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Uncertainty, Gains from Specialization and the Welfare State

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Temi di discussione n. 36

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Abstract

This paper presents a specific-factor model showing that, under technological uncertainty and risk averse agents, increasing trade integration is not always welfare increasing. The reason is that changes in the country's specialization level induced by trade integration produce both benefits and cost. Increasing specialization increases wages (efficiency gains), but, modifying the tax scheme of the Welfare State, it also increases income variance. The model identifies a trade-off, absent in the standard deterministic model, between gains from specialization and the higher cost of the Welfare State. It is shown that, depending on the parameter's configuration, it exists a specialization level beyond which aggregate expected income under free trade becomes lower than that achieved under autarky.

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1 Introduction

The first mantra of trade theory is that free trade is always superior to autarky. This result immediately follows from the application of the cornerstone of classical trade theory: the principle of comparative advantage. The story is well known: opening up to free trade induces a efficiency-enhancing reallocation of production factors that, increasing productivity and reducing prices, increases aggregate real income. The trade-induced specialization process is *good* because it allows the exploitation of the country's comparative advantages. It can also be easily shown that the gains from trade are higher the more different is the free trade specialization equilibrium from the autarky one. Furthermore, any type of government intervention (i.e. the existence of a Welfare State) that modifies the free trade equilibrium would just reduce the countries' ability to gain from trade. Summarizing: under standard assumptions, free trade is optimal, the more the country specializes the better it is and government intervention is welfare reducing.

Things are very different under uncertainty. As it is well known, under uncertainty most of the standard trade theorems are not valid and, if agents are risk averse, it is also possible that autarky becomes better than free trade (Newbery and Stiglitz, 1984). Furthermore, differently from the deterministic case, there are numerous instances in which government intervention is welfare increasing precisely because it forces the country out of the free trade equilibrium (Eaton and Grossman, 1985; Brainard, 1991). Several authors have also emphasized that, since higher trade integration may increase the level of uncertainty each country faces, as globalization proceeds there is probably the need for more and not less Welfare State (Andersen (2002), Bowles and Pagano, 2006). Furthermore, Rodrik (1997) argues that in order to evaluate the optimality and the sustainability of free trade when there is uncertainty it is crucial to explicitly consider its impact on the Welfare State. His model shows that if globalization increases the cost of maintaining the Welfare State (only) for the immobile factor (i.e. labour), it is very well possible that workers' support to keep the domestic market open would progressively decrease to the point that a return to protectionism becomes a real possibility.

The present paper identifies another channel through which a similar outcome can be obtained. The basic intuition is that, under uncertainty, increasing trade integration entails both benefits and costs. In my model, the trade-induced increase in the specialization level is beneficial because it increases allocational efficiency and thus wages. But it is also costly because, modifying the taxation mechanism that finances the Welfare State, it increases the variability of risk averse agents' income and thus reduces their utility. This trade-off is formalized using a two-sector specific factor model modified to consider: 1) uncertainty, in the form of stochastic production technologies (productivity shocks); 2) temporary specificity also of the mobile factor (labour). At the beginning of each period, a stochastic parameter determines which sector is *lucky*, i.e. the comparative advantaged sector, and the *unlucky*, i.e. the comparatively disadvantaged one. While capital is sector specific, labour is mobile across sectors. But workers' mobility is not perfect: workers cannot relocate immediately after uncertainty resolves. This gives room to the positive role of insurance. Insurance is provided by (an extremely stylized) Welfare State. In particular, the benevolent government has the objective to equalize incomes across sectors in each period. To this end it uses a system of state-contingent transfers that redistributes from the *lucky* to the *unlucky*. In the second period, when uncertainty has resolved, workers in the *lucky* sector are taxed to finance a (fixed) transfer τ that goes to all the workers in the *unlucky* sector. The most important feature of this insurance mechanism is that preferences and workers' specialization decision determine the sectoral tax level necessary to finance the system. I consider two distinct ways of choosing the level of the transfer τ. First I consider τ as a parameter, i.e. as the result of a (non-modeled) bargaining process between the workers and the government. Then I explore the effects of τ when its level is chosen by a benevolent government that maximizes the welfare gains produced by the insurance mechanism. The main result of the model is that, if the induced reallocation of workers is *too* large, it is possible that aggregate (expected) income under free trade is lower than the autarky one.

The model identifies a *trade-off*, new to the literature, between gains from specialization (due to higher trade integration) and the gains from insurance (due to the presence of the Welfare State) both depending on the level of specialization. It thus provides an argument against any naive application of the comparative advantage doctrine. To the best of my knowledge, this is the first paper that, modeling the impact of free-trade-induced specialization on the working of the Welfare State, shows that the gains from trade are not necessarily increasing in the level of trade integration.

The paper proceeds as follows. In the next section, I present a two-sector specific factor trade model with uncertainty in which the government uses a tax-based insurance mechanism, i.e. the Welfare State, to stabilizes income of risk averse agents. In section 3, I characterize both the autarky and the free trade equilibrium, I measure the welfare effects of moving from autarky to free trade and of introducing the Welfare State under both scenarios. Finally I derive the conditions under which autarky is welfare superior with respect to free trade. Section 4 concludes.

2 The model

In this section I present a specific-factor model with technological uncertainty and I introduce a very simple tax-based insurance mechanisms, i.e. the Welfare State. As it is usually done in models of trade under uncertainty (see for instance Newbery and Stiglitz (1984)), I make the following two assumptions. First, the *market* fails to provide insurance of specific investment. Since I will consider the case of human capital investment, this assumption is less heroic than it may appear. In this case, the private insurer, unable to distinguish clearly between exogenous events and the endogenous behaviour of the worker, would provide an incentive for the insured worker to work less hard or to choose the riskiest job. In such a situation the well-know problems of moral hazard and adverse selection are particularly strong and the market is unlikely to provide insurance for wage variance[1]. Second, workers cannot fully diversify risk through international capital markets. In fact, while it is true that there is an increasing trend in this direction, this possibility still pertain primarily to institutional investors, i.e. pension funds[2].

2.1 Production and uncertainty

Consider a small country populated by N identical risk averse maximizing workers. There are three goods. Goods x and y are manufactured for export, while good z is imported for consumption. The latter is the numeraire good[3]. Both export sectors are subject to uncertainty in the form of a stochastic technology parameter. The two sectors are characterised by the following production technologies:

$$X = \theta_x K^\alpha L_x^{1-\alpha}$$

and

$$Y = \theta_y T^\alpha L_y^{1-\alpha}$$

where $i = x, y$, L_i is the labour input in sector i (with $L_x + L_y = \bar{L} = 1$), θ_i is a stochastic technology parameter, K and T are the specific capital to sector x and y, respectively and are assumed to be owned by foreign individuals.

