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Trade Liberalisation and Human Capital Adjustment

By

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Abstract:

This paper highlights the way in which workers of different age and ability are affected by anticipated and unanticipated trade liberalisations. A two-factor (skilled and unskilled labour), two-sector Heckscher-Ohlin trade model is supplemented with a education sector which uses skilled labour and time to convert unskilled workers into skilled workers. A skilled worker's income depends on her ability, but all unskilled workers have the same income. Trade liberalisation in a relatively skilled labour abundant country increases the relative skilled wage and induces skill upgrading by the existing workforce, with younger and more able unskilled workers most likely to upgrade. But not all upgraders are better off as a result of the liberalisation. The older and less able upgraders are likely to lose. For an anticipated liberalisation we show that the preferred upgrading strategies depend on a worker's ability and that much of the upgrading will take place before the liberalisation. Hence some workers who would have upgraded had they anticipated the liberalisation will not if it is unanticipated, and that adjustment assistance that applies only to post-liberalisation upgraders will fail to compensate some losers and distort the upgrading decisions of others.

Keywords: Trade liberalization, Skill acquisition, Labor market adjustment.

JEL Classification: F11, F16, J31, J62.

Outline

- 1. Introduction*
- 2. The Model*
- 3. An Unanticipated Trade Liberalisation*
- 4. An Anticipated Trade Liberalisation*
- 5. Adjustment Assistance*
- 6. Conclusions*

Non-technical abstract

This paper highlights the way in which workers of different age and ability are affected by anticipated and unanticipated trade liberalisations. In particular, we explore the implications of trade liberalisations for *skill acquisition* by the existing workforce. This is a relatively neglected aspect of adjustment. Trade liberalisation in a relatively skilled labour abundant country increases the relative skilled wage which will cause some currently unskilled workers to rethink and reverse their decision to stay unskilled. The adjustment process that this induces begins immediately, and may not be completed until long after the short run frictions have been overcome. Worker characteristics will be crucial in determining their decisions, and our paper highlights the way in which workers of different age and ability are affected by a trade expansion. In fact, our framework applies to any production or price shock that changes relative wages, including those induced by technological change. We focus on trade liberalisation because its timing is also a policy choice, which allows us to consider whether it should be pre-announced.

This paper sheds light on issues in three areas. First, the effects of an *unanticipated* trade liberalisation in a skill abundant country. The increase in the relative return to skilled labour leads to some skill upgrading by the existing workforce. Which workers upgrade and which of them will gain (relative to the pre-liberalisation equilibrium)? Because the return on upgrading is increasing in ability and decreasing in age, younger, more able workers are more likely to upgrade and older, less able workers to remain unskilled. Not all upgraders are better off. Specifically, for any given ability cohort the youngest workers upgrade and gain, an intermediate range upgrade but lose and the oldest remain unskilled (and lose). The balance among these three groups shifts towards the losers as we consider lower ability cohorts. These results confirm the widespread view that older workers are more likely to lose among the adjusters to liberalisation.

Second, the effects of an *announced* liberalisation (to take place at a known future date) and, in particular, the pattern of upgrading in the workforce existing at the time of announcement. Which workers will choose to upgrade and when? Much of the adjustment - or indeed all of it if the liberalisation is small enough - will take place in advance. This has implications for both empirical measurement of adjustment and the design of programs of adjustment assistance. Neither of these should be restricted to the post-liberalisation period. Interestingly, we find that the optimal timing of any upgrading depends only on ability. Upgraders fall into three ability categories. The highest ability upgraders will do so immediately after the announcement. The next highest group will upgrade immediately before the liberalisation and the final group immediately after. The significance of this is that much of the medium term adjustment (upgrading) to an announced liberalisation will occur *before* liberalisation takes place: anticipatory investments in human capital can be part of the adjustment. We also argue that worker adjustment in anticipation of the increase in the relative wage of skilled workers that took place after 1980 could provide an alternative explanation for the differing paths of relative wages and relative supplies of young and old workers considered by Card and Lemieux (2001).

Third, the implications of our analysis for the design of programs of adjustment assistance. The first is to note that those undertaking adjustment (the upgraders) are a mixture of gainers and losers from the liberalisation. Any given age cohort contains both, depending on the upgrader's ability. Since the latter is likely to be unobservable, it will be difficult to target assistance at losers. The second implication is that if the liberalisation is anticipated much of the upgrading will (and should) take place before it occurs. But if assistance is only provided post-liberalisation then early upgraders will not be covered. More importantly the decision on when to upgrade will be distorted towards the post-liberalisation period.

1. Introduction

The links between product prices and factor returns are a key element of general equilibrium trade models. Interest in these links was heightened by the recent “trade and wages” debate, where lower prices of unskilled labour intensive products were put forward as one explanation for the decline in the relative wage of unskilled workers in advanced, skill-abundant countries. The underlying argument was based on the Stolper-Samuelson theorem which implies that trade liberalisation in unskilled labour scarce countries will lead to a fall in the relative price of unskilled labour intensive imports and a fall in the relative return to unskilled labour. The general conclusion of this debate seems to be that, while trade liberalisation may have been a contributing factor, technological change played the major role.

The changes in relative product prices that follow from trade liberalisation will also cause domestic resource reallocation towards those traded goods industries in which the country has a comparative advantage. These reallocations are an important source of gains from trade. But in the short run they will involve adjustment costs, and adjusting workers in particular are likely to suffer periods of unemployment, in addition to any longer run changes in their income streams. Although these costs are conventionally viewed as transitory and small relative to the benefits of liberalisation (Matusz and Tarr, 2002, for example), the characteristics of the affected workers indicate that they may be larger than previously thought. Trade-related displaced workers tend to be older and have less formal education than other displaced workers, characteristics that reduce the re-employment prospects of any worker (Kletzer, 2004).

Our aim is to extend the analysis of adjustment to trade liberalisation in a slightly different direction. Accepting that liberalisation in developed countries leads to an increase in the relative return to skilled labour, we explore the implications this has for *skill acquisition* by the existing workforce - i.e. not just by new entrants. This is a relatively neglected aspect of adjustment. By treating workers within each skill group as homogeneous, most trade models implicitly assume all skilled and unskilled workers are affected equally. But the changes in relative factor returns will cause some currently unskilled workers to rethink and reverse their decision to stay unskilled. The adjustment process that this induces begins immediately, and may not be completed until long after the short run frictions have been overcome. Worker characteristics will

be crucial in determining their decisions, and our paper highlights the way in which workers of different age and ability are affected by a trade expansion. In fact, our framework applies to any production or price shock that changes relative wages, including those induced by technological change. We focus on trade liberalisation because its timing is also a policy choice, which allows us to consider whether it should be pre-announced.

Our model modifies and extends earlier work by Findlay and Kierzkowski (1983) [FK] and Borsook (1987). We consider a small economy which consists of a manufacturing (traded goods) and an educational sector. The manufacturing sector is Heckscher Ohlin in structure and produces two traded goods using the services of skilled and unskilled labour. Unskilled workers enter the labour force without training. Education transforms unskilled individuals into skilled workers but takes time and resources¹. We assume individuals differ in their (exogenous) ability level and, while the income of the unskilled is independent of their ability, more able skilled workers earn a proportionately higher income. Following Becker (1993), we model the educational investment decision accounting for the relationship between earning profiles, ability and age. In contrast to previous models we allow individuals to change labour status at any time in their working lives. The decision to enter the labour market as unskilled can be reversed later through schooling². The return to education is an increasing

¹ FK (1983) and Borsook (1987) assume the economy is endowed with a fixed stock of educational capital. In the FK model all individuals are *ex ante* identical, and the productivity of those that choose to become skilled is positively related to the capital/student ratio at the time they are educated. But in a steady state all skilled workers are identical. Kreickemeier (2009) adds a fair wages mechanism to this model to analyse the effects of globalisation on wages and unemployment. Borsook assumes, as we do, an exogenous distribution of individual ability. His main concern is the link between ability and schooling undertaken by individuals of different ability. While the length of time spent in school is fixed, more able students receive a more intensive education, because the optimal capital/student ratio is increasing in ability. Earnings differentials then reflect the interaction of ability and schooling and not just schooling. In both these models the relative stock of educational capital is an important determinant of the pattern of trade. We simplify the educational process by assuming that skilled labour (staff) rather than some exogenously given educational capital is the educational input (besides students) and there is a fixed staff/student ratio. Since our educational process has the same length and skilled labour input for all students regardless of ability, we assume their productivity as skilled workers depends only on inherent ability. Dinopoulos and Segerstrom (1999) make a similar assumption, but in their case schooling takes time only. In our case the trade pattern will be determined by inter-country differences in the length of working lives, birth rates and efficiency of the educational sector.

