Intersectoral labour allocation, wage-employment bargaining and monopolistic competition

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Abstract. This paper presents a two-sector general equilibrium model: one sector is monopolistically competitive and characterised by wage-employment bargaining at firm level; the other sector is perfectly competitive in both the product and the labour markets and it produces an intermediate good for the first sector. It is shown that: (a) an increase in unions' power over employment lowers firm efficiency but raises total employment and, if unions have more power over wage than over employment, also consumption and welfare; (b) a decrease in unions' power over wage increases total employment but, if unions have more power over employment than over wage and labour supply is rigid, it reduces consumption and welfare; (c) an increase in product market competition generally raises employment, consumption and welfare. The reason why increasing product market competition is almost always beneficial while changing unions' bargaining power can be sometimes harmful is that making the output market more competitive always improves the intersectoral allocation of labour while changing unions' bargaining power may make it worse.

1 Introduction

The economic literature offers a wide range of theoretical models dealing with imperfectly competitive labour and product markets. This field comprises both partial and general equilibrium approaches and has a few well established results. One of them is that making either the labour or the product market more competitive will lead to higher employment, production and welfare. Specifically, in a context in which firms and unions bargain over wage or over both wage and employment and the product market is monopolistically competitive, reducing either unions' bargaining power over wage or firms' price setting power in the output market raises labour demand. As a result, the equilibrium levels of employment, output and welfare also rise (see Booth [1], Dixon and Rankin [4] and Silvestre [11]). More controversial is the effect of an increase in unions' bargaining power over employment. In principle, the effect should be the same of a reduction in unions' bargaining power over wage, i.e., an increase in labour demand. Hence, allowing unions to bargain over employment should have a positive impact (see McDonald and Solow [9] and Dixon and Santoni [5]). However, Layard and Nickell [7] show that if unions bargain over employment as well as wages, employment may be the same as if they bargain over wages only.

The analysis of the relationship between product/labour market conditions and labour demand provides sufficient information to determine the equilibrium of an economy in which the labour market does not clear, i.e., in which there is involuntary unemployment (see for example D'Aspremont *et al.* [2]). However, if in equilibrium the labour market clears, labour supply characteristics must also be taken into account. In particular, the size of the impact on the equilibrium of an increase in labour demand is positively correlated to the elasticity of labour supply. This means that if labour supply is completely inelastic the equilibrium level of employment will not vary in response to changes in labour demand. However, Dixon and Hansen [3] show that output and welfare may still rise as more labour demand brings about a better labour allocation across the different sectors that make up the economy.

This paper presents a model in which increases in labour demand caused by changes in unions' bargaining power or firms' market power raise employment but reduce output and welfare. Moreover, we show that making firms more efficient may ultimately lead to a fall in employment, consumption and welfare. These results are obtained by considering a two sector general equilibrium model of a closed economy. One sector produces consumption goods using as inputs labour and capital. The other sector produces the capital input using only labour. The consumption good sector is monopolistically

competitive with a unionised labour market in which unions and firms bargain over both wage and employment. The capital good sector is perfectly competitive in both the product and the labour markets. So, our model is very similar to Dixon and Santoni [5]. The main difference, on which all our results hinge, is that we use Cobb-Douglas production functions and different degrees of labour supply elasticities while Dixon and Santoni [5] assume linear production functions and an infinitely elastic labour supply. We consider first the effects of changes in unions' bargaining strength over employment and wage and then the impact of a decrease in firms' market power. We find that varying labour and/or product market conditions has two effects: a change in labour demand (*demand effect*) and a change in the intersectoral allocation of labour (*allocation effect*). While the former effect has been extensively dealt with in the literature, the latter has so far attracted little attention. It turns out that the demand effect drives the equilibrium level of employment while, when labour supply is inelastic, the allocation effect determines the equilibrium levels of output and welfare. As a result, the impact on output and welfare of a change in unions' bargaining power over wage or over employment is not necessarily quite like the one predicted by the existing literature. In particular, reducing unions' power over wage may reduce both output and welfare. The same can happen if unions' power over employment is increased. This is because changing the relative strength of the unions at each stage of the bargaining process may worsen the intersectoral allocation of labour. Whether a change in labour market conditions will lead to a better or to a worse labour allocation depends on the unions' differential control over wage and employment. Specifically, for the intersectoral allocation of labour to improve, the difference between unions' bargaining power over wage and their power over employment must decrease. So, when unions have more power over wage (employment), the intersectoral allocation of labour improves if unions' power over employment (wage) is raised.