[1] Andersen (2002) argues that international integration is not reducing capital markets problems related to human capital insurance.

[2] According to van Wincoop (1991) the assumption that there is no international trade in risky assets is a more realistic assumption than the opposite.

[3] This assumption limits the effect of uncertainty on consumption to indirect effect through income (Brainard, 1991).

To simplify the analysis, ssume that there are only two states of the world, which appear with given, constant probabilities. The θ_i parameter is thus distributed according to the following binomial distributions:

$$\theta_x = \begin{cases} 0 & \text{if } j = 1 \\ 1 & \text{if } j = 2 \end{cases} \qquad\qquad \theta_y = \begin{cases} 1 & \text{if } j = 1 \\ 0 & \text{if } j = 2 \end{cases}$$

where j is the state of the world, with

$$P[j = 1] = \pi_1 \qquad \text{and} \qquad P[j = 2] = \pi_2$$

Sector $i = \{x, y\}$ is said to be *lucky* if $\theta_i = 1$, i.e. if the sectoral output level is positive. This formalization could describe two situations: 1) cases of (extreme) technological uncertainty, e.g. the case of agricultural production; 2) instances in which comparative advantages have a stochastic component that dominates the institutional and economic determinants of sectoral relative productivities.

2.2 Labour income and the Welfare State

Workers are assumed to be internationally immobile, i.e. because of cultural and/or linguistic barriers. Each is endowed with one unit of labour that she inelastically supplies in a competitive labor market. Aggregate labour supply (and total number of workers) in sector i is:

$$L_i = \sum_{h \in i} s_{ih} \qquad i = x, y \qquad h = 1, 2, ..n$$

where s_h is the individual labour supply.

The good markets are perfectly competitive. The *pre-tax* wage is the value of the marginal product of labour in the two sectors and it is given by

$$w_x = p_x \theta_x (1 - \alpha) \left(\frac{K}{L_x} \right)^{\alpha} \tag{1}$$

$$w_y = p_y \theta_y (1 - \alpha) \left(\frac{T}{L_y} \right)^{\alpha} \tag{2}$$

where p_i, is the market price of good $i = x, y$.

At the beginning of the period, before the state of the world is known, each worke decides in which domestic sector to invest her unit of human capital, i.e. where to be employed. The equilibrium is reached when expected utility is equalized across sectors. Once the investment decision has been made, workers are assumed to become specific to the sector. Then uncertainty resolves and the lucky (and the unlucky) sector is determined. The specificity assumption implies that, after uncertainty resolves, workers cannot immediately move from one sector to the other. As I will show below, it is the existence of this 'friction' that makes the provision of an insurance scheme welfare increasing.

The Welfare State: taxation as an insurance device The objective of the benevolent government is to equalize incomes across sectors in each period. To this end it uses sectoral taxes to provide an insurance scheme, i.e. the Welfare State. The working of the Welfare State is extremely simple: in the second period, when uncertainty resolves, workers in the *lucky* sector are taxed and workers in the *unlucky* sector receive a transfer τ (i.e. a temporary unemployment benefit)[4].

In the following, without any loss of generality, I describe the working of the model in the case in which y is 'unlucky'. In this case, the government budget constraint reads:

$$\tau L_y = t_x L_x w_x$$

where τ is the individual transfer to workers in sector y (i.e. the 'unlucky' sector), t_x is the wage tax imposed on workers in sector x (i.e. the 'lucky' sector), L_y and L_x are the number of workers employed in sector y and x, respectively. The tax rate in sector x is thus given by:

$$t_x = \frac{\tau L_y}{w_x L_x} \tag{3}$$

The important thing to note is that the sectoral tax rate necessary to finance the Welfare State, i.e. the insurance system, depends on workers' preferences and specialization decisions.

I will consider two distinct ways of choosing the level of τ. First, τ is a parameter: in this case the level of the transfer can be thought as the result of a (non-modeled) bargaining process between the workers and the government. Second, the level of τ is chosen by a benevolent government that maximizes the welfare increasing effect of the Welfare State for each level of specialization. I begin the analysis of the model considering τ as a parameter, postponing the case of the 'optimal' τ to section 3.4.

[4] In principle this insurance could be possible privately provided. However:

> "It is difficult to imagine endowing private agencies with the extensive monitoring and enforcement rights enjoyed by tax authorities. In the absence of such rights, moral hazard and adverse selection problems renders a broad based private solution impossible." [Sinn (1995), p.495]

Labour Income Labour income for workers in sector y is:

$$I_{yj} = \begin{cases} \omega_y & \text{if } j = 1 \\ \tau & \text{if } j = 2 \end{cases}$$

where $\omega_y = (1 - t_y)w_y$ is the net of taxes sectoral wage. Using (2):

$$I_{yj} = \begin{cases} (1 - t_y)p_y(1 - \alpha)K^{\alpha}L_y^{-\alpha} & \text{if } j = 1 \\ \tau & \text{if } j = 2 \end{cases}$$

Normalizing $\bar{L} = 1$, income in sector x is given by

$$I_{xj} = \begin{cases} \tau & \text{if } j = 1 \\ (1 - t_x)p_x(1 - \alpha)T^{\alpha}(1 - L_y)^{-\alpha} & \text{if } j = 2 \end{cases}$$

Expected utility of workers in sector i is given by

$$E(U_i^z) = \pi_1 U_{i1}^z + \pi_2 U_{i2}^z$$

where $E(\cdot)$ is the expectation operator and

$$U_{ij}^z = 1 - e^{-rI_{ij}^z} \tag{4}$$

is workers' utility in sector i when the state of the world is j and $z = \{a, ft\}$ is the superscript to indicate that the variable refers to the autarky or the free trade situation, respectively. The parameter $r \geq 0$ measures the degree of risk aversion. Equation (4) is a standard risk averse utility function featuring constant absolute risk aversion (r) and increasing relative risk aversion (rI).

Finally, note that the tax-based insurance mechanism, i.e. the Welfare State, has two effects:

- it reduces expected income (*income effect*)[5]
- it reduces income variability (*government risk sharing effect*)

3 Results

In this section I characterize and compare the autarky and the free trade equilibrium. Then I discuss how the presence of the Welfare State affects the optimality of free trade.

