CAN LABOUR MARKET RIGIDITY LEAD TO ECONOMIC EFFICIENCY? THE TECHNICAL CHANGE LINK

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Can Labour Market Rigidity Lead to Economic Efficiency? The Technical Change Link

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Abstract

The extent to which labour market rigidity can be beneficial for an economy is investigated in a model where technological change is non-general purpose and different types of skills are available to workers. More precisely, specific skills lock a worker into a particular technology but increases productivity. Conversely, general skills allow workers to move across technologies at the cost of lesser productivity. Labour market rigidity is modelled as cross-sectors transfer costs for general skill workers. The main result is that a positive level of labour market rigidity is in general beneficial for the economy. In fact, *ex post* efficiency calls for low market rigidity, as this allows more workers to transfer to the innovating sector of the economy. Conversely, *ex ante* efficiency calls for high labour market rigidity, as this favours workers' acquisition of specific skills, which increases output. The combination of these two effects results in an inverse-U shaped relationship between output and labour market rigidity. A necessary condition for this result to hold is that the acquisition of specific skills is *ex ante* costly, as the rent that must be paid in equilibrium to specific skill workers determines a gap in marginal productivity in favour of specific skill labour.

Keywords: Non-general purpose technology, labour market rigidity, specific and general human capital.
JEL classification: J24, J31, O30

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1 Introduction

Labour market rigidity has been studied extensively over the last three decades in relation to the problem of the poor performance of continental Europe labour markets in comparison to that of the Anglo-Saxon countries. In particular, the various aspects that contribute to make a labour market 'rigid' have been analyzed, generally leading to negative conclusions as to their effects. For instance, it has been argued that high firing costs may increase firms' reluctance to hire workers, thus contributing to make unemployment persistent (Bentolila and Bertola, 1990). The unemployment benefit system has also been widely blamed for rising unemployment above its natural level, because of the related moral hazard problems (Layard *et al.*, 1991), and the loss of human capital during unemployment spells (Ljungqvist and Sargent, 2002). The rigidity of wage setting mechanisms has also been singled out as a possible cause of hysteresis in unemployment[1], in particular when insiders have higher power than outsiders in wage bargaining (Blanchard and Summers, 1987).

Other scholars have taken a more systemic approach, emphasizing the inability of systems characterized by rigid labour markets to adjust either to macroeconomic shocks – e.g. the oil price surge, total factor productivity decline, spread of information technology and labour demand shifts (Blanchard and Wolfers, 2000; Ljungqvist and Sargent, 1998) –or to microeconomic shocks – e.g. increased turbulence in the earning and employment prospects facing a worker (Gottshalk and Moffitt, 1994), which may lead to increased volatility in local labour demand (Bertola and Ichino, 1995). Moreover, these scholars have pointed to such increased variability in the economic environment as the main reason why the European labour markets outperformed the U.S. labour market before the 70s and later underperformed with respect to the U.S. In particular, the interaction between different institutions and different shocks may account for different experiences in unemployment patterns across countries (Blanchard and Wolfers, 2000).

That globalisation has played a part in such increased variability of economic environments has been stressed by several scholars. For instance, Ljungqvist and Sargent (1998: 518) argue that *"[...] competition from newly industrialized countries increasing internationalization of the production, distribution, and marketing of goods and services are rapidly changing the economic environment"*, and they assign to such changes a key role in their account of the labour market performance. From the economic policy standpoint, 'global' institutions advocate lesser rigidity in the labour market as a necessary step for a country to benefit from trade and capital liberalization (e.g. World Bank, 2005). For it is argued that reducing labour costs

[1] Hysteresis is defined as the situation when temporary shocks have permanent effects on the economy.

will create incentives for foreign firms to invest in a country, thus boosting employment and generating positive externalities for the rest of the economy. This view is supported by the claims that economic globalization is reducing poverty around the world and increasing economic prosperity(Collier and Dollar, 2002).

Although the focus of labour market scholars has generally been on the impact of regulation on unemployment, some studies have also emphasized the negative consequences of rigidity on productivity, as it contributes to keep inefficient firms on the market, in addition to generating rents for employed workers at the expense of the unemployed (Saint-Paul, 2000). Hence, considerations of both efficiency and equity pave the way for labour market reforms reducing rigidity and inducing higher degrees of workers turnover across jobs.

Obviously, voices of dissent have been raised against this general view. Atkinson (1999) has argued that the rolling back of the welfare state to which the process of liberalization would lead may in fact decrease labour markets efficiency. Others have claimed that higher liberalization, in particular in product markets, may end up as having negative effects on employment (Amable and Gatti, 2004). Their arguments are bolstered by the conclusion reached by Layard and Nickell (1998) that the empirical evidence on the negative impact of labour market rigidity is limited to some institutions, mainly unemployment benefits and strong and uncoordinated unions, but is at best weak for the remaining ones. Others have also pointed to the social costs associated with market liberalization (Rodrik, 1997), and have noted that welfare institutions tend to be larger in more open countries, thus underlining their positive function (Agell, 1999). Finally, the view that economic globalisation is increasing prosperity and reducing poverty has been contested on empirical and methodological grounds (Wade, 2003), thus undermining the claim that flexible labour market are necessary for making globalisation work for the poor.

In this paper I wish to add to this debate by focussing on the impact of labour rigidity on economic efficiency, as measured by output maximization. The line of argument draws upon the classical distinction, originally put forward by Becker (1964), between specific and general skills. The former define skills that may mainly be used by a worker in relation to a specific firm (or industry), whereas the latter refer to skills that may be transferred across jobs. As a result, firm-specific skills should result in higher labour productivity at the firm level. Hence, labour market rigidity may give appropriate incentives to workers to acquire job-specific skills, through decreasing job turnover and increasing job duration. In other words, long-term relationships in the labour market make for mutual specific investments in a worker's human capital. As a result, labour market rigidity may turn out to be the most efficient institutional setting, at least in those contexts where productivity gains were favoured by intensive knowledge of a certain technology. On the other hand, the choice of general skills, which is in turn favoured by a flexible labour market, may be appropriate in contexts of fast technological change.