By contrast, an increase in product market competition in the consumer good market has almost always a positive impact on the equilibrium. Again the explanation lies in the allocation effect. In fact, intersectoral labour allocation always improves after a fall in firms' market power.

We use our framework also to discuss the impact of a change in either the labour or the product market conditions on firm efficiency. Firm inefficiency arises when firms fail to employ factors in proportion to their relative prices. In our model firms are inefficient as long as unions bargain over employment. A fall in unions' power over employment or in firms' market power reduces firm inefficiency. However, while in the latter case this effect is generally associated with higher employment, output and welfare, in the former case all these three variables fall if the intersectoral allocation of labour worsens.

That is, reducing unions' power over employment makes firms more effcient but may lower employment, output and welfare. This result is due to the fact that prices are distorted and hence a bad signal for allocating resources. So, a reduction in firm inefficiency may mean a worse allocation of labour across sectors as firm efficiency is measured relative to the distorted equilibrium input prices while how efficiently labour is allocated between sectors depends on the available technology which is fixed and independent of prices.
The remaining of the paper is organised as follows. The basic model is outlined in section 2. Section 3 describes the equilibrium. Section 4 analyses the consequences of changing unions' bargaining power and increasing competition in the monopolistic sector. Section 5 contains final remarks.

2 The model

There is a closed economy composed of a continuum of households, a consumer good sector and a capital good sector. The consumer good sector has monopolistic competitors, each producing its own brand of the consumption good using labour and capital. Firms bargain sequentially over wages and employment with enterprise unions. The capital good sector is perfectly competitive. The only production factor is labour and output is sold to firms in the monopolistic sector.

2.1 Households

There is a continuum of households $i \in [0,1]$. They derive utility from consumption of leisure and of differentiated goods, each of them denoted by the subscript $j \in [0,1]$. Preferences of the representative consumer over goods are expressed by a symmetric CES utility function. Formally

$$U\left(c_{ij}, l_i\right) = \left(\int_{j=0}^{1} {c_{ij}}^{\lambda} dj\right)^{\frac{1}{\lambda}} - \frac{\gamma}{\gamma+1}\left(l_i^k + l_i^m\right)^{\frac{\gamma+1}{\gamma}} \qquad i \in [0,1] \qquad (1)$$

The first term is the utility of consumption with $\lambda \in (0,1)$. The utility of leisure is represented by the second term, which is formally the disutility of labour. l_i^k and l_i^m are the amounts of work performed by i in, respectively, the capital good and the consumption good sector[1]. The budget constraint

[1]So in our model each household works in both sectors. Constraining households to be employed in either one sector or the other would make notation more cumbersome without adding any new insight. In fact, the results of the paper depend on how total employment is allocated across sectors rather than on its allocation across households.

of household i is

$$PC_i = w^k l_i^k + w^m l_i^m + \pi_i \tag{2}$$

where C_i is identically equal to the first term in the utility function, π_i is profit, w^k is capital sector wage and w^m is monopolistic sector wage. P is the consumer price index, which is given by

$$P = \left(\int_{j=0}^{1} p_j{}^{\frac{\lambda}{\lambda-1}} dj \right)^{\frac{\lambda-1}{\lambda}} . \tag{3}$$

We choose the aggregate consumption good, C_i, as the numeraire and set therefore $P = 1$. Maximising utility yields aggregate consumption and capital sector labour supply:

$$c_j = (p_j)^{-\frac{1}{1-\lambda}} C \qquad\qquad j \in [0,1] \tag{4}$$

$$l^k = \left(w^k\right)^{\gamma} - l^m \tag{5}$$

where $1/(1-\lambda)$ denotes the constant price elasticity of demand corresponding to the elasticity of substitution between any two consumption goods produced in the economy. The parameter $\gamma > 0$ represents the wage elasticity of labour supply and its inverse value the marginal disutility of work. As we shall see, $w^m > w^k$, so that households strictly prefer to work in the monopolistic sector. However, monopolistic sector labour supply is not relevant as there employment will be demand determined. Hence, households' capital sector labour supply can be seen as a residual labour supply. Finally, C is total consumption, i.e.