[5]In this model I do not explicitly consider any distortionary effect of taxation, i.e. the reduction of labour supply. These features can be easily added to the basic model without affecting its qualitative results.

Since the focus of the model is not on consumption decision, workers are assumed to spend an equal share of income for each good. For the sake of simplicity, I assume that $K = T$ and that $\pi_1 = \pi_2$, i.e. the two states of the world are equi-probable and thus sectoral outputs are perfectly negatively correlated.

3.1 Autarky

In the following, the superscript a identifies the variables in the autarky situation. As a consequence of the symmetry assumptions made, the labour-output ratio in both sectors is equal and the domestic relative price is $p = p_y/p_x = 1$. It also follows that at the autarky equilibrium workers are equally distributed among the two sectors. Formally:

$$E(U_x) = E(U_y)$$

when $L_x = L_y = 0.5\bar{L} = 0.5$.

The effect of taxation under autarky As a first step, I consider the effect produced by the introduction of the Welfare State in the economy under autarky. In order to evaluate the benefits of the tax-based insurance mechanism, I compare the aggregate welfare (computed as the sum of individual expected utilities) in the two situations. Define the difference between aggregate welfare under autarky with and without the Welfare State as:

$$\Delta = W^a_{tax} - W^a \tag{5}$$

where

$$W^a_{tax} = L^a_y E(U^a_{y,tax}) + (1 - L^a_y) E(U^a_{x,tax})$$

is the expected welfare under autarky when there is the Welfare State and

$$W^a = L^a_y E(U^a_y) + (1 - L^a_y) E(U^a_x)$$

is the aggregate expected welfare under autarky when there is no Welfare State.

Proposition 1 *Under autarky, the Welfare State is welfare improving and its positive effect increases with the degree of workers' risk aversion.*

Proof. See Appendix ■

Proposition 1 states that when there is uncertainty the tax-based insurance mechanism is worth pursuing. In addition, it demonstrates that the higher the risk aversion the more effective is the Welfare State. The result that the insurance mechanism is welfare

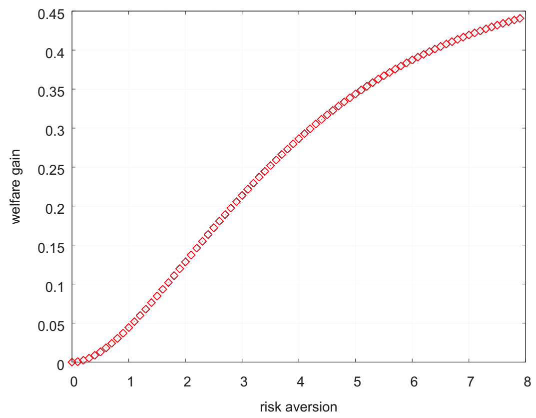

Figure 1: Welfare gain of insurance under autarky

improving when the environment is uncertain is clearly shown by Figure 1 which plots[6] the difference (for any given level of risk aversion) between the autarky welfare level with Welfare State and without it.

3.2 Free Trade

Under the small country assumption, when the country enters free trade its domestic relative price converges to the world one. Assume, for instance, that $p = p_y/p_x = 1$ (the domestic relative price under autarky) is lower than under free trade, i.e. $p^{ft} > p = 1$. This implies that, given the autarky allocation of workers, at the free trade price we have that:

$$E(U_y) > E(U_x)$$

Free trade modifies the relative profitability of the two sectors and the expected utility in sector y becomes higher than the one in sector x. As a consequence, workers reallocate toward sector y, i.e. the sector in which the country has the comparative advantage, and the free trade equilibrium is reached when expected utilities are equalized for the new value of p_y. Noting that in a two-sector model the level of specialization is given by the ratio of the number of workers employed in each sector and that our benchmark situation is the perfectly symmetrical autarky equilibrium, it follows that the country level of specialization increases with the free trade price.

[6] All the following Figures are drawn using the following parameters' values: $T = K = 1$, $\pi_1 = \pi_2 = 0.5$, $\alpha = 0.5$. The transfer is fixed at $\tau = 0.35$, a value that is half the wage rate under autarky. As it will shown in section 3.4, this is also the value of the transfer that, for this configuration of parameters, maximizes the welfare effect of taxation. Effects of changes in the parameters' values are explored in section 3.3.

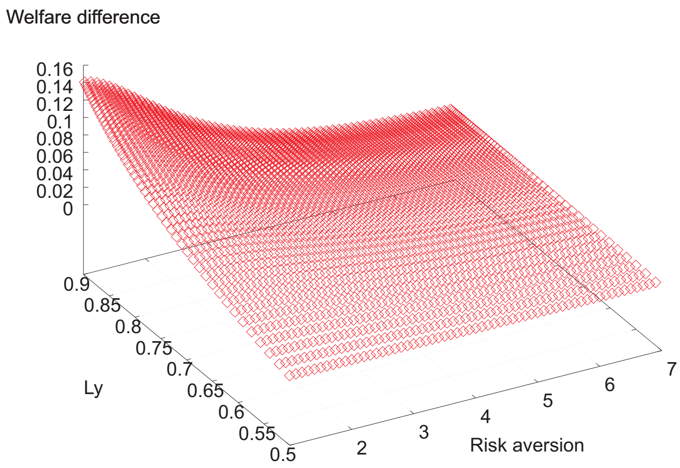

Figure 2: Free trade vs autarky

In the following, I will compare the free trade equilibrium (with and without Welfare State) with the autarky one.

Free trade vs autarky Is the free trade equilibrium welfare superior to autarky[7]? As in the standard specific-factor model the answer is always yes. This is stated in the following:

Proposition 2 *Free trade is always superior to autarky. Trade gains are larger the higher the specialization level induced by free trade, and smaller the higher the risk aversion.*

Proof. See Appendix ■

While the fact that the welfare gains of opening to trade are increasing in the free trade-induced specialization level is not surprising, the presence of uncertainty has an interesting and unexpected additional effect. Under uncertainty, the benefits of free trade decrease with the degree of risk aversion. This implies that for high level of r, the welfare gain of opening-up the economy becomes negligible. This is shown in Figure 2 which plots, for any given level of risk aversion, the welfare difference between free trade and autarky for each free trade-induced specialization level (i.e. L_y)[8].

[7]Note that here I consider a comparison between the simple sum of workers' expected utilities under free trade and under autarky. No discussion will be made concerning Pareto superiority of free trade over autarky.

[8]Recalling that at the symmetric autarky equilibrium $L_a = 0.5$, it follows that the higher L_y the higher the free-trade induced country specialization level.