²A significant proportion of students have previous labour force experience, so reversing the decision to remain unskilled by formal education is a viable option for many, particularly

function of ability and youth. Given relative product prices, all individuals with ability above an endogenous threshold will become skilled. A trade liberalisation changes this steady state threshold and affects relative factor supplies and hence outputs in the long run. While we also consider these long run changes, which are the main focus of FK (1983) and Borsook (1987), our main concern is with the medium run effects on the skill composition of the workforce existing at the time liberalisation occurs or is announced³.

Two key simplifying assumptions are worth emphasising. First, we abstract completely from the short run frictional costs that are the focus of much of the adjustment literature. The movement of skilled and unskilled workers between production activities is assumed to be instantaneous and costless. This simplification allows us to highlight the adjustment through skill upgrading by the existing workforce that has been largely neglected to date. Second, the HO structure implies that, as long as a country's manufacturing sector is non-specialised, factor returns depend only on product prices. In particular factor returns are constant throughout the adjustment process, so that workers' skill upgrading decisions are based on fixed and known future earnings. It should be emphasised that these assumptions are made for simplification only. Their relaxation will greatly complicate the analysis but should not invalidate the general results.

We are concerned with issues in three areas. Once the model is set up, Section 3 considers the effects of an *unanticipated* trade liberalisation in a skill abundant country. The increase in the relative return to skilled labour leads to some skill upgrading by the existing workforce. Which workers upgrade and which of them will gain (relative to the pre-liberalisation equilibrium)? In each ability cohort we determine an upgrader age cutoff, with younger workers upgrading and older workers remaining unskilled. The higher the ability level, the higher this age cutoff. But not all upgraders gain from

younger workers. In 1990, 42% of US college students were 25 years and older. The corresponding figure in 2005 was 39%. During this period, college enrolment of students 25 years and older increased considerably (18%), although less than the enrolment of younger students (33%). Interestingly, between 2005 and 2016, the number of older students is projected to grow more rapidly than the number of younger students (21% versus 15%) (see http://nces.ed.gov/programs/digest/d07/tables/dt07_181.asp?referrer=report).

³ In this sense our work can be considered complementary to Artuc et al. (2008), which considers the intersectoral adjustment of workers, and focuses on the decisions of (otherwise homogeneous) workers located in the import-competing or exporting sectors at the time of the liberalisation or its announcement

liberalisation, and for each ability cohort we can also determine an analogous gainer age cutoff, which is lower than the corresponding upgrader cutoff. Thus in any given ability cohort older upgraders tend to lose and younger ones to gain from liberalisation. These results confirm a common perception that older adjusters lose. We then use the relative changes in US wages of high-school and college graduates over the period 1979-92 (as reported by Autor et al. (2008)), as the basis for simulating the effects of an unannounced trade liberalisation in 1992, to illustrate our results.

The effects of an *announced* liberalisation (to take place at a known future date) are then derived in Section 4. Here our main concern is the pattern of upgrading in the workforce existing at the time of announcement. Which workers will choose to upgrade and when? Interestingly, we find that the optimal timing of any upgrading depends only on ability. Upgraders fall into three ability categories. The highest ability upgraders will do so immediately after the announcement. The next highest group will upgrade immediately before the liberalisation and the final group immediately after. The significance of this is that much of the medium term adjustment (upgrading) to an announced liberalisation will occur *before* liberalisation takes place⁴. Freund and McLaren (1999) provide evidence that trade flows begin to adjust before preferential trading arrangements come into force, and refer to models where firms make anticipatory “investments” to explain this. We show that anticipatory investments in human capital can be part of the same process. These results are illustrated by simulating the labour market outcomes if the 1992 liberalisation considered in Section 3 was announced in 1979. We also argue that worker adjustment in anticipation of the increase in the relative wage of skilled workers that took place after 1980 could provide an alternative explanation for the differing paths of relative wages and relative supplies of young and old workers considered by Card and Lemieux (2001).

⁴ A similar outcome occurs in Artuc et al. (2008), although the motivation for early adjustment (avoiding higher adjustment costs) is different. They model labour market adjustment to trade liberalisation in a specific factors context. Workers, who are infinitely lived, choose their sector of employment in each period depending on their “costs” (which may be negative) of switching sectors. These costs have a common component and a time-varying idiosyncratic component. Adjustment to an unanticipated liberalisation is then delayed as import-competing workers with high current idiosyncratic costs wait to see if their costs are lower in the future, while some adjustment to an announced liberalisation occurs before the liberalisation itself, as import-competing workers with low current idiosyncratic costs move early for fear that these costs will be higher later.

Section 5 briefly highlights two implications of our analysis for the design of programs of adjustment assistance. The first is to note that those undertaking adjustment (the upgraders) are a mixture of gainers and losers from the liberalisation. Any given age cohort contains both, depending on the upgrader's ability. Since the latter is likely to be unobservable, it will be difficult to target assistance at losers. The second implication is that if the liberalisation is anticipated much of the upgrading will (and should) take place before it occurs. But if assistance is only provided post-liberalisation then early upgraders will not be covered. More importantly the decision on when to upgrade will be distorted towards the post-liberalisation period. Section 6 concludes.

2. The Model

2.1 Technology and factor prices

Consider an economy with a manufacturing sector producing two tradable goods (1 and 2), using two factors (unskilled labour (L) and skilled labour (S in efficiency units)) under standard constant returns to scale technologies. Factor services are assumed to be homogeneous and costlessly mobile between industries, implying that factor returns per efficiency unit (W_L and W_S) are common across industries. With perfectly competitive markets for goods and factors and assuming incomplete specialization, relative product prices determine factor returns in the manufacturing sector in equilibrium. Skilled labour is also employed in the education sector, which turns unskilled into skilled workers, a process that takes E time periods and requires the services of β units of skilled labour per student per time period. The quantity of skilled labour services available for use in manufacturing (S_M) then depends on the quantity of skilled labour services allocated to education (S_E). If X_E is the number of students, then the skilled labour allocated to education is βX_E . Assuming full employment:

$$L = L_1 + L_2 = a_{L1} X_1 + a_{L2} X_2 \quad (1A)$$

$$S = S_M + S_E = (S_1 + S_2) + S_E = (a_{S1} X_1 + a_{S2} X_2) + \beta X_E \quad (1B)$$

where X_j denotes the output of good j .

2.2 Individual investment behaviour and human capital acquisition

We assume individuals are heterogeneous with respect to ability, which is a combination of ordinary and general knowledge that is innate and acquired prior to working age⁵. Individuals are indexed by their ability (α) which for convenience we assume to be uniformly distributed among the population and to vary along the unit interval: $\alpha \in [0,1]$. Each individual's working lifetime is finite and exogenously given by T . We suppose that the gross working earnings, per unit of time, of an unskilled worker do not depend on ability and are equal to W_L . The gross working earnings of a skilled worker depend on the number of efficiency units of skill she possesses and are equal to αW_S ⁶. Because skilled workers differ in ability they also differ in earnings. Moreover, the lifetime net earnings of skilled workers differ from their lifetime gross earnings, because of the cost of schooling.

Becoming skilled involves an investment in formal education, which we assume can be undertaken at any time during an individual's working life. Consider an unskilled worker with t periods experience in the labour market (i.e. whose time to retirement is $T-t$ periods). The net present value to this worker of now becoming skilled is the difference between discounted costs and discounted benefits:

$$R(\alpha, t) = -\int_0^E [\beta W_S + W_L] e^{-rz} dz + \int_E^{T-t} [\alpha W_S - W_L] e^{-rz} dz \quad (2)$$

where r is the interest rate. For simplicity, we assume perfect capital markets and that no agent's education decision is affected by borrowing constraints. The first term on the right of (2) represents the cost of skill upgrading, and is composed of the direct cost (βW_S per period) and the opportunity cost (W_L). The second term is the present value of the wage premium earned by a skilled worker. We assume all agents with positive net returns to schooling will upgrade. Given a wage structure,

$$\frac{\partial}{\partial t} R(\alpha, t) = -\frac{[\alpha W_S - W_L]}{e^{r(T-t)}} < 0 \quad \text{and} \quad \frac{\partial}{\partial \alpha} R(\alpha, t) = \frac{W_S}{r} [e^{-rE} - e^{-r(T-t)}] > 0 \quad (3)$$

⁵ We can interpret this background period as the compulsory stages of education.

