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The Dynamic Effects of Skilled Labour Targeting in Immigration Programs

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Abstract

We consider the impact of the recent trend in immigration policies towards selecting migrants on the basis of skills. The analysis uses an inter-temporal general equilibrium model with endogenous skill formation. The model is calibrated to a steady state benchmark that represents Australia in 2000-2001. We then consider the impact of the increase in skilled migrants of approximately 20 thousand per year, which corresponds to the increase in flows of migrant *Professionals* in Australia since 2000. We find that this generates substantial crowding out of the higher Education sector in Australia. Moreover we show that, when this shock is anticipated as a permanent policy change, there is very little net increase in the stock of skilled labour due to falling student enrollments of 12%. Paradoxically, in this case, the decline in students increases the number of unskilled workers in the economy such that the ratio skilled to unskilled workers in the economy actually falls and the skill premium increases.

Keywords Immigration, Human Capital, Computable General Equilibrium Models.

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1. Introduction

According to Hatton and Williamson (2006) there is a major difference between the current era of globalization and the Globalization experience of the late 19th Century. Then the focus was on labour flows, whereas now it is mainly about trade. Nevertheless, over the last decade, flows of skilled labour from developing to developed countries have increased dramatically. The increase in labour flows is in part related to increased global supply of labour - particularly with the opening of China, India and the former Eastern Bloc (IMF 2007, Freeman 2006, Salt 1997). In addition, however, there has also been a sharp shift in demand for skilled immigrants in developed market economies. Many developed countries, including Australia, Canada, U.K. and Germany, have sought to take advantage of the foreign supply of skilled workers by tailoring their immigration programs to attract workers with skills (Cobb-Clarke 2004).¹ Moreover the USA appears to be moving towards skilled migrants with the Kennedy-Rodino Immigration Act of 1990 and immigration reform currently being considered at various levels of governments in the USA (Antecol *et al* 2003, The Economist 2007).

An extensive literature exists on the effects of skilled migration exists both from the host and source country perspectives. With respect to the host country much of the focus is on the effects on factor returns. There is relatively little literature on the effects of the increase in skilled labour inflows on the dynamics effects such as economic growth and the incentives for human capital accumulation. The aim of this paper is to consider these dynamic effects in a general equilibrium setting. In particular we focus on Australia where there has been a dramatic increase in skilled visa migrants in the last decade. The model emphasizes the effects on the accumulation of skills in Australia and other distributional impacts, such as wages and inter-sectoral effects.

We find that a change in the composition of migration towards high skilled labour has a substantial crowding out effect on the education sector in the Host country. Moreover, in the case of a permanent increase in skilled migration, there is almost full crowding out. We find that the inflow of professionals in Australia reduces student enrollments by a similar number resulting in very little increase in the supply of skilled workers. Paradoxically the fall in student enrollments causes an increase in the supply of unskilled labour. Hence an increase in

¹ According to Antecol *et al* (2003) a “points system” for screening a substantial portion of immigrant applicants was introduced in Canada in the late 1960s and a similar system was introduced in Australia in the early 1970s,

skilled labour migrant flows reduces the skill intensity of the economy and raises the skill premium

2. Background

The US literature on immigration has been quite tentative in endorsing skilled immigration as beneficial to the US. In particular Borjas (2006) emphasizes some negative impacts of skilled immigration on skilled wages and crowding out of university places by foreign students.² Borjas (1995) also emphasizes that the national welfare gains from immigration are very small. However Chellaraj et al (2004) have found evidence that skilled immigrants stimulate innovation in the USA. Likewise Ottaviano and Peri, (2006) and Peri, (2006) argue that, empirically, immigrants in the USA tend to have different skills to domestic labour and hence do not directly compete in the same labour market.