Therefore, the consideration of the right 'match' between skills acquisition and labour market institutions, and their impact on productivity, should add an element of analysis thus far partially neglected in the debate on labour market institutions. In fact, the conjecture that economic systems with more rigid labour markets are characterized by higher labour productivity receives some support at the empirical level (Layard and Nickell, 1998). Figure 1 plots data for a cross-section of OECD countries. These are ranked according to the OECD index of employment protection legislation (EPL) on the horizontal axis (with more rigid economies to the right-hand side of the axis), whereas the per hour productivity growth rates over the 1976-1992 period is reported on the vertical axis. The relationship between employment protection and productivity growth appears to be positive, and a quadratic interpolation of the data results in an inverse-U shaped relation. The fact that the quadratic term turns out to be weakly significant in a linear regression gives some grounds to the conjecture that such a relationship may be non-linear[2]. Clearly both results have to be interpreted with some caution, given the limited amount of observations and the presence of some outliers.

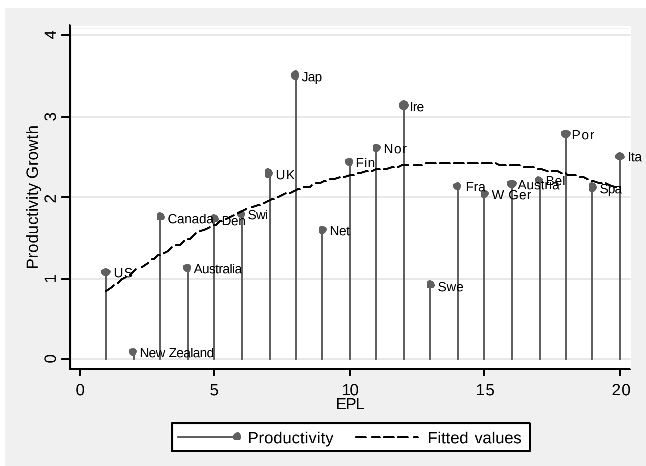

Figure 1

Sources: OECD *Jobs Study* (1994). Part II, Table 6.7, Col. 5, for Employment Protection Index (EPL). Country ranking with 20 as the most strictly regulated. Refers to 1990.
Data for productivity growth rates are taken from Nickell and Layard (1998), Table 4, col. 2. This is based on the Summers and Heston database, with hours of work from the OECD Employment Outlook, various issues.

At the theoretical level, some studies have indeed taken into account the distinction between specific and general skills. For instance, Chari and Hopenayn (1991) and Parente (1994) have developed macroeconomic models where learning-by-doing increases human capital at the firm-specific level. Jovanovic and Nyarko (1996) build on this approach to study the trade-off between expanding the knowledge of a certain technology, and transferring to more recent technologies. The key parameter is the degree of transferability of one's skills to another

[2] In particular, a linear regression on this sample of 20 countries, with productivity growth as a dependent variable, and EPL and EPL squared as independent variables, returns a positive and significant coefficient for EPL (t=2.30), and a negative and weakly significant coefficient for EPL^2 (t=-1.83).

technology, and as a result a worker may be locked into a certain technology although technologies with higher profitability are available in the economy. Some studies have applied the distinction between specific and general skills to the study of labour market institutions. Ljungqvist and Sargent (1998, 2002) make of the loss of human capital during unemployment spells one of the key parameters of their analysis of labour market institutions. They contrast a 'laissez-faire' and a 'welfare-state' economy which emerge as possible equilibria of their setting. Wasmer (2002) makes the choice of the investment in specific as opposed to general human capital explicit in her analysis. As a result, the structural parameters of the labour market favour the acquisition of one or the other type of skill, so that two different steady states emerge. In particular, the acquisition of specific (general) skills is favoured by less (more) changeable environments.

The present paper is related to Wasmer (2002) in that the choice between specific and general skills is the result of an endogenous choice by workers, which in turn depends on the conditions in the labour market. However, with respect to this and the other papers cited above, the main contribution of the present paper lies in a different characterization of technical progress. In fact, most of the literature characterizes technical progress as being embodied in different vintages of a same technology. Typically, an exogenous process makes a new vintage of a certain technology available at each instant of time, thus making possible to the agent to switch to a more recent vintage or stay put in the vintage currently used. New vintages are characterized by higher overall productivity, although, as stressed above, learning-by-doing effects may prevent an agent from attaining newly available vintages. This approach is consistent with the view that technological progress is of the general purpose type, that is, it is accessible to all the economic agents.

In the present model I instead take the opposite view that technological progress is not of the general purpose type. In spite of its indubitable relevance (see e.g. Petit and Soete, 2001) only rarely has this case been investigated in the literature, an exception being the model of Violante *et al.* (2002) in their account of wage inequalities within a model of growth. This is partly due to the fact that much attention has been recently given to the so called Information Technology revolution, which is seen by many as having radical effects on today's societies. Given its wide range of applicability across industries and jobs, this may be deemed as a typical general purpose technology. However, this should not lead us to neglect the role of sector-specific, if not firm-specific - incremental innovations in technological progress (Dosi, 1988). Hence, some investigation in this area appears to be necessary, and, as outlined in section 4, may also help generate innovative empirical research.

In the present model I assume that two technologies are available to produce the same commodity, and that an innovation occurs in one and only one technological sector. This boosts the productivity potential of that sector with respect to the other. Moreover, workers may choose between acquiring specific or general skills before entering the labour market. Specific skills tie workers to one technology of the economy, but in turn bring about, *ceteris paribus*, higher marginal productivity relative to general skill. Conversely, general skills allow workers to move towards the technological sector where the innovation has occurred, but determine smaller levels of marginal productivity. Specific skills are characterized by requiring the payment of a cost by a worker who wants to acquire this type of skill, which will prove a critical factor of the model. Finally, labour market rigidity is characterized by the transfer costs that general skilled workers have to pay to move from the non-innovating to the innovating sector of the economy.

The equilibrium conditions for this economy are then studied. This enables to spell out the trade-off between what I call *ex ante* and *ex post* efficiency. The former requires more workers to acquire specific skills, because the gap in marginal productivity between specific and general skill production implies that more output may be produced by transferring workers from the latter to the former sector of production. On the other hand, *ex post* efficiency calls for more workers acquiring general skills, as this enables more workers to move to the innovating sector after the innovation has occurred. I show that higher labour market rigidity, as modelled in the present setting, has a positive (negative) effect on *ex ante* (*ex post*) efficiency. The overall relationship between rigidity and total output is non-linear, and gives rise to an inverse-U shaped pattern, with *ex ante* efficiency being predominant at low values of rigidity, and *vice versa*.

The model allows a comparison between the incentives to invest in specific as opposed to general skill in a context characterized by non-general purpose technical change. This offers a direct counterargument to Saint-Paul's idea that removing rigidities will boost productivity by pushing out of the market firms that are not productive. In terms of this model, that argument only takes into account *ex post*, but not *ex ante*, efficiency.