$$C \equiv \int_{i=0}^{1} C_i di$$

2.2 The consumer good sector

The consumption good sector is characterised by monopolistic competition. Firms employ two factors of production: capital and labour. The production function is the same for all monopolistic firms, exhibits constant or decreasing returns to scale, and is given by

$$x_j = \frac{n_j^{\alpha} k_j^{\beta}}{\alpha^{\alpha} \beta^{\beta}} \qquad\qquad j \in [0,1] \tag{6}$$

where x_j is the level of output of firm j; k_j and n_j are, respectively, the amount of capital and of labour employed by firm j and $\alpha > 0$ and $\beta > 0$ are the technology parameters with $s \equiv \alpha + \beta \leq 1$.
Wage and employment are determined at the firm level in a sequential bargaining between each firm and its union. Following most of the economic literature, we assume Nash bargaining (see Nash [10]). In particular, we borrow the two-stage procedure described in Manning [8]. This is a two stage Nash bargaining, whereby first firm and union bargain over wage and then over employment. The solution is found by working backwards from the second stage.
Each firm's payoff corresponds to their profit while each union has the following objective function

$$H_j = n_j(w_j^m - w^k) \qquad j \in [0,1] \tag{7}$$

where w_j^m denotes the wage paid to firm j's workers. Union's fall-back utility and firm's fallback payoff are equal to 0. Since all union-firm pairs are identical, the bargained wage-employment combination is the same for all of them. In particular, bargained wage is

$$w^m = w^k (1 + v\sigma) \tag{8}$$

and, in equilibrium, bargained employment is

$$n^m = \left(\frac{1+q\sigma}{1+v\sigma}\right) \frac{\alpha\lambda C^*}{w^k} = \phi \frac{\alpha\lambda C^*}{w^k} \tag{9}$$

where

$$\sigma := \frac{1-(\alpha+\beta)\lambda}{\alpha\lambda} = \frac{1-s\lambda}{\alpha\lambda}$$

and C^* is the equilibrium level of output. $v \in [0,1]$ and $q \in [0,1]$ are, respectively, the unions' bargaining power over wage and employment. Setting $v > 0$ and $q = 0$ yields the right-to-manage model, while $v = q$ corresponds to the efficient bargaining model.

2.3 The capital good sector

In the sector producing the capital good the only production input is labour. Returns to scale are constant and production is normalised to be equal to employment. So,

$$k = n^k \tag{10}$$

where n^k denotes the amount of labour employed in the capital sector. Perfect competition is assumed in both the labour and the product markets. Hence, capital is sold at its marginal cost, i.e.

$$r = w^k \tag{11}$$

with r the price of capital. As a convention, we shall use k to refer to both the amount of physical capital and the employment level in the capital sector.

3 Equilibrium

Equations (4) to (6) and (8) to (11) allow us to derive the equilibrium of the economy. Equilibrium total employment is given by

$$l^* = z \left[\frac{\lambda^\gamma \phi^{\alpha\gamma}}{z} \right]^{\frac{1}{1+(1-s)\gamma}} \tag{12}$$

where $z \equiv \alpha\phi + \beta$. Labour is distributed between the two sectors in the following way

$$k^* = \beta \left[\frac{\lambda^\gamma \phi^{\alpha\gamma}}{z} \right]^{\frac{1}{1+(1-s)\gamma}} \tag{13}$$

$$n^* = \alpha\phi \left[\frac{\lambda^\gamma \phi^{\alpha\gamma}}{z} \right]^{\frac{1}{1+(1-s)\gamma}} . \tag{14}$$

Total consumption/output is given by

$$C^* = \phi^\alpha \left[\frac{\lambda^\gamma \phi^{\alpha\gamma}}{z} \right]^{\frac{s}{1+(1-s)\gamma}} . \tag{15}$$

As a measure of welfare we take the utility function, that in equilibrium is equal to

$$U^* = C^* \left[1 - \frac{\gamma}{\gamma+1} \lambda z \right] . \tag{16}$$

(13) and (14) can be used to obtain a measure of how efficiently labour is allocated between the two sectors. If the economy were perfectly competitive, labour would be allocated according to the ratio β/α. So, as long as the ratio k^*/n^* differs from β/α, labour is inefficiently allocated. To measure intersectoral labour misallocation we use the following expression

$$AE := \left| \frac{n}{k} \frac{\beta}{\alpha} - 1 \right| \tag{17}$$

AE stands for Allocative Efficiency. If $AE = 0$ labour is efficiently allocated, otherwise the intersectoral allocation of labour is inefficient.
A similar measure can be constructed for firm efficiency. Firms are inefficient if the technical rate of substitution between labour and capital differs from the corresponding price ratio[2]. This type of inefficiency is captured by the following expression