⁶ These assumptions are based on the idea that unskilled work involves standard tasks, while skilled work involves more complex tasks for which training is required and on which the time taken depends on the worker's ability.

The gains from becoming skilled increase with ability, and an agent of given ability with a positive return from education should undertake it as early as possible. We can solve $R(\tilde{\alpha}, t) = 0$ to find the level of ability ($\tilde{\alpha}(t)$) above which an agent of age t would choose to skill upgrade:

$$\tilde{\alpha}(t) = \Gamma(t)\beta + [1 + \Gamma(t)]w = w + \Gamma(t)[\beta + w] \quad (4)$$

with $\Gamma(t) \equiv \frac{e^{rT}[e^{rE} - 1]}{e^{rT} - e^{r(E+t)}}$ and $w = \frac{W_L}{W_S}$. In the steady state, all individuals with $\alpha > \tilde{\alpha}$ ($\equiv \tilde{\alpha}(0)$) will become skilled and individuals with $\alpha \leq \tilde{\alpha}$ will enter the labour market immediately unskilled. As $\Gamma(0) > 0$, $\beta > 0$ and $w > 0$, the critical level of ability ($\tilde{\alpha}$) is always higher than zero⁷.

Figure 1 about here

Figure 1 illustrates the relationship between ability level and gross earnings (GE). In equilibrium, agents with ability in the interval $[0, \tilde{\alpha}]$ do not acquire skills and spend their entire working life earning W_L per period. Agents with higher ability become skilled and spend their post-educational working life earning αW_S per period. If education were costless, GE would be continuous, and agents with ability in the interval $[\alpha_0, \tilde{\alpha}]$ would decide to become skilled. But costly education (in either time or resources) implies a decrease in the number of skilled workers and an increase in the average ability of the skilled labour force. In the steady state equilibrium those unskilled workers in the range $(\alpha_0, \tilde{\alpha}]$ have a positive skill premium (i.e. $\alpha W_S > W_L$), but its present value is not sufficient to offset the costs of education. The existence of this group will prove significant when we consider the adjustment process to an anticipated liberalisation below.

2.3. Factor endowments in the steady-state

We assume that at each point in time an exogenous number of agents (n) are born and die, and each agent's replacement is identical in terms of ability. Thus the workforce at any time is equal to $Tn = N$, and in the steady state $\tilde{\alpha} N$ agents constitute the supply of unskilled labour. The remaining $[1 - \tilde{\alpha}]N$ are either skilled

⁷ If becoming skilled was instantaneous ($E = 0$), $\tilde{\alpha}$ would simply equal the relative wage (as then $\Gamma(0) = 0$).

$([1 - \tilde{\alpha}][T - E]n = [1 - \tilde{\alpha}][1 - \frac{E}{T}]N)$ or students $([1 - \tilde{\alpha}]En = [1 - \tilde{\alpha}]\frac{E}{T}N)$. The average level of ability of agents who decide to become skilled is $[1 + \tilde{\alpha}]/2$. The ratio of the average incomes of skilled and unskilled workers is given by

$$A(\tilde{\alpha}, w) = \frac{[1 + \tilde{\alpha}]}{2} \frac{1}{w} \quad (5)$$

and is increasing in the ability cutoff but decreasing in the relative wage. The supplies of unskilled and skilled labour services are then, respectively:

$$L = \tilde{\alpha}N \quad (6A)$$

$$S = \frac{1}{2}[1 + \tilde{\alpha}][1 - \tilde{\alpha}][1 - \frac{E}{T}]N = \frac{1}{2}[1 - \tilde{\alpha}^2][1 - \frac{E}{T}]N \quad (6B)$$

Not all skilled labour services will be used in the production of goods, since β units of skilled labour are allocated to each student. The units of skill allocated to education and goods production are then given by

$$S_E = \beta[1 - \tilde{\alpha}]\frac{E}{T}N \quad (6C)$$

$$S_M = S - S_E = [1 - \tilde{\alpha}]\left[\frac{[1 + \tilde{\alpha}]}{2}\left[1 - \frac{E}{T}\right] - \beta\frac{E}{T}\right]N \quad (6D)^8$$

3. An Unanticipated Trade Liberalisation

3.1 Skill-upgrading and welfare effects

In this section we consider the effects of an unanticipated trade liberalisation on factor returns and skill acquisition in a small skilled-labour abundant country. Since world prices are given, the liberalisation changes domestic product and therefore domestic factor prices in accordance with the Stolper-Samuelson theorem. The real return to the abundant factor (skilled labour) will rise (from W_s to W'_s), and real return to unskilled labour will fall (from W_L to W'_L), so that $w' < w$. For convenience, and without loss of generality, we label the time that the liberalisation occurs as time 0.

⁸ The lifetime supply of skilled labour (in efficiency units) of the average skilled worker is $[1 + \tilde{\alpha}][T - E]/2$. The number of units of skilled labour required to educate a skilled worker is βE . Therefore, when converted to an annual flow, the net supply of skilled labour of the average skilled worker over her working life is $\frac{[1 + \tilde{\alpha}]}{2}\left[1 - \frac{E}{T}\right] - \beta\frac{E}{T}$.

All existing skilled workers gain from the liberalisation, but gains are larger for younger and for more able workers ⁹. Students benefit from an increase in their discounted earnings as skilled workers, but lose through an increase in the direct cost of education. They are net gainers overall, however¹⁰. The biggest gainers at each ability level are students on the verge of graduating at the time of liberalisation ($t = E$). All (continuing) unskilled workers lose, and the losses are larger for the younger workers. It is customary to then conclude that all unskilled workers lose as a consequence of liberalisation due to their lower wage. But this does not allow for reversal of the decision to stay unskilled, and skill upgrading will be an attractive alternative for some existing unskilled workers as we now show. Workers differ in age and ability, and it is informative to consider both dimensions.

We begin by considering an age cohort. The new ability cutoff for workers of age t $\tilde{\alpha}'(t)$ is obtained by rewriting (4) at the new factor prices. All unskilled workers with ability in the range $\tilde{\alpha} - \tilde{\alpha}'(t)$ will find that skill upgrading raises their discounted lifetime earnings at the post-liberalisation factor prices. This range is positive for $t = 0$ (i.e. there are always gainers among the new entrants), but is declining as t increases and becomes zero once t is sufficiently large. Not all of those who upgrade “gain” from the liberalisation of course¹¹. The gain for the upgraders is given by

$$G_U(\alpha, t) = \int_E^{T-t} [\alpha W'_S - W_L] e^{-rz} dz - \int_0^E [\beta W'_S + W_L] e^{-rz} dz \quad (7)$$

By setting $G_U(\alpha, t) = 0$ we can solve for an ability cutoff at each age level ($\hat{\alpha}(t)$), above which upgrading workers are better off as a result of the liberalisation. It is then straightforward to show that

⁹ This income gain can alternatively be viewed as a (human) capital gain or a higher than expected return on education.

¹⁰ Clearly the discounted value of their earnings must have exceeded the discounted direct cost of education at the pre-liberalisation skilled wage, otherwise education would not have been profitable in the first place. The liberalisation has simply increased both earnings and direct education costs in the same proportion.

¹¹ The decision to upgrade is based on a comparison of the discounted net benefits from being skilled with the discounted lifetime income at wage W'_L . The gain depends on a comparison of the same net benefits with the alternative income at the higher wage W_L .

$$\hat{\alpha}(t) - \tilde{\alpha}'(t) = \frac{W_L - W'_L}{W'_S} \Gamma(t) > 0 \quad (8)$$

Upgraders in the ability range $\hat{\alpha}(t) - \tilde{\alpha}'(t)$ are better off than they would have been had they remained unskilled, but are worse off than if the liberalisation had not occurred. Since $\Gamma(t)$ is increasing in t , this range is larger among older workers.