The structure of the paper is as follows. Section 2 illustrates the setting of the model and puts forward the conditions for a steady state. Section 3 studies the impact of a change in labour market rigidity on the steady state of the economy, and discusses its effects on production. Finally, section 4 concludes and suggests possible extensions of the model.

2 The Model

2.1 Basic Features

The model I develop is related to Violante *et al.* (2002) in assuming that two different technologies are available to produce a certain commodity, and in that technological change is *not* of the general purpose type. That is, innovations occurring for a technology cannot be used to improve the productivity of the other. In particular, I model technological change by assuming that at each unit of time a technical innovation occurs for just one of the two technologies, with even probability for this event to happen. In other words, although there is certainty that an innovation will occur, it is *a priori* unknown in which technology the innovation will take place. Moreover, I abstract away from dynamic economies of scale, which may make innovations more or less likely in one of the two sectors depending on the past history of technical progress, and I assume that technologies are exactly equivalent prior to the innovation taking place.

Another crucial assumption I make is that the workforce entering the high-tech sector may choose between two different types of skills, which I call *specific* and *general*. A specific worker is able to work more efficiently on a given technology relative to a general skill worker, so that her productivity is *ceteris paribus* higher. However, a general skill worker is able to transfer her skills across the two technologies more easily than a specific worker. For simplicity, I assume that specific workers may only be employed in one technology, whereas general skill workers may migrate across the two technologies, up to a transfer cost. Another way to look at this assumption is to think that a specific skill worker executes a specific investment in the firm at which she is hired, which makes it economically unprofitable to switch to the alternative technology. In particular, workers have to choose in which sector to locate as they enter the high-tech sector. Being the individual probability of innovation equal to ½, agents are indifferent as to which technological sector to choose, so that they will distribute equally across the two sectors. In this version of the model, I do not model managers' choice explicitly, and I assume in particular that they may not move across sectors.

The timing of the model is described in the diagram below. Agents decide as to whether to acquire specific or general skills prior to accessing the labour market. Their type of skills remains fixed thereafter. Each agent has then to choose which technological sector to enter. Once such a choice has been made, a manager and a worker are matched and constitute a firm. Subsequently, workers observe in which technique the innovation has occurred, and general skill workers may decide to migrate towards the alternative sector upon the payment of a transfer cost. At this point, production occurs and wages are paid according to workers' marginal productivity.

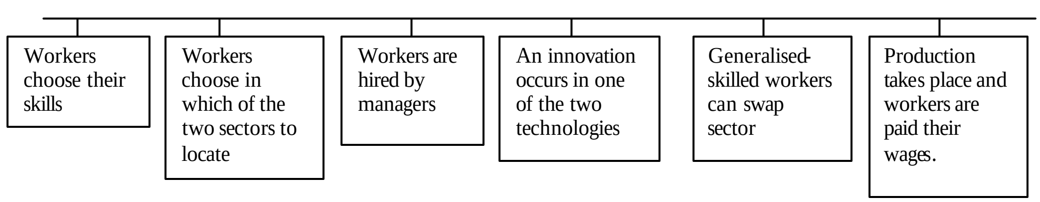

Figure 2

I now illustrate the formal specification of the model proceeding backwards. The superscripts S, G denote whether agents have acquired a specific or a general type of skill, respectively. The subscript I, N and M denote the sectors where workers are located. In particular, I stands for innovating sector, N non-innovating sector, and M characterizes those workers with general skills who migrate from the non-innovating to the innovating sector.

First, let us deal with the innovating sectors. Managers who are active in this sector maximize the following profit function:

$$p_I = Y_I^S + Y_I^G - w_I l_I^S - w_I^G \left(l_I^G + l_M^G\right) \qquad (1)$$

where

$$Y_I^S = A^S (1 + tg)\left(l_I^S\right)^a \qquad (2)$$

$$Y_I^G = A^G (1 + g)\left(l_I^G + l_M^G\right)^a \qquad (3)$$

and where the following set of restrictions apply:

$$\begin{aligned} &A^S > A^G \\ &t > 1 \\ &g > 0 \\ &a \in (0,1) \end{aligned} \qquad (4)$$

Managers can employ both specific and general skill workers, whose respective contributions to production are additively separable. In particular, note that the general skill labour input comprises both workers who were already located in this sector, or who have migrated after the innovation has taken place. Different wage rates are paid to specific and general skill workers on the basis of their marginal productivity, but the same wage rate is paid to the two categories of general skill workers. Furthermore, output has decreasing returns to scale on labour in both the specific and the general labour input[3]. Specific skill workers are characterized as being more effective in using a certain technology. This is reflected in two assumptions on the parameters. First, the overall productivity of the relative production function is *ceteris paribus* higher than the other ($A^S > A^G$). Second, specific skill workers are better able to reap the benefits of the innovation. In fact, an innovation brings about a productivity bonus equal to ($1 + t$?) when used by specific skill workers, and equal to just ($1 + g$) when used by a general skill worker. Hence, t denotes the degree to which specific skill workers are better capable than general skill workers in utilising the innovation.

Maximization of the profit function with respect to either labour input yields the following optimality conditions:

$$w_I^S = aA^S (1 + tg)\left(l_I^S\right)^{a-1} \qquad (5)$$

[3] In a more complex version of the model, where managers are mobile across sectors, too, the production function may have decreasing returns in each input of production and constant return in both inputs. See Rigolini (2004) for an example. However, this generalization does not appear to change the main conclusions of this paper.

$$w_I^G = aA^G(1+g)(l_I^G + l_I^M)^{a-1} \qquad (6)$$

Additionally, I assume that the transfer cost equals a proportion c_T of the wage general skill workers earn in the innovating sector. The net wage rate that accrues to those of them migrating to the innovating sector is then equal to:

$$w_M^G = w_I^G(1-c_T) \qquad (7)$$

Let us now consider the sector that does not innovate. Managers who are active therein will maximize the following profit function:

$$p_N = Y_N^S + Y_N^G - w_N^S l_N^S - w_N^G l_N^G \qquad (8)$$

$$Y_N^S = A^S(l_N^S)^a \qquad (9)$$

$$Y_N^G = A^G(l_N^G)^a \qquad (10)$$

This is identical to (1) through (3) above but for the absence of the productivity bonus associated with the innovation. l_N^G is the number of general skill workers who do not migrate to the innovating sector. Optimal employment of labour yields the following conditions:

$$w_N^S = aA^S(l_N^S)^{a-1} \qquad (11)$$

$$w_N^G = aA^G(l_N^G)^{a-1} \qquad (12)$$

2.2 The Equilibrium Conditions

Since in this version of the model managers are assumed not to be able to move across sectors (see footnote 3), the equilibrium conditions only concern workers' decisions. Overall we have five different categories of workers, specific and non-specific active in either the innovating or in the non-innovating sector, and non-specific skill workers migrating to the innovating sectors. I therefore need five conditions to determine labour sectoral allocation and the choice of skills. Equations (5) – (7) and (11)-(12) above will set wages accordingly.

