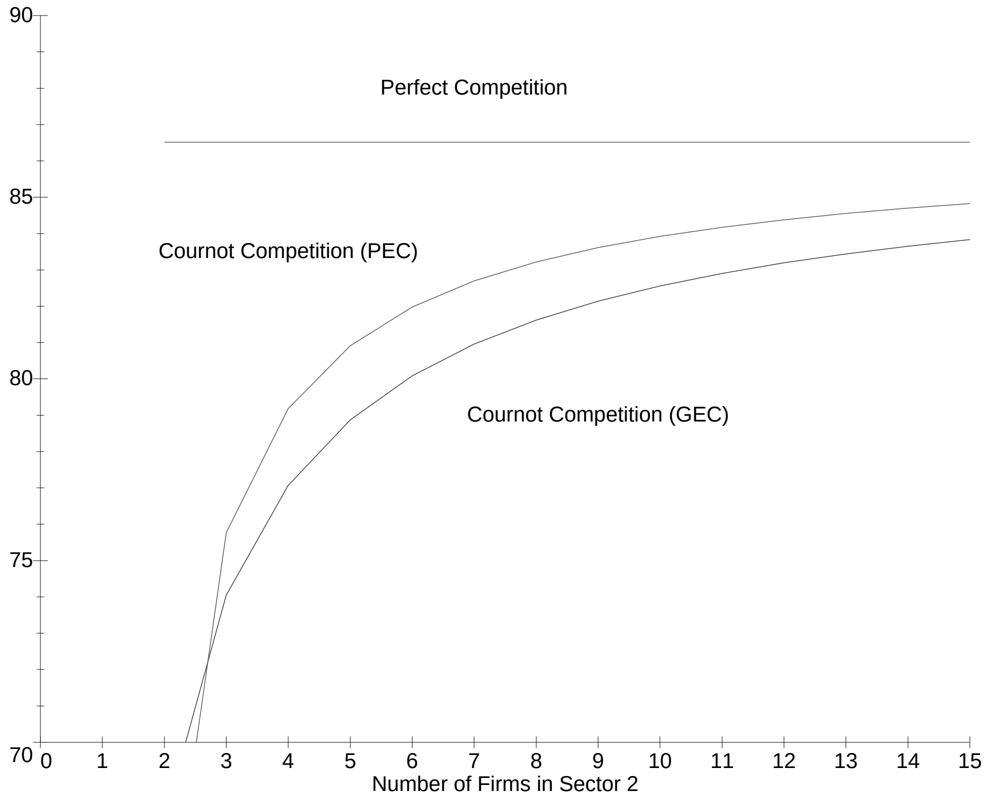


Figure 13: Competition and Employment (Imall)