We can find analogous age specific cutoffs for each ability cohort. The return to upgrading for a worker of ability α and age t at the time of the liberalisation (time 0) is given by rewriting (2) at the new factor prices as $R(\alpha, t; 0)$. Setting this term to zero, we can solve for the oldest worker of ability level α who finds upgrading worthwhile:

$$t(\alpha) = T - E + \frac{1}{r} \ln[1 - \Delta(\alpha)] \quad (9)$$

where
$$\Delta(\alpha) \equiv \frac{[e^{rE} - 1][\beta W'_S + W'_L]}{\alpha W'_S - W'_L} = \frac{\tilde{\alpha}' W'_S - W'_L}{\alpha W'_S - W'_L} [1 - e^{-r[T-E]}] \quad (10)$$

Here $\Delta(\alpha)$ captures the minimum time spent earning the new skilled premium that is necessary to cover the cost of education. This cost (represented by $[e^{rE} - 1][\beta W'_S + W'_L]$) is the same for all upgraders, but the skill premium ($\alpha W'_S - W'_L$) is positively related to the upgrader's ability. More able workers can cover this cost more quickly, and therefore the higher the ability level the older the eldest worker that finds upgrading attractive. Note that $\Delta(\alpha)$ is decreasing in α , and that $\Delta(\tilde{\alpha}') = 1 - e^{-r[T-E]}$ so that $t(\tilde{\alpha}') = 0$ - i.e. only new entrants upgrade at the new ability threshold. Again not all upgraders gain from the liberalisation. The eldest worker of ability α who does so is aged $\hat{t}(\alpha)$, where

$$\hat{t}(\alpha) = T - E + \frac{1}{r} \ln[1 - \hat{\Delta}(\alpha)] \quad (11)$$

and
$$\hat{\Delta}(\alpha) \equiv \frac{[e^{rE} - 1][\beta W'_S + W'_L]}{\alpha W'_S - W'_L} \quad (12)$$

here $\hat{\Delta}(\alpha)$ has an analogous interpretation to $\Delta(\alpha)$.¹² It is straightforward to establish that $t(\alpha) > \hat{t}(\alpha)$ - i.e. for each ability level there is a range of older upgraders who are

¹² The (hypothetical) comparison here is between upgrading at the post-liberalisation skilled wage and remaining unskilled at the pre-liberalisation unskilled wage.

worse off after the liberalisation. This range is larger the larger are the time and resource costs of education (E and β), and the lower the level of ability of the cohort.

Figure 2 about here

These results are summarised in Propositions 1 and 2 below, and illustrated in Figure 2, where ability is measured on the horizontal axis and time to retirement ($T - t$) on the vertical. $R(\alpha, t; 0) = 0$ shows combinations of age and ability where skill upgrading breaks even, and $G_U(\alpha, t; 0) = 0$ the corresponding combinations that imply no gain or loss from the liberalisation. Workers with characteristics above $R(\alpha, t; 0) = 0$ upgrade; those with characteristics above $G_U(\alpha, t; 0) = 0$ gain. Figure 2 also illustrates the characteristics of those who upgrade (adjust) but are worse off as a result of the liberalisation. These are the least able upgraders in each age cohort or, equivalently, the oldest upgraders in each ability cohort. Consider, for example, workers with τ years to retirement. Those whose ability lies in the range $[\tilde{\alpha}, \tilde{\alpha}'(\tau)]$ will upgrade, but of these only the subgroup $[\tilde{\alpha}, \hat{\alpha}(\tau)]$ will be better off as a result of liberalisation. Those with ability less than $\tilde{\alpha}'(\tau)$ will remain unskilled.

Proposition 1. An unanticipated trade liberalisation in a small skilled-labour abundant country leads to: (a) gains to all existing skilled workers, with larger gains for younger more able workers; (b) gains to all existing students, with larger gains to more able students and the largest gain in each ability cohort to those just completing their training at the time of liberalisation; (c) losses to all continuing unskilled workers, with larger losses to younger workers.

Proposition 2. An unanticipated trade liberalisation in a small skilled-labour abundant country leads to skill upgrading by some existing unskilled workers. Only workers with ability above the new steady-state cutoff will upgrade, and within this range there is an age-ability tradeoff, with younger or more able workers most likely to upgrade. Not all upgraders gain (relative to the pre-liberalisation equilibrium), and in any given ability cohort it is the older upgraders who lose.

3.2. Long run adjustments in factor supplies

Liberalisation leads to a fall in the ability threshold and thus an increase in the number of skilled workers and a fall in the number of unskilled workers. The new long run equilibrium supply of skilled and unskilled labour can be determined by replacing $\tilde{\alpha}$

with $\tilde{\alpha}'$ in (6A) to (6D)¹³. The effects on the composition of traded goods production follows from the Rybczynski Theorem – output of the relatively skilled-labour intensive good increases and output of the other good falls. This is consistent with the findings of FK (1983) and Borsook (1987), and models of variable factor supplies in a H-O-S setting (e.g. Martin, 1976; Neary, 1978; Woodland, 1982).

3.3 An application using US data.

This medium run adjustment process is illustrated by the solid lines in Figure 3, which simulate the adjustment in labour supplies following an unannounced trade liberalisation in the US economy. Our data is taken from Autor et al. (2008), with high-school graduates as unskilled workers and college graduates as skilled workers. The model is calibrated to US values in 1979 (data and sources are listed in the Data Appendix), with $E=4$, $T=40$, $\beta=0.066$, $L=46.473$ million and $w=1.24$. Given these parameters, our model implies an initial steady state unskilled labour force share ($\tilde{\alpha}$) of 0.51, equal to one minus the actual proportion of new high-school graduates enrolled in college in 1979 (0.49¹⁴). The hypothetical scenario we simulate assumes relative wages were constant (at their 1979 value) before 1992 and then fell as the result of an unannounced trade liberalisation to their actual 1992 value of $w'=1.06$. This represents a 15% fall in the relative wage. No change is assumed in the other parameters. Using (10) and (12) we find the oldest worker who upgrades and the oldest who gains in each ability cohort are given by, respectively

$$t(\alpha) = 36 + 20 \ln \left[1 - \frac{0.29}{3.97\alpha - 1.06} \right] \quad \text{and} \quad \hat{t}(\alpha) = 36 + 20 \ln \left[1 - \frac{0.33}{3.97\alpha - 1.24} \right]$$

implying $t(\tilde{\alpha}) = 29$, and $\hat{t}(\tilde{\alpha}) = 25$.

From Figure 3 we see that liberalisation prompts an immediate drop of 8m (17%) in the supply of unskilled labour¹⁵. These are the upgraders in the existing workforce. This is

¹³ The skilled labour employed in both education and manufacturing increases.

¹⁴ See U.S. Department of Commerce, Census Bureau, Current Population Survey (CPS) Digest of Education Statistics (http://nces.ed.gov/programs/digest/d07/tables/dt07_191.asp).

¹⁵ Note that an immediate adjustment of this magnitude represents about a 50% increase in college enrolments and would clearly overwhelm the education system. In practice some form of rationing would be employed which would spread the adjustment and probably permanently turn away some upgraders. Alternatively, we could follow FK (1983), Borsook (1987) and Kreickemeier (2009) and model the quality of the education, reflected in the number of efficiency units acquired, as dependent on the staff-student ratio. Erstwhile upgraders may

followed by a steady decrease (totalling a further 6.5m or 14% of the initial unskilled labour force) over the next 40 years, where retiring cohorts have a higher, but declining, proportion of unskilled workers than entering cohorts. These adjustments would be matched by a corresponding jump and then steady increase in the supply of skilled labour 4 (E) years later. Since this is not the manner in which these wage changes actually occurred, these simulations are intended as an illustration only. Even so, one might feel that the changes they imply for the unskilled labour supply are unrealistic. But in fact the proportion of new high-school graduates enrolled in college in 1992 was 0.62, well on the way to the simulation's steady state prediction of 0.65 (i.e. $\alpha' = 0.35$), and Kletzer (2004, pp. 726) estimates a total of 44.9 million non-agricultural jobs (skilled and unskilled) lost during the period 1979-99.

Figure 3 about here

4. An Announced Liberalisation

We now consider skill upgrading where the government announces (at arbitrary time 0) a trade liberalisation that will take place at a known point in the future (t_0). Agents accord this full credibility and we suppose the prevailing wage rates after the liberalisation are as in the previous section. We now determine which agents working as unskilled at the time of the announcement will choose to upgrade and when.

4.1. Upgrading strategies

We begin by looking at the timing of the upgrading decision for current unskilled workers. They have three alternative strategies available: (1) upgrade immediately; (2) upgrade just prior to liberalisation (so as to be able to take advantage of the higher skilled wage as soon as it is available); or (3) upgrade immediately after the liberalisation¹⁶. The corresponding income streams for an agent of ability α and age t at the time of the announcement are, respectively:

$$I_1(\alpha, t; t_0) = -\int_0^E \beta W_s e^{-rz} dz + \int_E^{t_0} \alpha W_s e^{-rz} dz + \int_{t_0}^{T-t} \alpha W'_s e^{-rz} dz \quad (13A)$$

then optimally delay (or forego) retraining depending on the level of congestion in the higher education system.