The effect of taxation under free trade I now compare the free trade equilibrium with and without the Welfare State. While the taxation mechanism is the same as before, the values that the transfer τ can assume must be restricted according to:

Condition 1 *An increase of the free trade price induces an increase in the specialization level under the condition that* $\tau < \hat{\tau}$

Condition 1 implies that if $\tau > \hat{\tau}$, i.e. if the transfer is too high, an increase of p_y would induce a reduction of L_y, i.e. opening to free trade would induce the country to specialize against its comparative advantages. On the contrary, if $0 < \tau < \hat{\tau}$, the higher the free trade price the higher the trade-induced specialization level. In the following, I will focus on this second case.

Under Condition 1, the effects of the presence of a Welfare State under free trade are described in the following:

Proposition 3 *Under free trade, the welfare gain produced by the existence of the Welfare State increases with the degree of risk aversion and decreases with the free trade price.*

Proof. See Appendix ■

This results is illustrated by Figure 3.

$$\Omega = W_{tax}^{ft} - W^{ft} \tag{6}$$

i.e. the difference, for each combination of free trade price and level of risk aversion, between aggregate welfare with and without the Welfare State. For a given free trade price, as risk aversion increases, the welfare gain of the Welfare State increases because insurance is more valuable to the workers. Conversely, for a given degree of risk aversion, the higher the free trade price (i.e. the higher the specialization gains), the lower the value of insurance. In fact, the higher the world price the higher wages and aggregate welfare: under this circumstance the relative effect of the Welfare State becomes smaller. These results suggests that, when workers are risk averse, specialization and insurance are substitutes.

Gains from specialization and insurance gains Given an equilibrium situation, it is possible to measure the relative effects on aggregate welfare of the gains from specialization and the insurance gains. The gains from specialization originates from the structural change induced by the opening up to free trade and are proportional to the difference between the the world price and the autarky one. Instead, the insurance gains are the

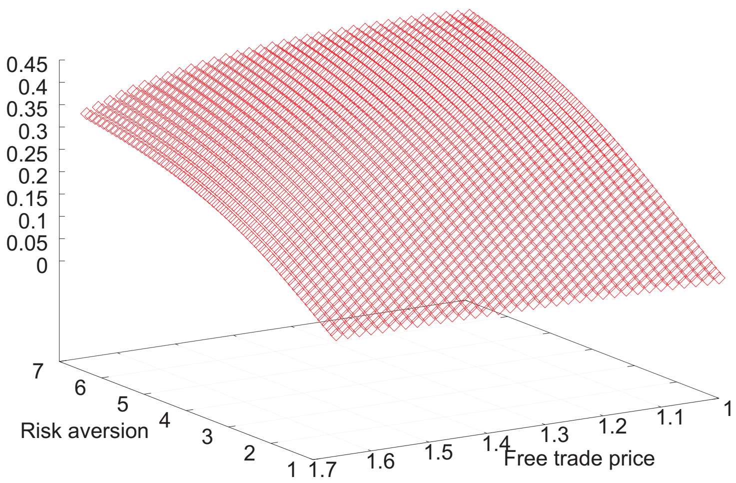

Figure 3: Welfare gain of insurance under free trade

effect of the presence of the Welfare State. Their net effect is described by the behaviour of:

$$\Theta = W^{ft} - W^{a}_{tax} \tag{7}$$

To understand why Θ measures the difference between specialization gains and insurance gains, note that W^{ft} increase in the free trade porice, i.e. in the free trade-induced specialization level and W^{a}_{tax} is equivalent to the welfare level under free trade with Welfare State when $p_{ft} = 1$ (i.e. when there are no specialization gains). Thus the first term captures only the specialization gains while the second only the effect of insurance. Their relationship is summarized by the following:

Proposition 4 *The welfare gain of free trade is increasing in the free trade price (i.e. in the induced specialization level) but decreasing in the degree of risk aversion.*

Proof. See Appendix ■

Proposition 4 has two interesting implications. First, it (always) exists a combination of free trade price and degree of risk aversion $[\hat{p}_{ft}, \hat{r}]$ for which if $p > \hat{p}_{ft}$ or $r < \hat{r}$ gains from specialization are higher than the insurance gains. Second, as shown in Figure 4, the difference between gains from specialization and insurance gains decreases in the level of risk aversion.

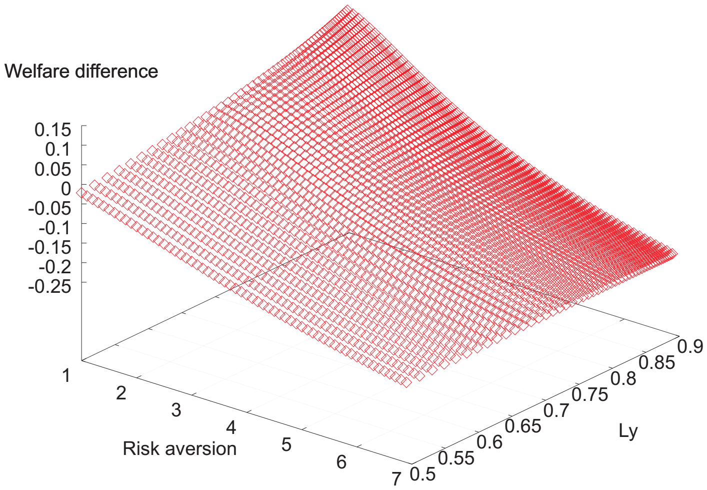

Figure 4: Gains from specialization vs. insurance gains

3.3 The main result: gains from specialization and the Welfare State

I am now ready to describe the main result of the paper. As shown in Proposition 1 and Proposition 3, the Welfare State is welfare improving under both autarky and free trade. But the taxation scheme needed to finance the Welfare State depends on the specialization level (recall eq.(3)). Thus the free trade-induced specialization level determines not only the gains from trade but *also* the cost of supplying internal insurance. The trade-off between specialization gains and insurance gains implies that, if the economy specializes *too much*, the rise in the cost of maintaining the Welfare State may outweighs the gains from trade benefits, making free trade welfare inferior with respect to autarky.