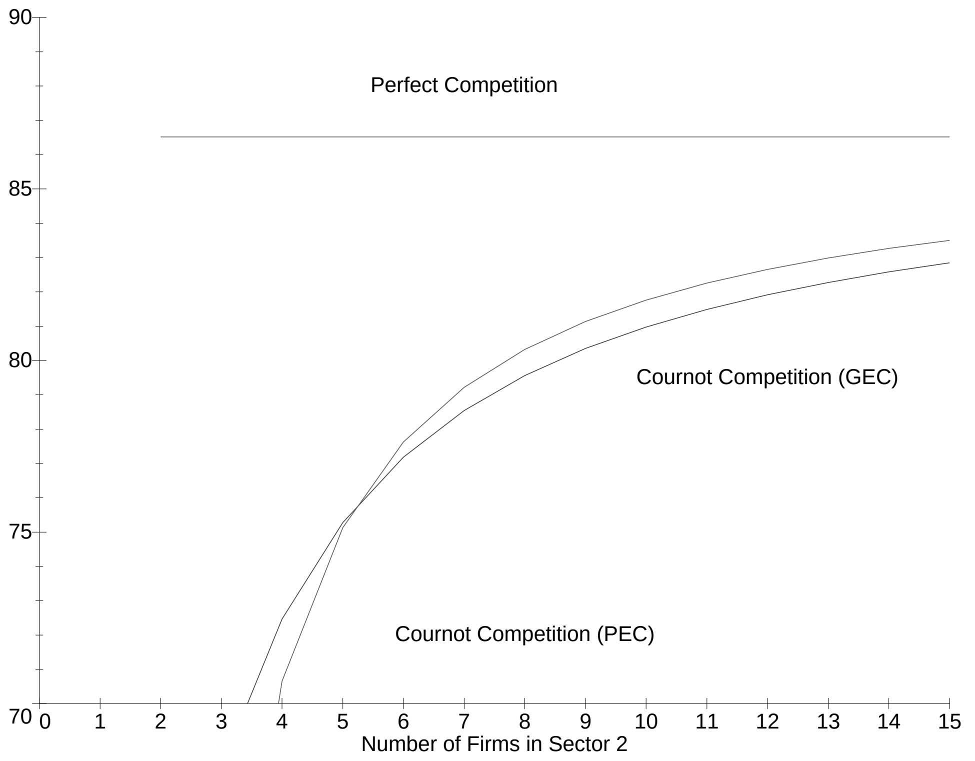
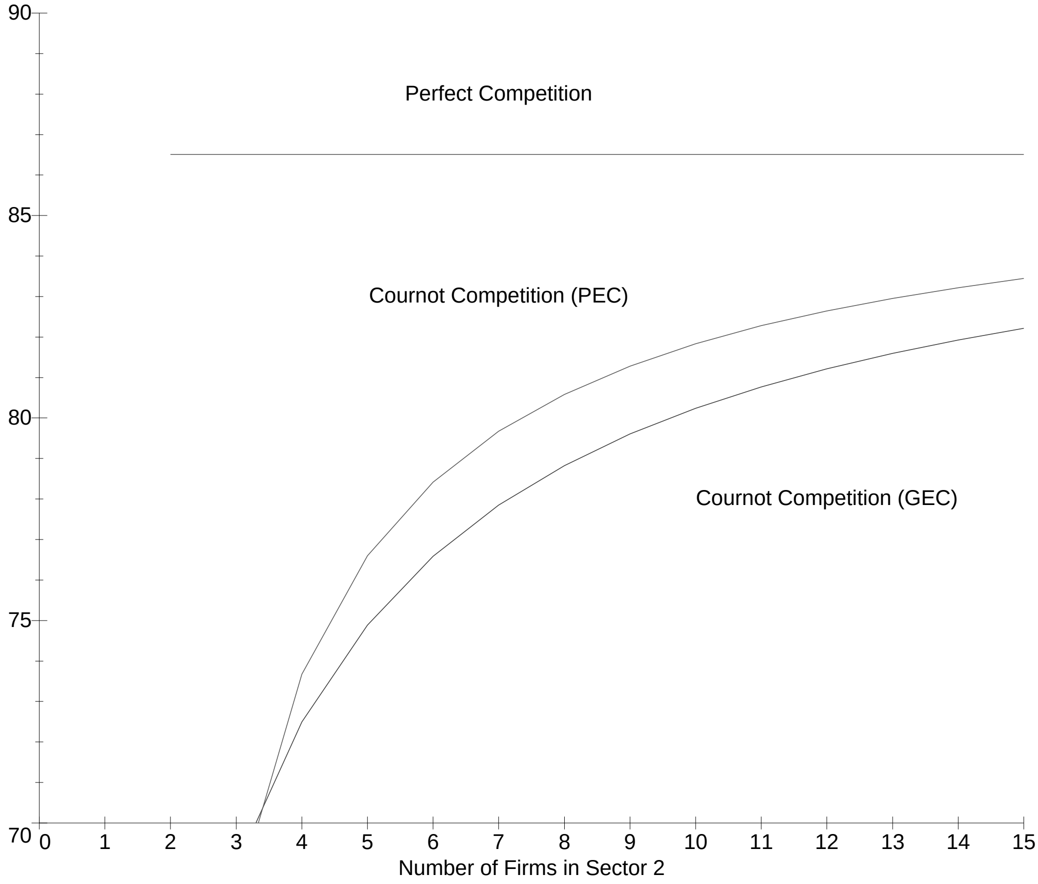


Figure 14: Competition and Employment (Imall)



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