In Australia, however, where the points system has been in place since the 1970s, the literature on skill based immigration is more sanguine. In particular a number studies have indicated that the points system has contributed to better labour market outcomes for migrants (see Withers 1987, Miller 1999, Cobb-Clarke and Connolly 1997).³

Within the broad immigration literature, however, there is relatively little discussion on the longer term effects on the human capital supply in the host country.⁴ As an interesting point of contrast standard models in the “Brain Drain” literature recognize that the outflow of migrants increases the incentive for human capital investment among workers in the source country,

² Borjas (2006) such as finds that foreign students studying in the US reduces expected earnings on domestic students by 3-4%. Borjas, (2004) finds that foreign students crowd out domestic student enrollments across institutions.

³ As Cobb-Clarke and Connolly (1997) the skill level under the points system also depends on external factor also and in particular the immigration policies of other countries. See also Withers 1987 and

⁴ For example in a recent reports by The Productivity Commission (PC) and by the department of Immigration and Multicultural Affairs (2006) into skilled immigration in Australia is perhaps representative of the literature by modeling the accumulation of physical capital as endogenous, but leaving the accumulation of skills as an endogenous variable.

(Bagwati and Hamada 1974 and McCulloch and Yellen 1977).⁵ The flip side of this – that higher skilled immigrant inflows may crowd out education in the host country – has received very little attention.⁶ Clearly however it is an important issue in terms of understanding how the mix of skilled workers in the immigration programme affects the structure of the economy and the distribution of factor incomes.

2.1 The skilled visa Programme in Australia

Between 1990 and 1995 Australia halved the intake of permanent migrants from 120 thousand per year to around 60 thousand. Between 2000 and 2006, however, the intake more than doubled to 140 thousand immigrants per year. The remarkable feature of this change is that, while the number of Family Visa entrants stayed roughly constant at the 1999 level, the number of people entering under the skilled migrant quota increased dramatically (Productivity Commission 2006). This change in composition can be seen in Figure 1.⁷

The expansion of Skilled Visa's implies an increase in the average skill level of immigrants. According to the Productivity Commission (2006) approximately 65% percent of those entering under this visa category have a bachelors degree, or equivalent, or higher. Although this is a high fraction it is clear that the total intake of skilled visa migrants overstates the impact on domestic skill levels on the ratio of skilled workers in the labour force. To gain a clearer picture of this we consider the net flow of migrants who stated a skilled occupation.

⁵ More recent models such as Mountford (1997), Beine, Docquier and Rapaport (2001) and Stark and Wang (2002) include human capital externalities such that the expansion of education investment in the home country may have positive net positive benefits. For a survey of this literature see Commander, Kangasniemi and Winters (2002)

⁶ The possibility of crowding out has been acknowledged in the literature however. Examples in clued Chapman and Withers (2002) and Corden (2003). A rare empirical study is Baker and Wooden (1992). They investigate, but dismiss, the proposition that immigration acts as a deterrent to employer sponsored training programmes for domestic workers in Australia.

⁷ The official reason given for this policy - to address the so called "skills-shortage" - has been widely commented in Australia. Alternative explanations include political economy motives, such a response to the growth lobby. As discussed above however, there is a general view that skilled immigrants are more desirable as they contribute more to the Australian economy. It is widely argued however that the aggregate gains form natives from immigration are likely to be very small, Borjas (1995). Thus it is perhaps more interesting to consider the distributional impacts of skilled immigration. In particular what effect does it have on wages of skilled natives, on sectoral output shares and in particular, the education sector.

This data, presented in Figure 2 reveals that the increase in net inflow of skilled migrants has almost all been due to a net increase in *Professional* occupations.⁸

In terms of the impact on the labour supply in the economy this represents an increase in the annual intake from 0.10-0.15 % of the labour force in the mid 1990s to 0.28% of the labour force in 2004-2005. This represents an increase of the annual flow of professionals of 15 thousand per year from 1996-2005, or an increase of 20 thousand per year from 1999-2005. As argued above, and shown in Figure 1, however this increase in *Professionals* mainly represents a change in the composition of immigration flows. In particular the total number of migrants between 1995 and 2006 has been relatively constant.