The welfare difference between the free trade and the autarky equilibrium is given by:

$$\Gamma = W^{ft}_{tax} - W^{a}_{tax}$$

where

$$W^{ft}_{tax} = L^{ft}_y E(U^{ft}_{y,tax}) + (1 - L^{ft}_y)E(U^{ft}_{x,tax})$$

is the aggregate expected welfare under free trade with the Welfare State and

$$W^{a}_{tax} = L^{a}_y E(U^{a}_{y,tax}) + (1 - L^{a}_y)E(U^{a}_{x,tax})$$

is expected welfare under autarky with Welfare State. Free trade is welfare superior to autarky if[9]:

$$(1-\alpha)\left[\frac{1}{(1-L^{ft}_y)^{\alpha}} - \frac{1}{L^{\alpha}_a}\right] > \tau\frac{2L^{ft}_y - 1}{1 - L^{ft}_y} \tag{8}$$

[9]See the Appendix for the derivation.

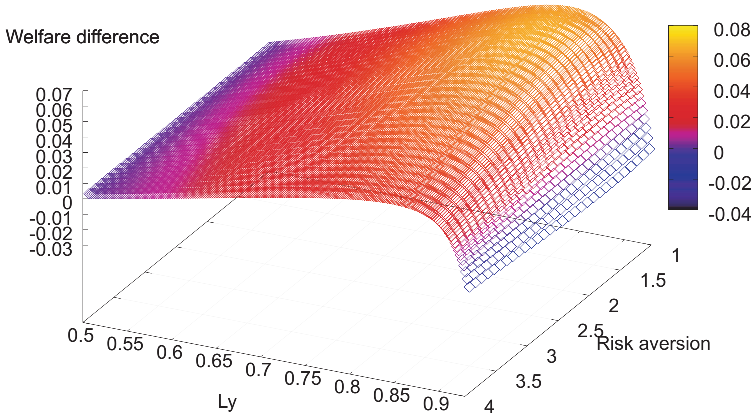

Figure 5: Welfare difference between free trade and autarky when in both there is the Welfare State and the transfer is set to $\tau = 0.1$.

The sign of inequality (8) does crucially depends upon the τ parameter and on the induced level of specialization L_y^{ft}. While if $\tau = 0$ free trade is always superior to autarky, this is not true when the transfer is positive. As shown by Figure 5, opening to trade is welfare improving for a large interval of free trade-induced specialization levels and the gains increase with the degree of specialization (L_y) though decreasing with the degree of risk aversion. But there exists a level of specialization L_y^* beyond which the welfare level of free trade with Welfare State becomes lower than the corresponding autarky one[10]. This is the main result of the paper and it is stated in the following:

Proposition 5 *Opening to free trade does not necessarily increase welfare. If the free trade-induced specialization level is too high, free trade becomes welfare inferior with respect to autarky.*

Proof. See Appendix ■

Why does free trade becomes sub-optimal if the induced specialization level is *too high*? The increase in the country level of specialization implies higher wages for all workers but also, through its effect on the tax rate (see eq.(3)), higher income variability. Since agents are risk averse, this makes the Welfare State (which is in any case welfare increasing) more costly to the workers. When the increase in the cost of insurance becomes larger than the specialization gains, free trade becomes welfare inferior with respect to autarky.

[10]The model has been numerically solved using FORTRAN77. The code programs are available upon request.

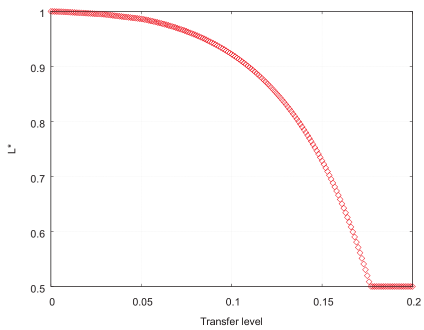

Figure 6: Plot of equation (8). For each level of the transfer τ, the graph plots the level of specialization L^* above which free trade becomes welfare inferior with respect to autarky. The graph shows that the smaller the transfer, the larger the interval of free trade-induced specialization levels for which free trade is welfare superior with respect to autarky.

Sensitivity of the result to the parameters' values Our main result crucially depends upon two parameters: 1) the probability of good and bad state (π); 2) the level of the transfer (τ).

Concerning the first, it is clear that an increase in the probability that the comparative advantaged sector is 'lucky' (i.e. higher values of π_1) makes free trade more attractive[11]. For each level of risk aversion, there is a level of π_1 for which free trade is always superior to autarky with Welfare State, even if this level increases with r.

The analysis of the second is more articulated. When the level of the transfer is exogenously given, *ceteris paribus*, a smaller τ has four effects. First, the welfare gain from insurance is smaller. Second, the smaller τ, the larger the range of free trade prices for which specialization gains are higher than insurance gains (see eq.(7)). Indeed, the smaller the transfer, the smaller the individual tax burden for any trade-induced specialization level and the smaller its welfare effect. Third, a smaller τ makes larger the range of specialization levels for which the welfare system is sustainable, i.e. $t_i < 1$ with $i = x, y$ (recall eq.(3)). Four, the smaller the transfer, the larger the interval of free trade-induced specialization levels for which free trade is welfare superior with respect to autarky. These values are reported in Figure 6

Since the level of the transfer plays a crucial role in determining the main result of the model, in order to check its robustness, in the following paragraph I consider a different way of choosing τ.

[11] Conversely, this implies that if the comparative advantaged sector is subject to high sectoral risk the expected welfare gain of free trade is lower.

3.4 Optimal transfer

While until now τ entered the model as a fixed parameter, in the following I will compare the autarky and the free trade equilibrium when the level of τ is optimally chosen by a benevolent welfare maximizer government for each level of specialization.

Definition 1 *The optimal transfer τ^* is the value of τ that, for given level of risk aversion and level of specialization, maximizes the welfare gains of due to the Welfare State.*

I begin reporting some results concerning the value of the optimal transfer under autarky and free trade. The symmetry assumptions made imply that under autarky the optimal level of the transfer is independent from the degree of risk aversion and on the probability of good and bad state. Instead, it depends on α: when the distributive parameter increases (i.e. the share of aggregate income that goes to labour decreases), the optimal level of τ decreases and the welfare gain of taxation decreases as well. The optimal level of τ under autarky is $\tau_a^* = 0.35$ and it is unique. When $\omega_a > \tau$, the higher the transfer the higher the welfare effect of the insurance mechanism[12]. When $\omega_a < \tau$, if τ increases, welfare decreases.

Under free trade, numerical results[13] indicate that, for given degree of risk aversion, the optimal level of the transfer decreases with free trade price. Thus, since the tax rate decrease with the transfer, *net wages* are increasing in the free trade induced specialization level. Finally, the optimal level of the transfer is increasing in the level of risk aversion. Finally, the welfare gain of using the optimal τ increases with the degree of risk aversion but decreases with the level of specialization.