Firstly, conditions (13) and (14) are direct consequences of the way the model has been constructed:

$$l_I^S = l_N^S \qquad (13)$$

$$l_I^G = l_N^G + l_I^M \qquad (14)$$

Each condition requires the distribution of workers across the two technological sectors to be even. The reason is that workers have to choose a sector before the innovation occurs, so that each sector should look equally profitable to both specific and non-specific skill workers. Condition (15) requires the number of workers employed be equal to the total supply of labour *L*.

$$l_I^S + l_N^S + l_I^G + l_I^M + l_N^G = L \qquad (15)$$

I do not consider the possibility of unemployment, so that (15) is always satisfied. Condition (16) requires general skill workers who are located in the non-innovating sector to be indifferent between migrating to the alternative sector and remaining in the current sector:

$$w_M^G = w_N^G \qquad (16)$$

In fact, if w_M^G was greater than w_N^G, then more general skill workers would have an incentive to move to the innovating sector. In contrast, were the opposite true, some workers who had migrated to the innovating sector would in fact be better off in the non-innovating sector.

The final condition concerns which type of skill to acquire. A specific skill worker has a probability equal to ½ of earning a wage in either the innovating or in the non-innovating sector, so that her expected wage, denoted with $\tilde{w}^S$, amounts to:

$$\tilde{w}^S = \frac{1}{2}\left(w_I^S + w_N^S\right)\left(1 - c_S\right) \qquad (17)$$

In (17) I have also made the assumption that a specific worker has to pay a portion c_S of her expected wage in order to acquire the specialisation. As we shall see in the remainder of the paper, this will turn out to be a crucial hypothesis.
For the same reason, a non-specific worker can expect a wage equal to:

$$\tilde{w}^G = \frac{1}{2}\left(w_I^G + w_N^G\right) \qquad (18)$$

Expression (18) for expected general skill wage makes use of condition (16) above in that a worker who is originally located in the non-innovating sector ends up with the same wage whether she moves to the alternative sector or not. Moreover, I assume that no additional cost is required to acquire this type of skill, unlike specific skill workers .

Finally, condition (19) requires the expected wage of specific and non-specific skill workers to be equal to one another:

$$\tilde{w}^S = \tilde{w}^G \qquad (19)$$

I define a steady state of the system as the set of wage rates and labour allocations that satisfies the system of 10 equations given by (5) – (7), (11)-(12), (13)-(16) and (19).

2.3 Efficiency

Some notion of efficiency is needed in order to evaluate different institutional settings. The notion I shall employ throughout the paper is the maximization of overall output. Obviously, a necessary condition for output maximization is that marginal productivity across the various sectors of the economy be equal to one another. For an increase in output may always be obtained by transferring labour inputs from the sector with lower marginal productivity towards the other.

Some *caveats* apply. The notion of efficiency as output maximization clearly differs from the classical notion of Pareto-efficiency. The reason for preferring output maximization is that Pareto-efficiency does not seem to be appropriate in the present context. In fact, Pareto-efficient allocations would be crucially affected by the dynamics of income distribution between capital and labour, and within the various labour categories. Since this is not the main focus of the paper, it is preferable to adopt a notion that abstracts away from distributive issues. Moreover, given the number of different categories of labour, and of capital holders, the risk is high that Pareto-efficiency would be too weak a concept to discriminate among allocations. Moreover, payoffs in the present model are computed in terms of monetary compensations. This makes it possible that output-maximizing allocations may become Pareto-improving by appropriate monetary side-transfers, in case they were not so originally. In other words, suppose that an output-maximizing allocation A were not Pareto-optimal, in that some agent is worse off in that allocation than in another allocation B with a lesser amount of output. Even so, one may think that a transfer from the better-off agents, which is always made possible by A having higher output than B, may compensate the worse-off agent for her loss in the output-maximizing allocation.

Another *caveat* refers to the exclusion of both transfer costs and skill upgrade costs from the efficiency computation. However, it suffices to assume that such costs represent the income for some agents who are part of the economy system, and whose utility is worth taking into account by the policy-maker. Consequently, the relative costs and benefits cancel out in the society's overall measure of efficiency. For instance, one may think that the costs for the acquisition of specific skill are paid to some other specific skilled worker or to the manager of the firm, for example because skills are acquired through on-the-job training. Furthermore, as I shall illustrate later, the cross-sector transfer costs are alike instruments of economic policy, and as such they are alike fiscal revenues for the government. As such, they may be thought of as being redistributed to the agents after they are collected.

As will become clear in the course of the analysis, I shall be dealing with two types of efficiency. *Ex ante* efficiency looks as output maximization *before* agents' decisions on which skill to acquire and thus before the occurrence of the innovation. *Ex post* efficiency assesses output maximization after the innovation has occurred. It will soon become clear that these two notions have contrasting implications for labour allocation across different sectors.

3 The Impact of an Increase in Labour Market Rigidity

3.1 An Overview

In analogy with Saint-Paul (2000), I model labour market rigidity as depending on the transfer costs with which agents are faced when changing their job. The underlying idea is that in more rigid labour markets agents have to sustain greater transfer costs when a worker decides to quit a job and/or a manager makes a worker redundant in comparison with more flexible labour market. In the present model, since it is workers who make decisions as to the sector in which to locate, an increase in labour market rigidity may thus be represented by an increase in c_T. Since costs are in this version of the model sustained by workers, this may be thought of as a penalty that a non-specific worker has to pay to her former manager in the non-innovating sector – or to the government - in order to abandon that firm and move to a firm in the innovating sector. Moreover, I assume that c_T is set by the economy's policy maker, so that it is possible to link explicitly the value that c_T assumes with different institutional settings. That is, economies with higher values for c_T will be thought of as having higher level of labour market rigidity[4].