3. Immigration and Skill Formation

To consider the effect of a change in the skill composition of immigration on human capital formation we employ a multi-sector computable general equilibrium model of growth due to Harris and Robertson (2005). The model has been employed elsewhere to quantify the interactions between trade and economic growth. In particular it incorporates endogenous skill formation. This section describes the human capital dynamics of the model which we modify to incorporate skilled immigration.

First we let the working population, or labour force, at time t be denoted P_t . The additions to the labour force have two sources, births and net immigrant flows. Let $m_t = M_t / P_t$ be the net immigration rate. Then allowing for retirements the net increase in the labour force is

$$P_{t+1} = (1 + b_t + m_t - d_t)P_t \quad (1.)$$

where b_t is the birth rate, d_t is the retirement rate. Thus once migrants enter the economy they form part of the representative household. At a point in time the labour force is defined in terms of skilled labour, LS , unskilled labour LU , and students, H .

$$P_t = LS_t + LU_t + H_t \quad (2.)$$

⁸ As stated by Birrell et al, this will exclude the onshore immigrants - students who undertook education in Australia and subsequently obtained a visa as most of these (93%) did not state an occupation when they applied for their visa.

The stock of skilled labour depends on past schooling decisions by unskilled workers and the skill level of past migrant flows. We denote the number of migrants who are skilled as $\gamma_t M_t$, where γ_t is the fraction of skilled migrants and is assumed to be an exogenous policy instrument. Thus increasing the skilled migrant intake can be interpreted as a change in γ_t .

The second source of skilled labour is the flow of students graduating each year and entering the skilled labour force. Thus we have $E_t = H_t / \zeta$ where H_t is the stock of students, E_t is the flow of graduates and ζ is number of years in school. The updating equation for skilled labour is then

$$LS_{t+1} = LS_t + H_t / \zeta + \gamma M_t - d LS_t \quad (3.)$$

3.1 The Steady State

It is useful to briefly consider the steady state constraints on migration and schooling flows. The ratio of skilled labour to population $\lambda = LS_t / P_t$ must be constant on steady state and hence LS_t must grow at the log run population growth rate. Likewise on a steady state the birth rate, b , retirement rate, d , and net migration rate, m , must be constant. Thus dividing (3.) by LS_t and re-arranging gives

$$\frac{H / \zeta + \gamma M}{LS} = b + m \quad (4.)$$

which shows that on a steady state the growth rate of human capital, LS , from migration and education must be constant. From this we can see that on a steady state path an increase in the skill intensity of the migrant population, γ , and no change in the total population growth rate $b+m$, then either (i) there must be an increase in LS or (ii) the annual flow of graduates, H / ζ must fall.

This holds irrespective of the nature of the dynamics, ie whether they are forward looking or recursive. Essentially any model of skill accumulation that permits a steady state, must exhibit a similar relationship between skilled labour inflows and education, as long as both types of skilled labour produce the same factor services.⁹

⁹ It is worth noting that some recent literature has emphasized the differences in factor services supplied by immigrant labour and domestic labour. This literature mainly refers to unskilled labour however There is no

Noting that $M/LS = m/\lambda$ is also constant on a steady state we can determine the required investment in schooling for any given demographic and policy variables.

$$\frac{H}{LS} = (b + m - \gamma m/\lambda)\zeta \equiv \sigma \quad (5.)$$

3.2 The Stock of Skilled Labour over a Transition

To model the transitional pattern of investment in schooling we consider a representative household who has members who are achieving schooling domestically and abroad. The foreign educated immigrants arrive exogenously from the household view since this is determined by the government's immigration quota.

Given this arrival of skilled (and unskilled) immigrants the household maximizes the present value of total labour incomes subject to on the job training costs faced by skilled labour. This is given by

$$\sum_{t=0}^{\infty} \frac{1}{1 + \rho^t} [u_{s,t} LS_t - u_t C(H_t, LS_t) + u_{u,t} LU_t - p_{e,t} A_t H_t] \quad (6.)$$

where $u_{s,t}$ is the after tax skilled wage, $u_{u,t}$ is the after tax unskilled wage, $p_{s,t}$ is the price of education, A_t is a technology parameter determining the quantity of education required to produce a skilled graduate, ρ is the households rate of time preference, and $C(H_t, LS_t)$ is the training costs function which plays the same rule as installation costs in the more general neoclassical model of investment.