Proposition 3 stated that, for a given level of the transfer, the welfare effect of the Welfare State changes with the degree of risk aversion and with the free trade price. Since also the optimal value of τ changes with p^{ft} and r, I now compare autarky and free trade with Welfare State when the transfer is set to the optimal level τ^* (i.e. the level that maximizes the welfare gain of insurance). Figure 7, 8 and 9 plot, for a given level of risk aversion, the difference between autarky and free trade welfare with optimal τ. The results show that for low levels of risk aversion, free trade is always welfare superior to

[12]This result obviously depends on the assumed no-distortionary nature of taxation.

[13]The optimal transfer under free trade is calculated in the following way. Given the level of risk aversion, the program calculates the welfare level in absence of Welfare State for any level of the free trade price. Then, for each free trade price and any sustainable level of τ (i.e. the level of the transfer for which $t_x < 1$ and $t_y < 1$), it computes the welfare level when there is the Welfare State. The optimal τ for a given level of free trade price (and risk aversion) is the value of τ that maximize the difference between the two computed welfare levels.

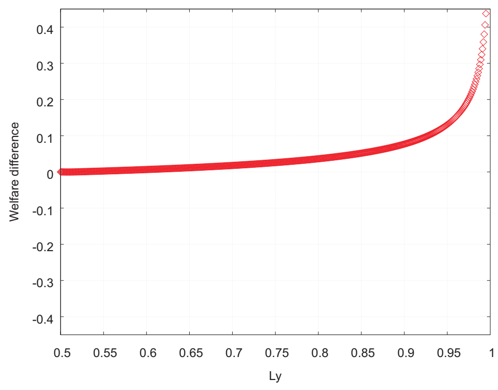

Figure 7: Welfare difference ($\Gamma = W^{ft}_{tax} - W^{a}_{tax}$) with optimal τ^* - Low risk version; $r = 0.1$

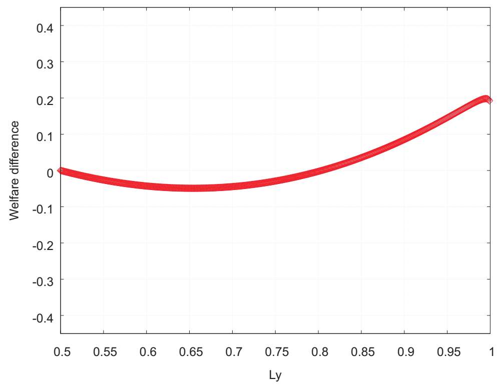

Figure 8: Welfare difference ($\Gamma = W^{ft}_{tax} - W^{a}_{tax}$) with optimal τ^* - Medium risk version; $r = 1.5$

autarky. But as risk aversion increases, the set of specialization levels for which autarky is welfare superior to free trade enlarges with risk aversion.

These results are important because they demonstrate that the theoretical possibility of welfare inferiority of free trade is robust to the way τ is chosen. In fact, even in the case in which the transfer is assumed to be set at the optimal level by a maximizing benevolent central planner, the expected welfare under free trade can be lower than the corresponding autarky one if the country specializes *too much*.

4 Concluding remarks

This paper presented a simple model showing that, under uncertainty, increasing trade integration entails both benefits and costs. Changes in the specialization level induced by opening up the economy not only determines the gains from trade but *also* the cost of supplying a Welfare State and how this burden is distributed across agents. As a first step, I have derived the conditions under which the provision of the tax-based insurance scheme,

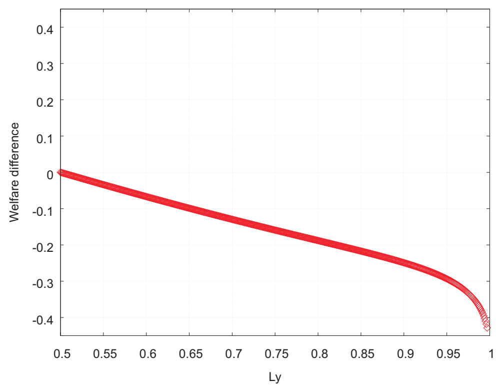

Figure 9: Welfare difference ($\Gamma = W^{ft}_{tax} - W^{a}_{tax}$) with optimal τ^* - High risk version; $r = 4$

i.e. the Welfare State, is welfare increasing under autarky and free trade. Then I have shown that the superiority of free trade *vs* autarky crucially depends on the effects that opening up the economy has on the working of the Welfare State. The main result of the model is that, under proper limitation of the parameters' space, if the economy specializes *too much* the increase in the 'average' cost of insuring workers may become bigger than the gains from opening up the economy. In this case, the free trade equilibrium turns out to be welfare inferior with respect to the autarky one. Note that the argument presented in this paper could be also reformulated considering a movement from a free trade position toward a situation in which there is a positive level of protection. Noting that a lower level of specialization reduces the cost of the insurance redistributive scheme, it follows that, if agents' level of risk aversion is high, increasing protection has a first order effect on aggregate welfare while the productivity loss (due to de-specialization and allocative inefficiency) is of second order. In this sense the optimal rule for increasing (reducing) protection would state that efficiency gains should never be higher (lower) than insurance gain (loss).

One possible solution to the negative effect of increasing trade integration here described would be the creation of a reliable system of international insurance (Pagano, 2003). But in the likely absence of it, free trade can, *via* the mechanism here described, bring a reduction of welfare in each and all countries. Thus this model shows that a 'naive' application of the comparative advantage doctrine may be misleading and that, since gains from specialization and the cost of insurance are the two sides of the same coin, only a good balance between the two would insure the maximization of welfare.

A convenient feature of the present model is that its basic framework could be easily extended. Two directions seems particularly promising. The model could be easily generalized to consider also other sources of gains from trade, i.e. technological spillovers or increasing returns. Since the basic idea of the model is that increasing specialization increases the gains from trade but it also has an impact on the cost of supplying a Welfare State, the argument remains valid if other sources of gains from trade are added. A second direction of future research concerns the modelization of the Welfare State. In this version of the model, I limited myself to consider only the insurance-provider function of the Welfare State. Further research should be devoted to incorporate a more sophisticated formalization of the taxation scheme and of the working of the Welfare State in order to consider also its risk-taking inducer function.