¹⁶ Any strategy dividing the education period before and after the liberalisation is dominated by either all before or all after depending on ability.

$$I_2(\alpha, t; t_0) = \int_0^{t_0-E} W_L e^{-rz} dz - \int_{t_0-E}^{t_0} \beta W_S e^{-rz} dz + \int_{t_0}^{T-t} \alpha W'_S e^{-rz} dz \quad (13B)$$

$$I_3(\alpha, t; t_0) = \int_0^{t_0} W_L e^{-rz} dz - \int_{t_0}^{t_0+E} \beta W'_S e^{-rz} dz + \int_{t_0+E}^{T-t} \alpha W'_S e^{-rz} dz \quad (13C)$$

We can establish ranges of ability over which each alternative will be preferred. Note that t affects each of these flows in exactly the same way. The period of earning the post-liberalisation skilled wage is shorter the older the worker at the time of the announcement. So as long as all three are viable for a given agent, her preferences over them will be independent of her age.

The agent's preferences between upgrading immediately or just prior to liberalisation will be determined by

$$I_1 - I_2 = \frac{[e^{rt_0} - e^{rE}]}{re^{rt_0}} \left\{ \frac{[\alpha + \beta]W_S}{e^{rE}} - [W_L + \beta W_S] \right\} \quad (14)$$

Note that $t_0 > E$ for the distinction between these options to be meaningful, and that (14) is increasing in α . The difference between the two strategies is clear. If the agent upgrades immediately the opportunity cost (relative to continuing to work as unskilled and upgrading later) is W_L , and then the agent's earnings depend on their ability and the current skilled wage. If the agent upgrades later, the cost of education is deferred but their earnings in the meantime are the current unskilled wage and the opportunity cost of upgrading is their foregone skilled earnings (αW_S). The agent indifferent between these two alternatives has ability α_{12} where

$$\alpha_{12} W_S - W_L = [e^{rE} - 1][\beta W_S + W_L] \quad (15)$$

Since $\tilde{\alpha} > \alpha_{12} > \alpha_0$, an agent on the margin of becoming skilled under the pre-liberalisation regime will prefer I_1 to I_2 once the liberalisation is announced. An agent who would earn the same whether skilled or unskilled under the pre-liberalisation factor prices (i.e. an agent of ability α_0) would prefer to defer the cost of education.

The agent's preferences between upgrading just before and just after the liberalisation are determined by:

$$I_2 - I_3 = \frac{[e^{rE} - 1]}{re^{rt_0}} \left\{ \frac{[\alpha + \beta]W'_S}{e^{rE}} - [W_L + \beta W_S] \right\} \quad (16)$$

Again this comes down to a comparison of discounted education costs. The advantage of delayed upgrading is that these costs are further in the future. The disadvantage is that both the direct cost and opportunity cost (i.e. working as skilled under the new wage structure) are higher. The agent indifferent between these two alternatives has ability α_{23} where

$$[\alpha_{23} + \beta]W'_S = e^{rE}[\beta W_S + W_L] \quad (17)$$

Since $\alpha_{12} > \alpha_{23}$ and both (14) and (16) are increasing in α , we have established that I_1 is the preferred option for upgraders in the ability range $\tilde{\alpha} > \alpha \geq \alpha_{12}$, I_2 is the preferred option for upgraders in the ability range $\alpha_{12} > \alpha \geq \alpha_{23}$, and I_3 is the preferred option for upgraders in the ability range $\alpha_{23} > \alpha > \tilde{\alpha}'$. Thus

Proposition 3. Workers who choose to upgrade in response to an announced liberalisation to take place in the future, will prefer one of three upgrading strategies, depending on their ability, but independent of their age:

- (i) *those most able among workers whose pre-liberalisation skill premium was positive will prefer to upgrade immediately following the announcement;*
- (ii) *those in an intermediate skill range will prefer to upgrade immediately before the liberalisation; and*
- (iii) *those closest to the new steady-state ability cutoff will prefer to upgrade immediately after the liberalisation.*

We noted that these cutoffs are independent of the worker's age. Equations (15) and (17) reveal they are also independent of the proximity of the liberalisation (t_0). Further, we see from (14) that the cutoff between strategies I_1 and I_2 is independent of the size of the liberalisation, and hence independent of the new steady state threshold ability. We can show that $\tilde{\alpha}' > \alpha_{12}$ if the liberalisation is sufficiently small - i.e. if

$$\frac{[e^{rE} - 1] [\beta W_S + W_L]}{[e^{rT} - 1] W_S} > \left[\frac{W_L}{W_S} - \frac{W'_L}{W'_S} \right] \quad (18A)$$

In this case *all* upgraders among the existing workforce would prefer to do so on announcement. In contrast from (17) we see that the cutoff between strategies I_2 and

I_3 is influenced by the size of the liberalisation. A larger liberalisation implies that both $\tilde{\alpha}'$ and α_{23} are smaller, the latter because the (direct and opportunity) cost of education is higher under strategy I_3 . Again it is possible that $\tilde{\alpha}' > \alpha_{23}$, this time if

$$\frac{[\beta W'_S + W'_L]}{[\beta W_S + W_L]} > \frac{[e^{rT} - e^{rE}]}{[e^{rT} - 1]} \quad (18B)$$

In this case all upgraders among the existing workforce would prefer to upgrade before the liberalisation occurs. Since the right side of this inequality is less than unity, then if the cost of becoming skilled is higher post-liberalisation, all upgrading will occur prior to liberalisation. These outcomes are summarised in:

Proposition 4. Suppose a liberalisation is announced to take place more than E periods into the future. If (a) the liberalisation is sufficiently small or (b) the cost of upgrading is higher after the liberalisation, then all induced skill-upgrading by the existing workforce will take place before the liberalisation occurs.

4.2. Returns to upgrading

Having established their preferred options should they choose to upgrade, we now consider the returns from skill upgrading for each group. These will depend on worker age. For a given size and proximity of liberalisation we wish to determine for each ability cohort, the maximum age for which an existing worker will find skill upgrading profitable. Clearly under options I_1 and I_2 this must be bounded by $T - t_0$, since workers of this age or older will have left the labour force before the liberalisation occurs. For option I_3 the bound is $T - t_0 - E$ since the worker would not complete schooling until E periods after the liberalisation. The returns to skill upgrading under the three options for a worker of ability α and age t , when a liberalisation occurs t_0 periods in the future are given by, respectively:

$$R_1(\alpha, t; t_0) = - \int_0^E [\beta W_S + W_L] e^{-rz} dz + \int_E^{t_0} [\alpha W_S - W_L] e^{-rz} dz + \int_{t_0}^{T-t} [\alpha W'_S - W'_L] e^{-rz} dz \quad (19A)$$

$$R_2(\alpha, t; t_0) = - \int_{t_0-E}^{t_0} [\beta W_S + W_L] e^{-rz} dz + \int_{t_0}^{T-t} [\alpha W'_S - W'_L] e^{-rz} dz \quad (19B)$$

$$R_3(\alpha, t; t_0) = - \int_{t_0}^{t_0+E} [\beta W'_S + W'_L] e^{-rz} dz + \int_{t_0+E}^{T-t} [\alpha W'_S - W'_L] e^{-rz} dz \quad (19C)$$

It is clear that $R_j(\alpha, t; t_0)$, $j=1,2,3$ is lower the older a worker of given ability. Set $R_j(\alpha, t; t_0) = 0$, and solve for the maximum age ($t_j(\alpha; t_0)$) at which a worker of ability α would find upgrading worthwhile under option j , obtaining

$$t_j(\alpha; t_0) = T - t_0 + \frac{1}{r} \ln[1 - \Delta_j(\alpha)] \quad (j=1,2); \quad t_3(\alpha; t_0) = T - t_0 - E + \frac{1}{r} \ln[1 - \Delta_3(\alpha)] \quad (20)$$

where $\Delta_2(\alpha)$ and $\Delta_3(\alpha)$ represent the minimum time spent working at the new skill premium necessary to offset the cost of upgrading, and $\Delta_1(\alpha)$ represents the minimum time spent earning the new skill premium that is required to offset the total costs of education that are not covered by earnings at the old skill premium. Since $\partial \Delta_j(\alpha) / \partial \alpha < 0$, $\partial t_j(\alpha) / \partial \alpha > 0$ within each range, and it is straightforward to show that the solutions to (20) have $t_1(\tilde{\alpha}) > t_1(\alpha_{12}) = t_2(\alpha_{12}) > t_2(\alpha_{23}) = t_3(\alpha_{23})$. We would expect to observe a decline in the age of the oldest worker upgrading as we consider workers of lower ability. The more proximate the liberalisation the longer the period spent earning the new skill premium and hence the higher the return to skill upgrading at any ability-age combination. Of course $t_j(\alpha) = 0$ will occur at some point in the range $[\tilde{\alpha}, \tilde{\alpha}']$, depending on the proximity of the liberalisation and its size. No current workers of lower ability will then upgrade.