$$FE := \left| \frac{dx/dk}{dx/dn} \frac{w^m}{w^k} - 1 \right| = \left| \frac{n}{k} \frac{\beta}{\alpha} \frac{w^m}{w^k} - 1 \right| \tag{18}$$

where FE stands for Firm Efficiency. If $FE = 0$ firms are perfectly efficient, otherwise they are inefficient.
AE and FE are the same when $w^m = w^k$ (that is, when $v = 0$) and are different otherwise (that is, when $v > 0$). In the former case there is no bargaining over wage and inefficient firms imply a bad allocation of labour and vice-versa. This is because there is no price distortion in the labour market. Hence, input prices correctly reflect households' preferences and technology conditions. By contrast, if firms and unions bargain over wage ($v > 0$), inefficient firms and optimal labour allocation can coexist. This is because now input prices are distorted and are therefore no longer a valid signal for allocating resources efficiently.
The equilibrium values of FE and AE are

$$FE^* = q\sigma \tag{19}$$

$$AE^* = |\phi - 1| \tag{20}$$

If $q = v$, $\phi = 1$, in which case labour is efficiently allocated between the two sectors ($AE^* = 0$). However, if $q > 0$, firms are inefficient. Hence, FE^* and AE^* are both equal to their optimal value of zero only if the monopolistic sector is not unionised ($q = v = 0$).

4 The impact of a change in competition

In this section we assess the impact of a change in either the labour or the output market conditions. In particular, we look at the effect of a change

[2]Our definition of firm efficiency corresponds to Farrell's allocative efficiency (see Farrel [6]).

in unions' bargaining power (over employment and over wages) and of an increase in product market competition. The latter is expressed by an increase in λ, i.e., in the degree of substitutability between the different brands produced in the monopolistic sector. All information required to conduct the analysis can be derived from appropriately decomposing the impact of an increase in output competition. In particular, the impact of a rise in λ is decomposed as follows

$$\frac{dy^*}{d\lambda} = \frac{\partial y^*}{\partial \lambda} + \frac{\partial y^*}{\partial \phi}\frac{d\phi}{d\lambda} \tag{21}$$

where $y^* = n^*, l^*, k^*, C^*, U^*$. $\partial y^*/\partial \lambda$ is the direct impact on y^* of an increase in competition in the product market. $\partial y^*/\partial \phi$ measures the effect of a change in the monopolistic sector labour market conditions. And $d\phi/d\lambda$ is the impact that a change in output market competition has on unions' and firms' behaviour in the monopolistic sector. So, when analysing the effect of a change in unions' bargaining power all we need to do is to look at $\partial y^*/\partial \phi$ as changing q and v is equivalent to changing ϕ. By contrast, to discuss the impact of product market competition we need to look at (21) in its entirety. So, given (12) to (16), the impact of an increase in competition can be written as follows

$$\frac{dk^*}{d\lambda} = \left\{ \frac{\gamma}{\lambda} + \alpha \left[\frac{\gamma}{\phi} - \frac{1}{z} \right] \frac{d\phi}{d\lambda} \right\} \frac{k^*}{g} \tag{22}$$

$$\frac{dn^*}{d\lambda} = \left\{ \frac{\gamma}{\lambda} + \left[\frac{1 + (1-\beta)\gamma}{\phi} - \frac{\alpha}{z} \right] \frac{d\phi}{d\lambda} \right\} \frac{n^*}{g} \tag{23}$$

$$\frac{dl^*}{d\lambda} = \left\{ \frac{1}{\lambda} + \alpha \left[\frac{1}{\phi} + \frac{1-s}{z} \right] \frac{d\phi}{d\lambda} \right\} \frac{l^*\gamma}{g} \tag{24}$$

$$\frac{dC^*}{d\lambda} = \left\{ \frac{s\gamma}{\lambda} + \alpha \left[\frac{1+\gamma}{\phi} - \frac{s}{z} \right] \frac{d\phi}{d\lambda} \right\} \frac{C^*}{g} \tag{25}$$

$$\frac{dU^*}{d\lambda} = \left\{ \gamma \left(\frac{s}{\lambda} - z \right) + \alpha \left[\frac{1+\gamma}{\phi} - \frac{s}{z} - \lambda z \gamma \left(\frac{1}{\phi} + \frac{1-s}{z} \right) \right] \frac{d\phi}{d\lambda} \right\} \frac{C^*}{g} \tag{26}$$

where $g \equiv 1 + (1-s)\gamma > 0$ and $d\phi/d\lambda > 0 (< 0)$ if $q < v (q > v)$. In the next two sections we look separately at changes in unions' bargaining power and in firms' pricing power.