I am in particular interested in studying the influence of c_T on the steady state allocation of labour and on the output produced in the economy. There are two ways in which c_T may affect total output, which are associated with the *ex ante* and the *ex post* stages, that is, prior to and after the innovation has occurred. First, an increase in c_T will have the effect of making the option of acquiring a specific skill *more* attractive to workers in the *ex ante* phase in which they have to decide which skill to acquire. The reason is that the higher c_T, the lower the expected wage for general skill workers. Consequently, more workers will be employed in the specific skill sectors of production in the economy, which will increase output given the presence of a productivity premium in that sector. This is a consequence of the rent acquired by specific skill workers for their investment in specific human capital, an aspect which will be further commented in section 3.4. Second, an increase in c_T will *ex post* curtail the possibility for general skill workers to move towards the innovating sector. As a result, fewer workers will be able to move to the sector of the economy where technology is more efficient, thus reducing output. Therefore, an increase in c_T has at the same time a *positive* effect on output in that it makes *ex ante* more convenient for workers to acquire a specific skill, but has a negative effect in that it hinders the possibility for general skill workers to migrate to the more efficient sector of the economy. These two effects are consequences of the *ex ante* and *ex post* notions of efficiency put forward in section 2.3, and the main goal of this

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[4] c_T may also be thought as incorporating some relocation costs that are not under the direct control of the policy-maker, such as costs for geographical relocations, fixed legal costs, *etc*.

section of the paper will be to clarify under which conditions either effect will prevail.

Since all of these effects are mediated by adjustments on labour allocation across sectors and skills, I start off by studying their effects on the economy by investigating the steady state configuration of labour. I commence with the results for general skills in section 3.2; section 3.3 comments on the results for specific skill labour, and section 3.4 finds general results in terms of output. In the appendix I report the analytical solution for the steady state in (23)-(26), and the proofs of the lemmas.

3.2 Effects on General Skill Labour Allocation

The first relevant result concerns the mobility of general skill workers across sectors:

Lemma 1: *As c_T increases, there will be fewer general skill workers able to transfer from the non-innovating to the innovating sector:*

$$\frac{\partial l_M^G}{\partial c_T} < 0 \quad \forall c_T < \bar{c}_T$$

The value of $\bar{c}_T$ is given in (28). It represents the greatest value that transfer costs can assume for an internal solution of the steady state. In fact, as shown in the Appendix, for values of c_T above $\bar{c}_T$, a corner solution obtains where no general skill worker wishes to transfer to the innovating sector. The reason is that transfer costs are then too high in comparison to the productivity premium to make transfer from the non-innovating to the innovating sector economically convenient. Hence, I limit the study of the model to values of c_T below $\bar{c}_T$. What Lemma 1 implies is not surprising. The higher the transfer costs, the fewer the general skill workers who are able to transfer to the innovating sector. Lemma 2 concerns general skill workers active in the innovating sector:

Lemma 2: *There exists an internal minimum in the steady state ex ante allocation of general skill labour in the innovating sector with respect to the transfer costs. In particular, l_I^G is increasing (decreasing) in c_T for values greater (smaller) than a threshold $\hat{c}_T$. Moreover, such a minimum is unique:*

$$\frac{\partial l_I^G}{\partial c_T} \gtrless 0 \Leftrightarrow l_I^G \gtrless \hat{c}_T, \hat{c}_T < \bar{c}_T$$

The expression for $\hat{c}_T$ is given in (30). The fact that the *ex ante* allocation of general skill worker decreases below the threshold $\hat{c}_T$ is not surprising. In fact, the higher the transfer costs, the lower the expected wage for general skill workers, and thus the fewer the workers who acquire this type of skill *ex ante*. The existence of a threshold beyond which the pattern of labour allocation changes is perhaps more surprising. This is due to the wage dynamics and to the shape of the production function, and will be further commented in section 3.3.

Lemma 3: *As c_T increases, the amount of general skill workers active in the innovating sector will decrease:*

$$\frac{\partial\left(l_I^G + l_M^G\right)}{\partial c_T} < 0 \quad \forall c_T < \overline{c}_T$$

Both l_I^G and l_M^G decrease for $c_T < \hat{c}_T$. For values of c_T above the threshold, instead, the fact that l_I^G starts growing is offset by the decrease in l_M^G. Overall, then, general skill labour in the innovating sector decreases as transfer costs rise. This result leads directly to:

Corollary 1: *As c_T increases, production by general skill workers active in the innovating sector will decrease:*

$$\frac{\partial Y_I^G}{\partial c_T} < 0 \quad \forall c_T < \overline{c}_T$$

This result is now to be contrasted with what occurs in the non-innovating sector for general skill workers:

Lemma 4: *As c_T increases, the amount of general skill workers active in the non-innovating sector will increase:*

$$\frac{\partial l_N^G}{\partial c_T} > 0 \quad \forall c_T < \overline{c}_T$$

The fact that more and more workers are unable to transfer to the innovating sector causes general skill labour to increase with c_T. Hence, as far as l_N^G is concerned, this effect must compensate the *ex ante* disincentive to acquire general skills due to increased transfer costs. Consequently:

Corollary 2: *As c_T increases, production by general skill workers active in the non-innovating sector will increase:*

$$\frac{\partial Y_N^G}{\partial c_T} > 0 \quad \forall c_T < \overline{c}_T$$

The impact of c_T on overall production by general skill workers is therefore ambiguous. Lemma 5 states that the impact is in fact negative throughout the relevant interval.

Lemma 5: *As c_T increases, overall production by general skill workers will decrease:*

$$\frac{\partial Y^G}{\partial c_T} < 0 \quad \forall c_T < \bar{c}_T$$

where:

$$Y^G = Y_I^G + Y_N^G \qquad (20)$$

This result is quite intuitive; higher transfer costs hinder general skill workers mobility from the less productive to the more productive sector of the economy. As a result, production from general skill workers decreases. This result reflects what I have defined above as *ex post efficiency*. The increase in transfer costs hampers the possibility of transferring labour inputs of the general type towards the more efficient sector of the economy. In this sense, higher labour market rigidity is detrimental to the economy in that it prevents adjustment to sectors with higher productivity. This idea may be restated more formally in Lemma 6:

Lemma 6: *The only ex post efficient allocation of labour inputs is for $c_T=0$. The higher c_T, the more ex post--inefficient the allocation is.*

This result descends directly from the definition of efficiency that I am using. For positive values of c_T, a gap is created between the two marginal productivity, as defined in expression (32) and (33) in the Appendix. Such gap is reduced to nought when $c_T=0$. Hence, one may say that *ex post* efficiency is maximized by setting $c_T=0$.