But like an unannounced liberalisation, not all upgraders are better off than they would have been if the liberalisation did not take place. The gain from liberalisation under upgrading strategy j can be determined from

$$G_j(\alpha, t; t_0) = I_j(\alpha, t; t_0) - I_0(t), \quad \text{where } I_0(t) = \int_0^{T-t} W_L e^{-rz} dz \quad (21)$$

Here $I_0(t)$ represents the (hypothetical) income with no liberalisation. It then follows that the difference between the gain from liberalisation and the return to upgrading is the same across the three upgrading strategies - i.e.

$$G_j(\alpha, t; t_0) - R_j(\alpha, t; t_0) = \frac{[W'_L - W_L]}{r} \left[\frac{e^{r[T-t]} - e^{rt_0}}{e^{r[T-t]} e^{rt_0}} \right] < 0 \quad (22)$$

Since this involves a comparison as an unskilled worker at the pre- and post-liberalisation wages it is independent of ability. The gain is always less than the return,

implying that, at each ability level, the marginal upgrader is worse off as a result of the liberalisation. The older the worker or the less proximate the liberalisation, the smaller the difference. The oldest worker who gains at each ability level can be determined in the same way as the oldest worker who upgrades, by solving $G_j(\alpha, t; t_0) = 0$ for $\hat{t}_j(\alpha; t_0)$. The solutions are analogous to (21) above, with $\alpha W'_S - W'_L$ replaced by the smaller quantity $\alpha W'_S - W_L$.

Again these outcomes can be illustrated by simulating on US data. We suppose that the hypothetical (unannounced) 1992 trade liberalisation considered in the previous section was announced in 1979. Recall that the initial and post-liberalisation steady state cutoffs are $\tilde{\alpha} = 0.51$ and $\tilde{\alpha}' = 0.35$ respectively. We then find $t_1(\tilde{\alpha}) = 20$; $\alpha_{12} = 0.49$ and $t_1(\alpha_{12}) = 18$. So workers in the ability range $\alpha \in [0.49, 0.51]$, who have between 20 to 22 years (depending on ability) of their working life remaining will upgrade immediately on the announcement. Those following strategy 2 (upgrading just before the liberalisation) have ability in the range $\alpha \in [0.38, 0.49]$, and between 38 and 22 years (depending on ability) to retirement. Because total education costs are reduced by the liberalisation (see data appendix), some of the existing workforce will choose to upgrade after it occurs. The older upgraders in each ability cohort, and all of the small number of upgraders who follow strategy 3, lose from the liberalisation.

4.3 Adjustments in factor supplies

The long run outcomes (i.e. when the existing labour force has retired) will be the same for an announced liberalisation of the same magnitude as the unanticipated liberalisation in Section 3. The medium run adjustments will differ, however, depending on the size and proximity of the announced liberalisation. The intriguing outcome is that some, or even all, of the skill upgrading by the existing workforce will occur before the liberalisation itself. The increase (decrease) in the supply of skilled (unskilled) labour will increase the output of the skill-labour intensive exportable and decrease the output of the unskilled-labour intensive importable, via the Rybczynski theorem. Thus a significant part of the adjustment in the trade volume “induced” by liberalisation may occur before the liberalisation itself. As noted above, this prediction

is consistent with that from intersectoral worker movements (Artuc et al., 2008) and is confirmed by the evidence in Freund and McLaren (1999)¹⁷.

The dashed lines in Figure 3 show labour market outcomes had the 1992 liberalisation been announced in 1979. Immediately upon announcement, unskilled labour supply falls (by 0.9m) because of upgraders following strategy 1. This is followed by a steady decline as liberalisation draws nearer due to entrants following the same strategy. There is then a significant drop (of 5.8m or 12% of the initial unskilled labour force) E periods before liberalisation because of upgraders following strategy 2, and a further drop (1.6m) at the time of liberalisation due to upgraders following strategy 3. The remaining adjustment to the new long run equilibrium then reflects the differing compositions of retiring and entrant cohorts. The skilled labour force will show corresponding increases 4 years later. As can be seen, most (82%) of the upgrading by the existing workforce has been started before the liberalisation¹⁸. The difference between the unskilled labour forces in 1992 under the unannounced and announced liberalisations - i.e. 0.7million - reflects those who would upgrade if liberalisation was announced, but not if it is unannounced¹⁹. By 2003 the adjustment paths differ by less than one percent of the initial unskilled labour force.

Consideration of labour market adjustments initiated by *anticipated* changes in relative wages, could also help explain the differing changes in relative incomes and factor supplies across age groups in the US since 1950 reported by Card and Lemieux (2001). Their Figure I (2001; 706) provides the relative incomes of skilled to unskilled labour in young (aged 26 to 30) and old (aged 46 to 60) cohorts; and their Figure III (2001; 723) provides relative supplies of skilled to unskilled labour in both cohorts. Viewed from the perspective of this model, this evidence is consistent with an increase in the relative wages of skilled workers that began in 1980, but was *anticipated* before then²⁰. Their

¹⁷ As Artuc et al. note, anticipatory actions may lead to underestimation of adjustment costs in empirical analyses based on comparisons of labour market outcomes before and after liberalisation occurs.

¹⁸ One advantage of an announced liberalisation, is that it spreads the upgrading adjustment over a longer time period and hence reduces potential congestion in the education sector.

¹⁹ All workers who upgrade under strategy 1 have at least 20 years to retirement at the time of announcement (1979) and are therefore still in the workforce at the time of liberalisation (1992).

²⁰ Card and Lemieux (2001) take a different perspective. They take the relative labour supply shifts as given and explain changes in relative incomes by assuming imperfect substitutability

Figure III shows the relative supply of skilled workers for both young and old cohorts is increasing up to 1975, after which relative supply of skilled workers is relatively stationary in the young cohort (suggesting $\tilde{\alpha}$ for entrants had reached a new long run equilibrium value), but continues to increase in the old group reflecting the passage through the system of cohorts for whom $\tilde{\alpha}(t)$ was successively lower. This helps explain why relative supply in older cohorts is lower than in the young.

With this in mind, we consider what happened to relative incomes (as shown in their Figure I). First, relative incomes for both groups decline from 1970 to 1980, but the decline is larger for young workers. This is consistent with relatively stable wage rates, but increasing acquisition of skill in anticipation of the wage increases that began in the 1980s. From (6) the relative average incomes of skilled to unskilled workers in a cohort

of age t is given by $\frac{1 + \tilde{\alpha}(t)}{2w}$ ²¹. Increased skill upgrading (a lower $\tilde{\alpha}(t)$) leads to a lower

relative income of skilled workers (given wage rates), so the relative wages in both groups decline. But since there is more upgrading in younger cohorts ($\tilde{\alpha}(t) < \tilde{\alpha}(t')$ if $t' > t$), the decline in relative wages is larger for the younger cohorts.

Second, after 1980 the relative income of skilled workers begins to rise, reflecting a process of increasing relative wages generated by relative price and/or technology changes as discussed in the “trade and wages” debate. At this stage the relative supply data indicates that the entry threshold ($\tilde{\alpha}$ of entrants) had stabilized, suggesting that the increase in the relative income of the skilled in the younger cohort is entirely due to relative wage increases. But the relative supply of skilled labour in the old cohort continues to increase, implying the corresponding thresholds are falling, reflecting the passage through the system of cohorts for which the upgrading cutoff was successively lower (but always higher than the threshold of younger entrants). So the effect on relative incomes for the old cohort is a combination of a falling w and a falling $[1 + \tilde{\alpha}(t)]/2$. From the data the net result is a slow rate of increase, certainly slower than that for entering cohorts for which only the relative wage effect applies.

between unskilled (and skilled) workers of different ages. In contrast our approach takes the relative wage changes as given and explain the changes in relative labour supplies.

²¹ Recall that $[1 + \tilde{\alpha}(t)]/2$ is the average skill level of cohort t assuming a uniform distribution of skill in the population.