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Appendix

Proof of Proposition 1 Consider equation (5)

$$\Delta = W^a_{tax} - W^a$$

The Welfare State is welfare increasing if

$$\begin{aligned} W^a_{tax} &> W^a \\ L^a_y E(U^a_{y,tax}) + L^a_x E(U^a_{x,tax}) &> L^a_y E(U^a_y) + L^a_x E(U^a_x) \end{aligned} \tag{9}$$

Given $\pi_1 = \pi_2$, it follows that $L^a_y = L^a_x$ and sectoral utility is equalized under each system (i.e. taxation and no-taxation). Condition (9) is then satisfied if

$$\begin{aligned} E(U^a_{y,tax}) &> E(U^a_y) \\ \left[1 - e^{-r(1-t)w^a_y}\right] + \left(1 - e^{-r\tau}\right) &> \left[1 - e^{-rw^a_y}\right] \end{aligned}$$

Since $t = \frac{\tau}{w_y}$ (see budget balance condition (3)), the inequality can be rewritten as

$$(e^{r\tau} - 1)\left[\frac{e^{rw_y} - e^{r\tau}}{e^{rw_y}e^{r\tau}}\right] > 0 \tag{10}$$

which is always true if $w^a_y > \tau$. Finally, note that (10) (and thus Δ) is increasing in the level of r. Thus, the higher the risk aversion the higher the positive effect of the Welfare State.

Proof of Proposition 2 Define the difference between aggregate welfare under free trade and autarky:

$$\begin{aligned} \Lambda &= W^{ft} - W^a \\ &= L^{ft}_y E\left(U^{ft}_y\right) + L^{ft}_x E\left(U^{ft}_x\right) - L^a_y E\left(U^a_y\right) - L^{ft}_x E\left(U^{ft}_x\right) \end{aligned}$$

Since, under each system, utility is equalized across sectors:

$$\Lambda = E\left(U^{ft}_y\right) - E\left(U^a_y\right)$$

Free trade is welfare superior to autarky if

$$E\left(U^{ft}_y\right) > E\left(U^a_y\right)$$

$$\frac{1}{e^{rw_a}} > \frac{1}{e^{rw_{ft}}}$$

because $\pi_1 = \pi_2$ and $U^{ft}_{y2} = U^a_{y2} = 0$. Since $w_{ft} > w_a$, free trade is always welfare superior with respect to autarky. In addition, note that

- for given r, the higher w_{ft} (i.e. the higher the free trade price and the induced specialization level), the higher the difference, thus the more welfare increasing is free trade

- for given wages, the higher the risk aversion the lower the gains from specialization

Proof of Proposition 3 The welfare effect of introducing a Welfare State under free trade is given by

$$\begin{aligned}\Omega &= W_{tax}^{ft} - W^{ft} \\ &= L_y^{ft} E\left(U_{y,tax}^{ft}\right) + L_x^{ft} E\left(U_{x,tax}^{ft}\right) - L_y^{ft} E\left(U_y^{ft}\right) - L_x^{ft} E\left(U_x^{ft}\right) \end{aligned} \tag{11}$$

To simplify notation I suppress the index $_{ft}$. Since expected utilities are equalized across sectors in each system, the sign of Ω is given by the difference between:

$$\begin{aligned} E\left(U_{y,tax}\right) - E\left(U_y\right) &> 0 \\ e^{rw_y}(e^{r\tau} - 1) - e^{r\tau}(e^{rt_y w_y} - 1) &> 0 \end{aligned} \tag{12}$$

Since $e^{rw_y} > e^{r\tau}$, the necessary condition for $\Omega > 0$ is that

$$\tau > t_y w_y$$

Given equation (3), it follows that if $p_{ft} = p_y > 1$ this is always true. In addition, differentiating equation (12) it yields that

$$\frac{\partial \Omega}{\partial r} > 0$$

Finally, the higher the specialization level the larger the positive effects of the Welfare State Ω. Indeed, since $\tau - t_y w_y = 1 - \frac{L_x}{L_y}$, eq.(11) is a positive function of L_y.

Proof of Proposition 4 To measure the difference between the gains from specialization and the gains from insurance, I consider the difference between aggregate welfare under free trade and under autarky with the Welfare State:

$$\begin{aligned}\Theta &= W^{ft} - W_{tax}^{a} \\ &= L_y^{ft}\left[\pi_1\left(1 - e^{-rw_{ft}}\right)\right] + L_x^{ft}\left[(1-\pi_1)\left(1 - e^{-rw_{ft}}\right)\right] \\ &\quad - L_y^a\left[\pi_1\left(1 - e^{-r(w_a - \tau)}\right) + \pi_2(1 - e^{-r\tau})\right] - L_x^a\left[\pi_1\left(1 - e^{-r\tau}\right) + \pi_2\left(1 - e^{-r(w_a-\tau)}\right)\right]\end{aligned}$$

Since $\pi_1 = \pi_2$, I obtain:

$$\phi - e^{-rw_{ft}} + e^{-r(w_a - \tau)} - 1 + e^{-r\tau} \tag{13}$$

Differentiating (13) with respect to w_{ft}, I obtain

$$\frac{\partial \phi}{\partial w_{ft}} = \frac{r}{e^{rw_{ft}}} > 0$$

thus, the benefit of free trade increases with specialization. Since ϕ increases with w_{ft}, let assume, in the last part of the proof, that $w_{ft} = w_a$. To evaluate the effect of higher risk aversion on the relative benefits of specialization and insurance, I calculate:

$$\frac{\partial \phi}{\partial r} = \frac{e^{r\tau}\left[w_{ft} - w_{ft}e^{r\tau} + \tau e^{r\tau}\right] - \tau e^{rw_{ft}}}{e^{rw_{ft}}e^{r\tau}} \tag{14}$$

Since the denominator is always positive, the sign of ϕ depends only on the numerator:

$$e^{r\tau}\left[w_{ft} - w_{ft}e^{r\tau} + \tau e^{r\tau}\right] - \tau e^{rw_{ft}}$$

Given that $e^{rw_{ft}} > e^{r\tau}$, the sign of (14) is negative if $\left[w_{ft} - w_{ft}e^{r\tau} + \tau e^{r\tau}\right] < \tau$. Rearranging it I obtain:

$$\left[1 - e^{r\tau}\right](w_{ft} - \tau) < 0$$

which is always true. It follows that (14) is always negative.