4.1 Competition in the labour market

In this section we discuss the effect of changing unions' bargaining power. A fall in unions' power over wage corresponds to a reduction in v and, therefore, to an increase in ϕ. Similarly, increasing unions' power over employment implies raising q and, hence, again raising ϕ.
The effect of changes in ϕ are captured in (22) to (26) by the expressions in the squared brackets which correspond to $\partial y^*/\partial\phi$ in (21). These expressions, together with (19) and (20), yield the following proposition

Proposition 1 *The effect of an increase in unions' power over employment (rise in q) or of a decrease in unions' power over wage (fall in v) is as follows:*

(a) firm efficiency worsens if q is raised and remains unchanged if v varies;

(b) monopolistic sector and total employment increase;

(c) capital sector employment rises (falls) if $\gamma > \gamma'$ ($\gamma < \gamma'$);

(d) if $q < v$

- *(d1) allocative efficiency improves;*
- *(d2) consumption and welfare rise;*

(e) if $q \geq v$

- *(e1) allocative efficiency worsens;*
- *(e2) consumption falls if $\gamma < \gamma''$ and increases otherwise;*
- *(e3) welfare falls unless $\gamma > \gamma'''$ and $AE^* < AE'$, in which case it increases.*[3]

Proposition 1 states that reducing (increasing) unions' bargaining power over wages (employment) has always a positive effect on employment and an ambiguous one on consumption and welfare. Specifically, output and welfare increase if ϕ is smaller than 1 and fall if both ϕ is larger than 1 and labour supply is rigid. These results can be explained as follows. An increase in q/reduction in v implies an increase in ϕ. This has two effects: a demand effect, as demand for labour in the monopolistic sector directly depends on ϕ (see (9)); and an allocation effect, as the intersectoral allocation of labour is a function of ϕ (see (20)). The demand effect is always positive. That is, labour demand rises in response to a fall in v/ increase in q. As for the allocation effect, its sign depends on the initial state of the economy as expressed by ϕ.

[3]The definitions of $\gamma', \gamma'', \gamma'''$ and AE' are given in Appendix.

If ϕ is smaller than 1 there is too much labour allocated to the capital good sector. In this case the allocation effect is positive and allocative efficiency improves as reducing v/increasing q means raising the ratio between monopolistic sector employment and capital sector employment. By contrast, if ϕ is larger than 1 the allocation effect is negative. In this case, there is too much labour allocated to the consumption sector so that further increasing its relative employment has a negative impact on allocative efficiency.
Total employment is mainly driven by the demand effect. Since this is always positive, total employment rises. The sign of the change in consumption and welfare, instead, depends on both the demand and the allocation effects. If they are both positive consumption and welfare rise. When, instead, the demand effect is positive and the allocation effect is negative, consumption and welfare fall (rise) if the latter is larger (smaller) than the former. Since the size of the demand effect is positively correlated to the elasticity of labour supply, if labour supply is rigid (small γ), the allocation effect dominates and consumption and welfare decrease. Notably, if the initial misallocation is large ($AE^* > AE'$), the allocation effect always dominates and welfare falls no matter what the value of γ is.
Finally, note that raising q makes firms more inefficient but, if $q < v$, it increases employment, consumption and welfare. The reason why the economy fares better if firms become more inefficient is that firm efficiency is measured relative to input prices (see (18)) and these are distorted by firm-union bargaining over wage.

4.2 Competition in the product market

We now look at the impact of an increase in product market competition. Equations (19), (20), and (22) to (26) yield the following proposition

Proposition 2 *An increase in product market competition (rise in λ) has the following impact:*

- *(a) firm efficiency improves;*
- *(b) allocative efficiency improves unless q=v in which case it remains unchanged;*
- *(c) if $q \leq v$,*
  - *(c1) monopolistic sector employment, total employment, consumption and welfare rise;*
  - *(c2) capital sector employment increases if $q = v$. If $q < v$, it rises (falls) if $\gamma > \gamma^k$ ($\gamma < \gamma^k$);*

(d) if $q > v$,

- *(d1) capital sector employment decreases if $|d\phi/d\lambda| > \epsilon^k$ and $\gamma > \gamma^k$. Otherwise it increases;*
- *(d2) monopolistic sector employment increases if $|d\phi/d\lambda| < \epsilon^m$ and $\gamma > \gamma^m$. Otherwise it decreases;*
- *(d3) total employment decreases (increases) if $|d\phi/d\lambda| > \epsilon^l (< \epsilon^l)$;*
- *(d4) consumption decreases if $|d\phi/d\lambda| > \epsilon^c$ and $\gamma > \gamma^c$. Otherwise it increases;*
- *(d5) welfare decreases if $\epsilon^u > 0$ and $\gamma > \gamma^u$. Otherwise it increases.*[4]