4.4. Timing of liberalisation

One implication of our analysis is that no existing worker will prefer an unanticipated liberalisation²². To make the comparison more precise, if a government is considering liberalisation at some future date t_0 ($t_0 > E$), then all existing workers will have a (weak) preference that the date be announced immediately rather than kept secret and then an unanticipated liberalisation occur at t_0 . This does not establish, of course, that a delayed, but announced liberalisation is preferred to an immediate, but unannounced liberalisation. From an aggregate welfare perspective, trade barriers are the only source of distortion here, distorting both production and consumption decisions. Further, the higher relative price of the importable increases the (real) wage to unskilled labour and reduces the (real) wage to skilled labour relative to their shadow values, distorting the upgrading decision towards insufficient skill acquisition.²³ Less than complete removal of the trade barriers will mean that consumption, production and upgrading decisions are still made under distorted prices (even if the distortion has been reduced). This leaves us firmly in the realm of the second best and we cannot say a priori whether a delay of the liberalisation, which may induce greater upgrading amongst the existing workforce but which leaves the production and consumption distortions at higher levels, will lead to a welfare superior outcome to an immediate liberalisation.

5. Adjustment Assistance

In this section we briefly discuss some issues our analysis raises for the design and implementation of “adjustment assistance” to compensate workers who are not net gainers from liberalisation *and* who undertake costly adjustment. Obviously this is not, and is not intended to be, a general model of adjustment. Along with skill upgrading, liberalisation in our model involves the reallocation of workers between sectors, which we assume takes place instantaneously and costlessly. This is of course unrealistic, but a necessary simplification to focus on adjustment through skills upgrading²⁴.

²² We are also able to identify those workers who would have upgraded prior to the liberalisation had they known it was coming when they entered the labour force, and to divide them into those who still upgrade and those who do not. Both subgroups regret the decision to remain unskilled but only the first reverse it.

²³ In principle this distortion, which is unlikely to form part of the political economy motivation for these trade barriers, can be corrected by an appropriate subsidy to skill acquisition.

²⁴ Policy options for adjustment assistance are discussed in Feenstra and Lewis (1994), Davidson and Matusz (2006), Davidson et al. (2007) and Artuc et al. (2008).

Governments do not provide specific schemes of redistribution of gains from trade²⁵. Where special assistance may be provided, it is to those who undertake costly adjustment as a result of liberalisation. In this model these are the members of the existing workforce who choose to upgrade. The general assumption underlying such programs is that worker adjustment that occurs in response to trade policy changes is involuntary and represents a cost imposed on a reluctant worker. As we have seen this is not necessarily the case. Among adjusters there are winners and losers: in particular the older workers in each ability cohort lose, whereas younger workers gain. This result is consistent with Kletzer's (2004) empirical findings.

5.1 An unanticipated liberalisation

Consider first an unanticipated liberalisation. Then, as discussed in section 3, those workers whose return from upgrading is now positive will undertake it. Not all these workers are better off as a result of liberalisation, but because the gains from upgrading are increasing in ability and decreasing in age, the age cutoff between those who gain and those who lose is increasing in ability. If both worker characteristics were observable, it would be straightforward, at least in principle, to design a scheme that only compensated the losers. But while age is likely to be observable, ability is not *ex ante*. Nor would it be revealed by a worker's unskilled income, which is assumed to be independent of ability. Any scheme based on age alone is likely to fail to capture some losers with low ability while rewarding some gainers of higher ability.

5.2 An anticipated liberalisation

When we turn to an announced liberalisation, it is apparent that a poorly designed scheme can distort decisions. Typically assistance includes subsidies to retraining but is only provided to members of the existing workforce adjusting *after* the liberalisation has occurred²⁶. But, as we saw, for an anticipated liberalisation it is optimal for much

²⁵ Ichida (2005) provides a careful discussion of the difficulties in designing compensation schemes to redistribute gains from trade through product / factor taxes and subsidies.

²⁶ Eligibility under the US Trade Adjustment Assistance (TAA) Program requires that workers "*have been* laid off or put on a reduced work schedule" (emphasis added) according to a U.S. Department of Labor Fact Sheet (www.doleta.gov/programs/factsheet/taa.htm). For the Department to issue a Certification Regarding Eligibility to Apply for Worker Adjustment Assistance, (a) workers must have been totally or partially laid off; (b) sales or production must have declined; and (c) increased imports must have contributed importantly to worker layoffs.

of the upgrading to take place in advance. Those upgraders following strategies I_1 and I_2 will be ineligible for adjustment assistance, although these groups will contain (older) workers who are net losers. The presence of training assistance restricted to strategy I_3 then distorts the timing of upgrading. An anticipated future liberalisation accompanied by a program of adjustment assistance that only compensates for upgrading costs undertaken after liberalisation, may lead to reductions in the numbers in schooling and a consequent increase in the unskilled workforce, prior to the liberalisation.

6. Conclusions

Our aim has been to highlight how the characteristics of unskilled workers, particularly age and ability, affect when and whether they opt for skill upgrading in response to liberalisation in a skill abundant country. An unanticipated liberalisation will induce those close to the old ability threshold to upgrade. Because the return on upgrading is increasing in ability and decreasing in age, younger, more able workers are more likely to upgrade and older, less able workers to remain unskilled. Not all upgraders are better off. Specifically, for any given ability cohort the youngest workers upgrade and gain, an intermediate range upgrade but lose and the oldest remain unskilled (and lose). The balance among these three groups shifts towards the losers as we consider lower ability cohorts. These results confirm the widespread view that older workers are more likely to lose among the adjusters to liberalisation.

A similar pattern applies for an announced liberalisation. The most significant difference is that announcement allows the option of upgrading prior to liberalisation and this option will be preferred by those closest to the pre-liberalisation ability threshold and hence those most likely to upgrade. The implication is that if a liberalisation is anticipated, much of the adjustment - or indeed all of it if the liberalisation is small enough - will take place in advance. This has implications for both empirical measurement of adjustment and the design of programs of adjustment assistance. Neither of these should be restricted to the post-liberalisation period.

Once a Certificate has been issued the workers can apply for benefits, which include allowances for up to 104 weeks of training in another job or career. For a more detailed description of participation in trade adjustment assistance programs in the US see Kletzer and Rosen (2005).

Whether anticipated or not, any adjustment to a trade liberalisation via upgrading is a dynamic process that may take much longer than suggested by conventional analysis. Until the new steady state is achieved (i.e. as long as the workforce contains individuals who entered prior to liberalisation or its announcement), the supply of skilled (unskilled) labour in a skill-abundant country will be below (above) its long run level. While in no way intending to offer a detailed analysis of adjustment assistance, our results suggest two important considerations for program design. First, some upgraders (adjusters) are gainers and some losers. There would seem to be little argument for compensating the former. Second, if liberalisation is anticipated, some adjustment optimally will occur beforehand. A similar outcome has been shown for inter-sectoral worker movements by Artuc et al. (2008). Hence a program of adjustment assistance that provides subsidies to adjustment costs, but only after the liberalisation has occurred, will distort the timing of adjustment away from its optimal path.

There are several directions in which this work might usefully be extended. The integration of short run adjustment costs would allow a more comprehensive consideration of adjustment assistance. Not all upgrading occurs via formal schooling. On-the-job training is an important alternative, often for skills that are firm or industry specific. Investigation of the effects of liberalisation on demand for and supply of these types of skills requires a different model²⁷. The range of skills relevant to the labour market and different channels through which they can be acquired (from formal schooling to experience) make empirical investigation difficult. Further complexity is added by potential capital market distortions and the role of governments financing and provision of training. But the growing availability of matched worker-firm data sets suggests progress may soon be possible.

²⁷ Long et al. (2007) note that firm specific human capital introduces a non-competitive element to wage determination, since a worker is more productive employed in a specific job. They therefore assume that the wage of a skilled worker arises as the Nash bargaining solution between worker and firm. Firms do not take the wages of skilled workers as given and have an incentive to negotiate the wage after skills have been accumulated. Workers underinvest in skills, since they know they will not receive the full benefit of their investment. Investment in skills is thus socially suboptimal and liberalisation may raise welfare through an additional channel if it increases the incentive to invest in skills.

Data Appendix.

As noted in the text, we employ a hypothetical liberalisation to illustrate the working of the model. We suppose that liberalisation leads to a change in the relative high-school to college wage gap as in fact occurred over the period 1979 to 1992. We choose this period because it was these changes that prompted the “trade and wages” debate. Our relative wage data is taken from Autor et al. (2008), Figures 2A (the log college/high-school wage ratio) and 5A (the log real weekly wages of college and high-school graduates). Thus in 1979 w is 0.3928; W_S is 3.158; W_L is 1.241; and in 1992 w' is 0.2657; W'_S is 3.975; W'_L is 1.056; where L are male high-school graduates and S male college graduates²⁸. Based on these estimates, between 1979 and 1992 the (real weekly full-time male) unskilled wage fell by 14.9% and the (real weekly full-time male) skilled wage increased by 25.9%.