3.3 Effects on Specific Skill Labour Allocation

The implications described in Lemma 5 and 6 above are to be contrasted with the following results for specific skill workers:

Lemma 7: *There exists an internal maximum in the steady state allocation of labour in the specific skill sector with respect to transfer costs. In particular, specific skill labour is increasing (decreasing) in c_T for values smaller (greater) than the same threshold $\hat{c}_T$ as in Lemma 2 above. Moreover, such a maximum is unique. That is,*

$$\frac{\partial l_j^S}{\partial c_T} \overset{>}{\underset{<}{-}} 0 \Leftrightarrow l_j^S \overset{<}{\underset{>}{-}} \hat{c}_T, \hat{c}_T < \bar{c}_T ; j = \{I, N\}$$

This result is symmetrical to what found in Lemma 2. For values below the threshold $\hat{c}_T$, as c_T increases, more workers will prefer to choose the specific type of skill, as the expectation of higher mobility costs in the alternative type of skill will hinder mobility and thus decrease the expected wage were they to acquire general skills. However, for values of c_T above the threshold, this pattern is reversed. This is linked to the wage dynamics for general skill workers. Lemma 1 states that, as c_T rises, fewer workers will be able to move from the non-innovating towards the innovating sector of the economy. This has two opposite effects on wages earned by

general skill workers. On the one hand, it will increase the wages of workers active in the innovating sector, because, as Lemma 2 shows, the overall number of workers who are active in that sector will drop. On the other hand, for symmetrical reasons, it will also decrease the wages of workers active in the non-innovating sector. However, these two effects are not equal in size, and expected general skill wages present a U-shaped pattern with respect to c_T. In particular, for values of c_T below (above) $\hat{c}_T$, the latter (former) between these two effects dominates, so that expected wages for general skill workers will decrease (increase). As a result, the number of workers acquiring specific skills will decrease when c_T exceeds the threshold $\hat{c}_T$, because the rise in expected wages in the general skill sector makes it *ex ante* more attractive to acquire the alternative type of skill. Alternatively, given the equilibrium condition (19) requiring the equality of expected wages for specific and general skill workers, fewer specific skill workers are needed in order to rise specific skill wages and compensate the rise of general skill wage.
More importantly, Lemma 7 leads to the following

Corollary 3: *There exists an internal maximum in the steady state production from specific skill workers with respect to transfer costs. In particular, production from specific skill labour is increasing (decreasing) in c_T for values smaller (greater) than the threshold $\hat{c}_T$. Moreover, such a maximum is unique. That is,*

$$\frac{\partial Y^S}{\partial c_T} \overset{>}{\underset{<}{-}} 0 \Leftrightarrow c_T \overset{<}{\underset{>}{-}} \hat{c}_T, \hat{c}_T < \overline{c}_T$$

where:

$$Y^S = Y_I^S + Y_N^S \tag{21}$$

Corollary 3 underpins the *ex ante* efficiency argument set out above. Corollary 3 states that higher transfer costs have, for values of c_T below the threshold $\hat{c}_T$, a positive impact on production from specific skill workers. The reason for this is apparent: higher transfer costs imply a decline in the expected general skill wage, so that more workers will find it optimal to acquire specific skills. Lemma 7 restates this argument in terms of efficiency:

Lemma 8: *The only ex ante-efficient allocation of labour inputs is for $c_T = \hat{c}_T$. The closer the economy to this value, the more ex ante--efficient the allocation is.*

3.4 Overall Effects

We have seen how *ex ante* efficiency prescribes to allocating more resources to specific skills (Lemma 8), whereas *ex post* efficiency calls for increasing the share of general skill workers (Lemma 6), which makes it possible a better use of technical innovations. It is then important to ask which between these two effects dominates. The following Lemma states a general result in this respect:

Lemma 9: *Suppose c_S is strictly positive. Then, there exists a maximum in the region $(0, \hat{c}_T]$ where total output as a function of c_T is maximized:*

$$\exists\ c_T^* \in (0, \hat{c}_T) \text{ such that } c_T^* = \underset{c_T}{\operatorname{argmax}} \{Y^S(c_T) + Y^G(c_T)\}$$

Lemma 9 claims that an economic system will increase its overall efficiency in the presence of some *positive* levels of labour market rigidity. Clearly, such a level implies that, in this decentralized economy, *ex ante* and *ex post* efficiency are traded off in an optimal way.

The reason for this result lies in the role played by the training costs c_S. As shown in the proof of Lemma 8 in the Appendix, the productivity gap between marginal product from specific and general skill production depends on c_S. This is in turn caused by the equilibrium condition (19) between expected wages in the two sectors, which implies that, *ex post*, the *average* wage for specific skill workers must be greater than the average wage for general skill workers [5]. This compensates specific skill workers for the payment of their training costs. Since wages are set according to *ex post* marginal productivity, this means that on average marginal productivity in the specific skill sector is higher than in the general skill sector. Therefore, a transfer of workers from the latter to the former sector brings about, on average, an increased level of output. In other words, the presence of such a 'rent' for specific skill workers creates a distortion in the allocation of factors of production, which is minimized by increasing the number of specific skill workers.

What has just been illustrated is the mechanism underlying the *ex ante* efficiency argument. In fact, the presence of the mobility costs c_T adds another source of distortion, which consists of the constraints for general skill workers to move towards the innovating sector. We already noted in Lemma 6 how *ex post* efficiency calls for a value for c_T as low as possible. However, mobility costs have at the same time an impact on *ex ante* efficiency, in that the higher c_T, the higher the incentives for workers to acquire specific skills. This reduces the distortions associated with the specific skill 'rent', and thus maximizes *ex ante* efficiency. Lemma 9 states a general result on the interaction between these two effects, and shows that some positive levels of labour market rigidity lead to higher efficiency in the economy.