Derivation of Condition 1 First I derive the equilibrium condition under free trade when there is the Welfare State assuming, as before, that the two states of the world are equi-probable. Expected utility in sector y is given by:

$$E\left(U_{y,tax}^{ft}\right) = \left[1 - e^{-r(1-t_y^{ft})w_y^{ft}}\right] + (1 - e^{-r\tau})$$

Using equation (3), the tax rate under free trade in sector y is given by:

$$t_y^{ft} = \frac{\tau L_x^{ft}}{w_y^{ft}L_y^{ft}} = \frac{\tau(1 - L_y^{ft})}{sL_y^{ft}(1-\alpha)K^\alpha\left(L_y^{ft}\right)^{-\alpha}}$$

The *net* wage in sector y can thus be written as:

$$(1 - t_y)w_y\frac{p_y^{ft}(1-\alpha)\left(L_y^{ft}\right)^{1-\alpha} - \tau(1 - L_y^{ft})}{L_y^{ft}}$$

The derivation of the net wage in sector x is identical and yields:

$$(1 - t_x)w_x = \frac{(1-\alpha)\left(1 - L_y^{ft}\right)^{1-\alpha} - \tau L_y^{ft}}{1 - L_y^{ft}}$$

Since the transfer τ and the level of risk aversion are assumed identical for all workers and the two states of the world are equi-probable, the equilibrium allocation condition (i.e. the equality of expected utilities) reduces to:

$$\begin{aligned} (1-t_y)w_y^{ft} &= (1-t_x)w_x^{ft} \\ \frac{p_y^{ft}(1-\alpha)\left(L_y^{ft}\right)^{1-\alpha} - \tau(1-L_y^{ft})}{L_y^{ft}} &= \frac{(1-\alpha)\left(1-L_y^{ft}\right)^{1-\alpha} - \tau L_y^{ft}}{1-L_y^{ft}} \end{aligned} \tag{15}$$

The solution of equation (15) gives the equilibrium allocation of workers under free trade. While equation (15) cannot be explicitly solved, it is possible to derive some of its properties. First, I describe the effect of an increase of the free trade price on the equilibrium allocation of workers. Define:

$$\Phi = p_y^{ft}(1-\alpha)\left(L_y^{ft}\right)^{-\alpha} - \tau\frac{1-L_y^{ft}}{L_y^{ft}} + \tau\frac{L_y^{ft}}{1-L_y^{ft}} - (1-\alpha)\left(1-L_y^{ft}\right)^{-\alpha}$$

At the equilibrium $\Phi = 0$. Applying the implicit function theorem, I obtain:

$$\frac{\partial L_y}{\partial p_y^{ft}} = -\frac{\partial\Phi/\partial p_y^{ft}}{\partial\Phi/\partial L_y} \tag{16}$$

The sign of the numerator is given by

$$\frac{\partial\Phi}{\partial p_y^{ft}} = (1-\alpha)L_y^{-\alpha} > 0 \tag{17}$$

The denominator of (16) can be rewritten as

$$\frac{\partial\Phi}{\partial L_y} = -\frac{\alpha p_y^{ft}(1-\alpha)}{L_y^{1+\alpha}} + \tau\frac{1}{L_y^2} + \tau\frac{1}{(1-L_y)^2} - \frac{\alpha(1-\alpha)}{(1-L_y)^{1+\alpha}} \tag{18}$$

Since (17) is always positive, the sigh of (16) is the same as the sign of (18) which depends on the level of τ. Equation (18) is positive if

$$\tau > \alpha(1-\alpha)\left[\frac{1}{(1-L_y)^{1+\alpha}} + \frac{p_y^{ft}}{L_y^{1+\alpha}}\right]\frac{L_y^2(1-L_y)^2}{(1-L_y)^2+L_y^2} = \hat{\tau} > 0 \tag{19}$$

Thus, if condition (19) is satisfied the sign of (16) is negative and thus an increase in the free trade price induces a reduction of the specialization level. To exclude this paradoxical case and in order to consider only the case in which opening to free trade increases the specialization, I restrict the range of the admissible values that the transfer can assume to $0 < \tau < \hat{\tau}$.

Derivation of Equation 8 Since the equilibrium conditions is the equalization of expected utilities in the two sectors, the comparison between free trade and autarky when there is the Welfare State can be written as:

$$E\left(U^{ft}_{y,tax}\right) > E\left(U^{a}_{y,tax}\right)$$

that under our symmetry assumptions reduces to

$$(1-t^{ft}_y)w^{ft}_y > (1-t^a_y)w^a_y$$
$$(1-\alpha)\frac{sL^\alpha_a - L^\alpha_{ft}}{L^\alpha_{ft}L^\alpha_a} > \tau\frac{1-2L^{ft}_y}{L^{ft}_y}$$

Since utility are equalized across sectors, it is indifferent which is the sector I consider in the comparison between the level of utility under free trade and under autarky. Choosing sector x, free trade is welfare superior to autarky if:

$$\frac{(1-\alpha)\left(1-L^{ft}_y\right)^{1-\alpha} - \tau L^{ft}_y}{1-L^{ft}_y} > (1-\alpha)\left(L^a_y\right)^{-\alpha} - \tau$$

Simplifying:

$$(1-\alpha)\left[\frac{1}{(1-L_{ft})^\alpha} - \frac{1}{L^\alpha_a}\right] > \tau\frac{2L^{ft}_y - 1}{1-L^{ft}_y}$$

Proof of Proposition 5 I begin this Proof showing that under free trade individual utility is a concave function of the level of specialization, and thus has a maxiumum. Considering again utility in sector x and differentiating it with respect to the specialization level I obtain:

$$\frac{\partial(1-t_x)w_x}{\partial L_y} = \frac{-(1-\alpha)^2(1-L_y)^{-\alpha} + (1-\alpha)^2(1-L_y)^{-\alpha}L_y - \tau + \tau L_y + (1-\alpha)(1-L_y)^{1-\alpha} - \tau L_y}{(1-L_y)^2}$$

Equalizing to zero the numerator and simplifying, it yields:

$$(1-\alpha)^2(1-L_y)^{1-\alpha} - \tau = 0$$

and finally utility in sector x is maximized when

$$\hat{L} = 1 - \left[\frac{\tau}{(1-\alpha)^2}\right]^{1/(1-\alpha)}$$

Thus for each level of the transfer there exist a specialization level that maximizes utility. If the trade induced specialization level is higher than this, i.e. when $L_y > \hat{L}$, increasing specialization would decrease free trade welfare. To conclude the Proof it is sufficient to observe that, since as stated by Proposition 2, the higher the risk aversion the lower the welfare difference between free trade and autarky it follows that there exist a set of parameter's values (i.e. risk aversion and level of the transfer) for which welfare under free trade becomes lower than under autarky.