The length of standard first-degree tertiary education (E) is 4 years; the working life (T) is taken to be 40 years; and the discount factor (r) is taken to be 0.05. The (full-time equivalent) staff/student ratio in higher education in the US in 1979 (β) is 0.066 (U.S. National Center for Education Statistics²⁹). Under these assumptions $\tilde{\alpha}$ is 0.51 and $\tilde{\alpha}'$ is 0.35, which are in line with statistics on the college enrolment of new high-school graduates in 1979 (49%, which implies $\tilde{\alpha}$ is 0.51) and 1992 (62%, which implies $\tilde{\alpha}'$ is 0.38) (U.S. Department of Commerce, Census Bureau, Current Population Survey (CPS), Digest of Education Statistics³⁰) The (annual) cost of education ($\beta W_S + W_L$) is then 1.448 at 1979 wages and 1.317 at 1992 wages. Thus the cost of education falls as a result of the liberalisation, implying that not all upgraders in the existing workforce will plan to upgrade before an announced liberalisation.

The total unskilled labour force in 1979 (L) is 46.473 million (Edstats - OECD Education Database³¹).

²⁸ Autor et al. (2008) use data from the Current Population survey. Estimates for the college to high-school wage gap are based on the weekly wages of full-time workers from a sample of male workers aged 16 to 64 with 0 to 39 years of potential experience in their current employment.

²⁹ See http://www.allcountries.org/uscensus/297_higher_education_summary.html.

³⁰ See http://nces.ed.gov/programs/digest/d07/tables/dt07_191.asp

³¹ The data underlying this figure is based on males aged 20 to 59 in the US labour force in 1979/80, whose highest degree attained was high-school graduation.

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Figure 1: Ability and Gross Earnings

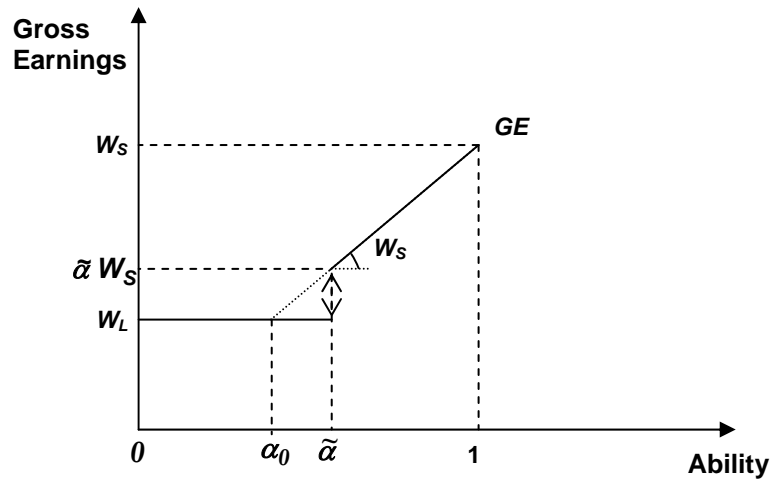


Figure 2: Upgraders, Gainers and Losers from an Unannounced Trade Liberalisation

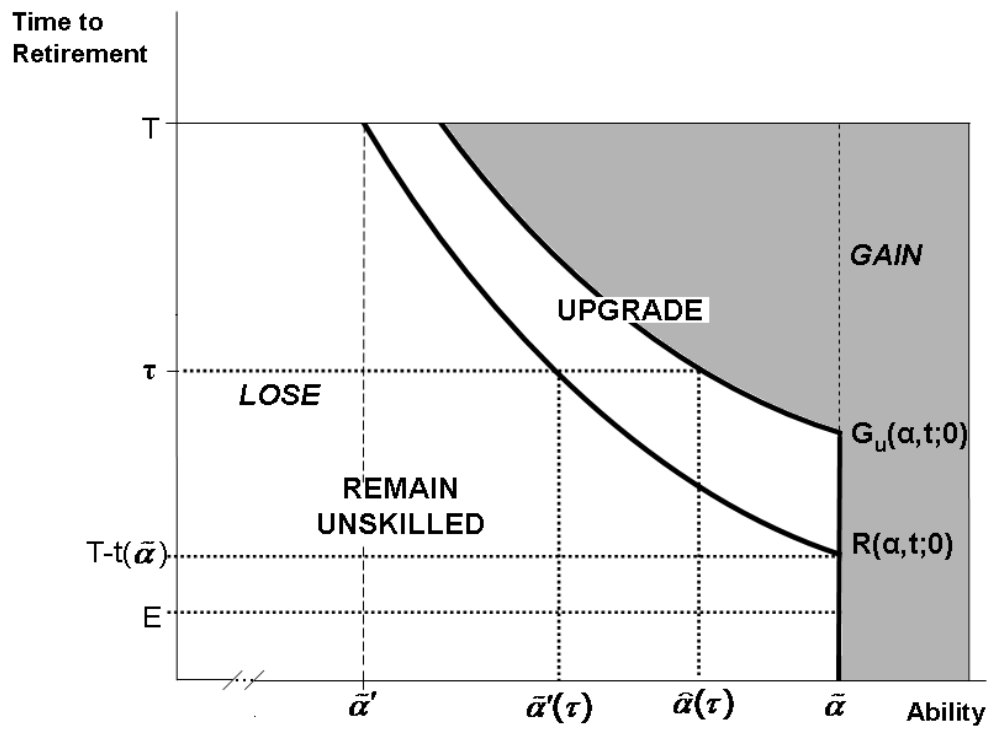
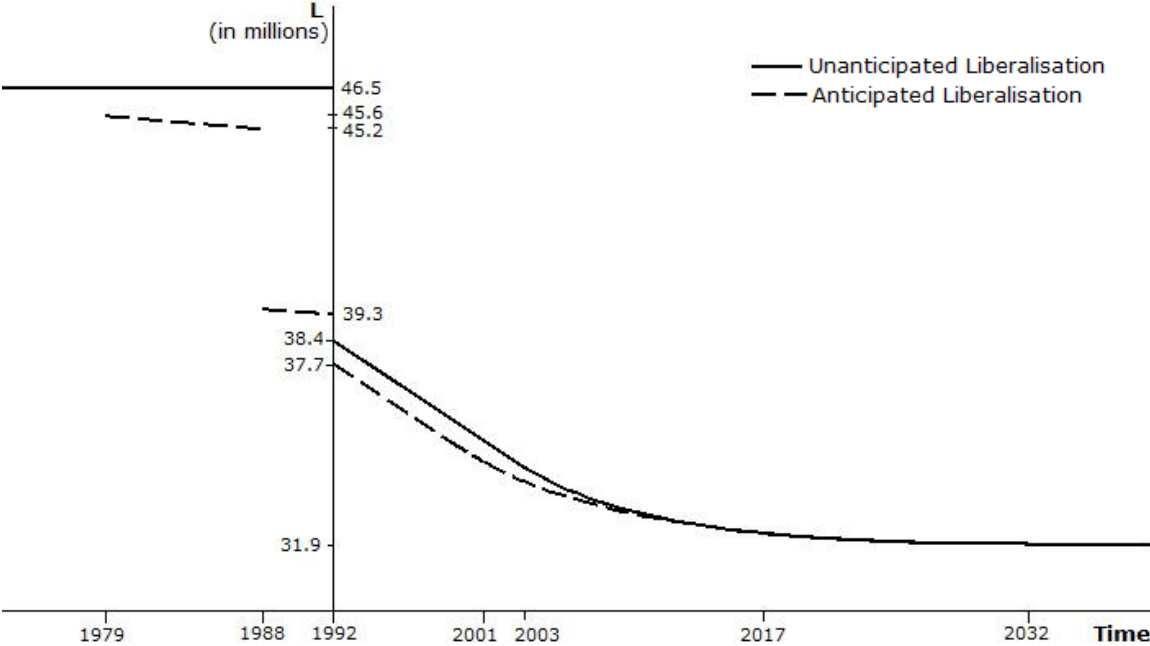


Figure 3: Adjustment of the unskilled labour supply to a trade liberalisation



Note: the liberalisation is in 1992, any announcement is in 1979.