4 Conclusions and Possible Extensions of the Model

The model developed in this paper has sought to show how, taking into account non-general purpose technical change and multiplicity of skills, labour market rigidity may have positive effects on an economy's output. The mechanism which leads to this result is that higher labour market rigidity raises the incentives to acquire productivity-enhancing skills. This is crucially due to the presence of a 'rent' accruing to specific skill workers for the cost they have to sustain in the *ex ante*

[5] Rearranging condition (19) leads to $w^S - w^G = c_S w^S > 0$, where $w^S = (w_I^S + w_N^S)/2$ and $w^G = (w_I^G + w_N^G)/2$.

phase of their skill acquisition. This creates a productivity gap between production from specific and general skill workers, which makes *ex ante* efficient to increase the share of the former. On the other hand, labour market flexibility is optimal *ex post*, because this allows more general skill workers to transfer to the innovating sector of the economy. The interactio n between these two effects leads to an inverse-U relation between labour market rigidity and output, which implies that some degrees of labour market rigidity are indeed beneficial for the economy. Therefore, the argument that some economists have put forward as to the efficiency gains of rigid labour markets are confirmed in this model. However, the explanation offered is new, in that this is the consequence of the generally neglected idea of non-general purpose technological change.

Obviously, the model lends itself to several generalisations. Firstly, the focus on a static problem has made it possible to study in detail the trade offs between labour market institutions, skills acquisition, and technical change. However, the study of dynamic effects, that is, the repetition of production on an arbitrarily long horizon, would introduce into the analysis the consideration of the 'turbulence' in the environment. This would permit us to take into account the role of skills as an insurance against variability in the environment. Since it is generally thought that general skills are better protection against fast technical change than specific skills (Wasmer, 2002), then the trade off between *ex ante* and *ex post* efficiency may result in a different outcome than what obtained in the present model. The study of this aspect would also have an obvious bearing on the role of globalisation in reshaping labour market institutions. As mentioned in the introduction, in fact, economic globalisation is seen as one of the major causes in the increased variability of the economic environment over the last decades.

Second, the model is amenable to what I believe would be innovative empirical analysis. The model rests on the distinction between specific and general skills, and introduces a horizontal differentiation in human capital that adds to the vertical characterization that is normally taken into account. That is, human capital and skills are usually associated with a higher level of educational attainment. In the present setting, instead, the choice between specific and general skills is central to the analysis. In empirical terms, this may be associated with different kinds of educational degrees, rather than with different degrees of educational attainment, so that the relation between skill differentiation and labour market rigidity may be investigated. Moreover, an index of globalisation may be employed in the analysis to test whether increased variability in the economy environment, as measured by globalisation, may influence the institutional setting present in the economy.

5 Appendix

The solution of the system of equations leads to the following steady state expressions for labour allocations across sectors and skills:

$$l_I^S = l_N^S = \frac{D_2}{2(1+D_1+D_2)}L \qquad (22)$$

$$l_I^G = \frac{1+D_1}{2(1+D_1+D_2)}L \qquad (23)$$

$$l_M^G = \frac{D_1}{2(1+D_1+D_2)}L \qquad (24)$$

$$l_N^G = \frac{1}{2(1+D_1+D_2)}L \qquad (25)$$

where:

$$D_1 = \frac{1}{2}\left\{[(1+g)(1-c_T)]^{\frac{1}{1-a}} - 1\right\} \qquad (26)$$

$$D_2 = \left[\frac{A^S(1-c_T)(1-c_S)(2+tg)}{A^G(2-c_T)}\right]^{\frac{1}{1-a}} \qquad (27)$$

Intuitively, D_1 depends positively on the incentives to migrate towards the innovating sector for general skill workers in the *ex post* stage. D_2, instead, weighs the incentives to acquire specific skills *vis-à-vis* general ones in the *ex ante* phase. As a result, a higher value of D_1 relative to D_2 favours allocation of labour to the general skills. A condition must be imposed on D_1 to ensure that l_M^G does not enter the negative region. That is, D_1 has to be non-negative, which leads to:

$$c_T \leq \bar{c}_T \equiv g/1+g \qquad (28)$$

I assume that such a condition is always satisfied, so that the system is studied over the range $c_T \in [0, \bar{c}_T]$. Intuitively, the above condition requires the productivity gain in the innovating sector be sufficiently high in comparison to the transfer costs. D_2 is non-negative across the relevant range of parameters. I also define

$$D_3 = [(1+g)(1-c_T)]^{\frac{1}{1-a}} \qquad (29)$$

so that $D_1 = \frac{1}{2}\{D_3 - 1\}$. As a result of the above restriction, the parameters have to satisfy the following inequalities for $c_T \in [0, \bar{c}_T]$:

$$D_1 \geq 0$$
$$D_2 \geq 0$$
$$D_3 \geq 1$$
$$c_T = \bar{c}_T \Rightarrow D_1 = 0 \wedge D_3 = 1$$

Proof of Lemma 1

Differentiating l_M^G with respect to c_T leads to:

$$\frac{\partial l_M^G}{\partial c_T}=\frac{L}{4(1+D_1+D_2)^2}\left\{\frac{-D_3(2-c_T)-D_2[1+D_3(1-c_T)]}{(1-c_T)(2-c_T)(1-a)}\right\}$$

Given the above restrictions on the parameters, this expression is always negative over the interval $[0,\bar{c}_T]$. QED

Proof of Lemma 2

Differentiating l_I^G with respect to c_T leads to:

$$\frac{\partial l_I^G}{\partial c_T}=-\frac{L}{4(1+D_1+D_2)^2}\left\{\frac{D_2[D_3(1-c_T)-1]}{(1-c_T)(2-c_T)(1-a)}\right\}$$

Given the restrictions imposed on the parameters, it is immediate to verify that this expression is negative for $c_T=0$ and positive for $c_T=\bar{c}_T$. Moreover, there exists only a value in which the differential is equal to 0, that is:

$$\hat{c}_T=1-\left(\frac{1}{1+g}\right)^{\frac{1}{2-a}} \qquad (30)$$

Such a value lies in the interior of the interval $[0,\bar{c}_T]$.