Proposition 2 states that increasing competition in the product market has, in general, a positive impact. This marks a stark difference with Proposition 1, which pointed to an ambiguous effect of changing unions' bargaining power. The main reason for this difference is that, while increasing (decreasing) unions' power over employment (wage) may have a negative impact on labour allocation, increasing product market competition always improves allocative efficiency. More in detail, we have now three effects: a demand effect, an allocation effect and a supply effect. The first two are the same that were discussed in the previous section. The latter, is, instead, specific of output market competition and corresponds to the direct effect of an increase in λ ($\partial y^*/\partial\lambda$ in (21)). In particular, the supply effect is the rise in labour supply due to the fact that more competition in the output market reduces profit and raises wage. Clearly, this effect is increasing in the elasticity of labour supply. The signs of the various effects are as follows: the allocation and the supply effects are always positive while the demand effect is positive if $q < v$ and negative otherwise. Hence, when unions have more bargaining power over employment than over wage, the demand effect is negative. However, only in extreme cases the demand effect will be so large to offset both the supply and the allocation effects. In particular, both a very large reduction in ϕ and a large elasticity of labour supply are needed for the overall impact of an increase in competition to be negative.

[4] ϵ^i and γ^i $(i = k, m, l, c, u)$ are defined in Appendix.

5 Conclusion

It is often argued that reducing unions' power over wage and increasing competition in the output market have positive effects on employment, output and welfare. Part of the literature supports the idea that also augmenting unions' power over employment has beneficial effects. On the one hand, both less unions' power over wage and more unions' power over employment increase demand for labour. On the other hand, increasing competition in the product market reduces the price level which, by increasing real wages, raises labour supply. All these arguments may not be valid if labour supply is rigid. In this case, changes in either labour demand or real wages do not make much of a difference. What is relevant is instead the impact that changes in labour and product market conditions have on the intersectoral allocation of labour. It turns out that increasing competition in the product market always improves the intersectoral allocation of labour, which generally leads to higher employment, consumption and welfare. By contrast, intervening in the labour market is less of a safe bet, since reducing unions' power over wages and/or augmenting it over employment will certainly lead to more employment, but, depending on how labour is allocated across sectors, it can lead to a worse labour allocation and eventually to lower levels of consumption and welfare. Finally, if unions distort input prices, making firms more efficient by lowering unions' power over employment may decrease employment, consumption and welfare.

Appendix

In this section we give the definitions of the variables of Proposition 1 and 2. As for Proposition 1, we have

$$\gamma' := \frac{\phi}{\alpha\phi + \beta} \qquad \gamma'' := \frac{s\phi}{\alpha\phi + \beta} - 1$$

$$\gamma''' := \frac{\gamma''}{1 - \lambda\left[\beta + (1-\beta)\phi\right]} \qquad AE' := \frac{1/\lambda - 1}{1 - \beta}$$

and for Proposition 2

$$\gamma^k := \frac{\phi}{z}\left[1 - \lambda\frac{(1+q\sigma)(1+v\sigma)}{q-v}\right]^{-1} \qquad \epsilon^k := \frac{\phi}{\alpha\lambda}$$

$$\gamma^m := \frac{\beta}{z}\left[\alpha\lambda\frac{(1+q\sigma)(1+v\sigma)}{q-v} - 1 + \beta\right]^{-1} \qquad \epsilon^m := \frac{\phi}{(1-\beta)\lambda}$$

$$\epsilon^l := \left[\alpha\lambda\left(\frac{1}{\phi} + \frac{1-s}{z}\right)\right]^{-1}$$

$$\gamma^c := \frac{\beta(\phi-1)}{z}\left[1 - s\lambda\frac{(1+q\sigma)(1+v\sigma)}{q-v}\right]^{-1} \qquad \epsilon^c := \frac{s\phi}{\alpha\lambda}$$

$$\gamma^u := \frac{\beta(\phi-1)}{z}(\epsilon^u)^{-1} \qquad \epsilon^u := 1 - \lambda\left[\beta + (1-\beta)\phi\right] + (\lambda z - s)\lambda\frac{(1+q\sigma)(1+v\sigma)}{q-v}$$

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