Proof of Lemma 3

Differentiating $l_I^G+l_M^G$ with respect to c_T leads to:

$$\frac{\partial\left(l_I^G+l_M^G\right)}{\partial c_T}=\frac{L}{4(1+D_1+D_2)^2}\left\{\frac{-D_3[(1+D_2)(1-c_T)+1]}{(1-c_T)(2-c_T)(1-a)}\right\}$$

Given the above restrictions on the parameters, this expression is always negative over the interval $[0,\bar{c}_T]$. QED

Proof of Lemma 4

Differentiating l_N^G with respect to c_T leads to:

$$\frac{\partial l_N^G}{\partial c_T} = \frac{L}{4(1+D_1+D_2)^2}\left\{\frac{D_3(2-c_T)+2D_2}{(1-c_T)(2-c_T)(1-a)}\right\}$$

Given the above restrictions on the parameters, this expression is always positive over the interval $[0,\bar{c}_T]$. QED

Proof of Lemma 5

By applying the chain rule, one obtains:

$$\frac{\partial Y_I^G}{\partial c_T} = \frac{\partial Y_I^G}{\partial (l_I^G + l_M^G)} \times \frac{\partial (l_I^G + l_M^G)}{\partial c_T}$$

After recalling the expressions for production, steady state labour allocation and the results from Lemma 3, and after simplifying, one obtains:

$$\frac{\partial Y_I^G}{\partial c_T} = \frac{aA^G(1+g)L^a}{[2(1+D_1+D_2)]^{1+a}}\left(\frac{1}{(1-c_T)(2-c_T)(1-a)}\right)\left\{-(D_3)^a[(2-c_T)+2D_2(1-c_T)]\right\}$$

This expression is negative over the interval $[0,\bar{c}_T]$.

Similarly, one has:

$$\frac{\partial Y_N^G}{\partial c_T} = \frac{\partial Y_N^G}{\partial l_N^G} \times \frac{\partial l_N^G}{\partial c_T}$$

After plugging in the relevant expressions from Lemma 4, and after some simplifications, the following expression obtains:

$$\frac{\partial Y_N^G}{\partial c_T} = \frac{aA^G L^a}{[2(1+D_1+D_2)]^{1+a}}\left(\frac{1}{(1-c_T)(2-c_T)(1-a)}\right)\left\{D_3(2-c_T)+2D_2\right\}$$

This is a positive expression over the relevant interval.

After summing up the two derivatives, we obtain:

$$\operatorname{sgn}\left\{\frac{\partial Y_I^G}{\partial c_T} + \frac{\partial Y_N^G}{\partial c_T}\right\} = \operatorname{sgn}\left\{D_3(2-c_T)+2D_2-(D_3)^a(1+g)[(2-c_T)+2D_2(1-c_T)]\right\}$$

After some tedious algebra, the expression in brackets can be simplified so as to yield:

$$\operatorname{sgn}\left\{\frac{\partial Y_I^G}{\partial c_T} + \frac{\partial Y_N^G}{\partial c_T}\right\} = \operatorname{sgn}\left\{-D_3\frac{c_T(2-c_T)}{1-c_T} - 2D_2(D_3-1)\right\} < 0 \text{ QED.}$$

Proof of Lemma 6

From the wage-setting rules (6), (7), (12), and from the equilibrium condition (16), one can derive the following inequality:

$$MP_I^G - MP_N^G = w_I^G c_T > 0 \tag{31}$$

where

$$MP_I^G = \frac{\partial Y_I^G}{\partial\left(l_I^G + l_M^G\right)} \tag{32}$$

$$MP_N^G = \frac{\partial Y_N^G}{\partial l_N^G} \tag{33}$$

Since *ex post* efficiency is associated with marginal productivity being equal in the innovating and non-innovating generalised skill production, it is apparent from (31) that the only allocation where this occurs is for $c_T = 0$.

Proof of Lemma 7

Differentiating l_I^S with respect to c_T leads to:

$$\frac{\partial l_I^S}{\partial c_T} = \frac{L}{4(1+D_1+D_2)^2}\left\{\frac{D_2\left[D_3(1-c_T)-1\right]}{(1-c_T)(2-c_T)(1-a)}\right\} = -\frac{\partial l_I^G}{\partial c_T}$$ QED.

Proof of Lemma 8:

From the equilibrium condition (19), and considering the wage-setting rules (5), (6), (7), (11), (12), one derives the following inequality:

$$MP^S - MP^G = c_S\left(w_I^S + w_N^S\right) > 0 \tag{34}$$

where

$$MP^S = \frac{\partial Y^S}{\partial l^S} \tag{35}$$

$$MP^G = \frac{\partial Y^G}{\partial l^G} \tag{36}$$

$$l^S = l_I^S + l_N^S \tag{37}$$

$$l^G = l_I^G + l_M^G + l_N^G \tag{38}$$

Given the negative relation between wages and labour, the right-hand side of (34) is minimized when l^S reaches its maximum, that is, according to Lemma 7, when $c_T = \hat{c}_T$. Hence, ex ante efficiency is maximized for $c_T = \hat{c}_T$, and efficiency gains may be obtained by moving closer to this value.

Proof of Lemma 9

Suppose c_S is strictly positive. By applying the chain rule, we have:

$$\frac{\partial Y^S}{\partial c_T} = \frac{aA^S(2+tg)L^a}{[2(1+D_1+D_2)]^{1+a}}\left(\frac{1}{(1-c_T)(2-c_T)(1-a)}\right)(D_2)^a\{D_3(1-c_T)-1\}$$

where $Y^S = Y_I^S + Y_N^S$. Hence, one has to compare the size of this derivative with that determined above for Y^G. After some algebra, this expression reads as follows:

$$\text{sgn}\left\{\frac{\partial Y^S}{\partial c_T}+\frac{\partial Y^G}{\partial c_T}\right\} = \text{sgn}\left\{A^S(2+tg)(D_2)^a[D_3(1-c_T)-1]-A^G\left[D_3\frac{c_T(2-c_T)}{1-c_T}-2D_2(D_3-1)\right]\right\}$$

After some simplifications, we conclude that the expression in brackets is positive for $c_T = 0$:

$$\text{sgn}\left\{\frac{\partial Y^S}{\partial c_T}+\frac{\partial Y^G}{\partial c_T}\right\}\Bigg|_{c_T=0} = \text{sgn}\left\{\left[(1+g)^{\frac{1}{1-a}}-1\right]\left[\frac{A^S(2+tg)(1-c_S)^a}{(2A^G)^a}\right]^{\frac{1}{1-a}}c_S\right\} > 0$$

Moreover, on the grounds of Lemma 5 and Corollary 3, we may observe that derivatives are negative for values of c_T above $\hat{c}_T$:

$$\text{sgn}\left\{\frac{\partial Y^S}{\partial c_T}+\frac{\partial Y^G}{\partial c_T}\right\}\Bigg|_{c_T\geq\hat{c}_T} < 0$$

Hence, given the continuity of Y^S for $c_T \in [0,\bar{c}_T]$, we can conclude that there exists a value of c_T internal to the interval $[0,\bar{c}_T]$ where the derivative of Y with respect to c_T equals 0. QED

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