We assume initially that on-the-job training costs apply only to domestic graduates and not to immigrants. This might be justified on the basis that skilled immigrants are selected according to particular "skills shortages" and will often have work experience. On the other hand it can be argued that immigrants also face significant training costs associate with language barriers and achieving local certification. An alternative assumption, that both immigrants and local graduates face symmetric on-the-job training costs, is considered below.

Noting that on a steady state we have $H = \sigma LS$ we initially we assume that the adjustment costs function takes the form

evidence to suggest that, for example, immigrant Doctors perform different services than domestically trained Doctors.

$$C = \frac{\alpha (H_t - \sigma LS_t)^2}{2 LS_t} \quad (7.)$$

Thus the size of the raining costs depend on deviations from the steady state growth path. The Household's objective is to maximize (6.) subject to (1.), (2.) and (3.). As show in the Appendix this gives the following demand function for education, which express as a demand for the stock of students relative to the current stock of skilled labour.

$$\frac{H_t}{LS_t} = \left(\frac{\hat{\Pi}_t / \zeta - u_{u,t} - p_{s,t} A_{s,t}}{\alpha u_{s,t}} \right) + \sigma \quad (8.)$$

where α is a parameter of the training cost function and $\hat{\Pi}_t$ is the Lagrange multiplier associated with the constraint (3.) and can be interpreted as the value of an additional unit of skilled labour.

Equation (8.) shows thus shows that, on a transition, variations in demand for students due to immigration will depend only on prices. In particular it will depend on the asset value of skilled labour relative to the current wage rate $\hat{\Pi}_t / u_{s,t}$, the relative unskilled wage, $u_{u,t} / u_{s,t}$, and the costs of education.

Further it may be noted that the adjustment cost parameter α enters in the dominator. Thus if the level of adjustment costs is large the term in brackets will tend to be smaller and H_t / LS_t will tend to be constant. Conversely if α is small H_t / LS_t may deviate a long way from the steady state level during a transition.

On the supply side education services are produced by a non-traded competitive industry which supplies these services at a supply price p_e . Education can be treated as a non-traded good or traded good. The production function for domestic education services is given by

$$y_e = \min[M^e, f^e(v^e)] \quad (9.)$$

This production function is constant returns in the vector of domestic factors v^e and in intermediate good input aggregate M^e which is defined by

$$M^i = \min_{j=1, \dots, n} \left[\frac{Y_{ji}}{a_{ji}} \right] \quad (10.)$$

Dual to the value added function $f^e(v^e)$ is a unit cost function $c^e(w)$. Factor demands are given by Shepherd's lemma applied to $c^e(w)$, which are then multiplied by the level of educational output y_e to give total demand. Note that in equilibrium price equal cost in the education sector so that

$$p_e = (1 - s^e) \left(c^e(w) + \sum_j a_{je} p^j \right) \quad (11.)$$

where the demand price p_e is net of any education subsidy provided at rate s^e . The total amount of educational output is given by

$$y_e = A_s H \quad (12.)$$

Thus the output of the educational sector is measured in units of person schooling per year (or students per year) efficiency adjusted. As economy wide technical change occurs more schooling output is required to produce skilled workers. This is to conform with the dynamic equations relating changes in schooling into units of skilled labour supply.

4. Experiment Design

To broadly capture the changes in Australian immigration policy over the last decade we consider the implications of an increase of 20000 immigrants. This is approximately the difference between the number of skilled immigrants arriving in 2006 and 1999. The change represents an increase of $\gamma m = 0.19\%$ of the labour force in 2006. As discussed above, over the longer term this increase has come at the expense of the family visa programme with little change in the total flow of immigrants. Thus the experiments we consider the total migration rate, m , is assumed to be constant since we focus on the skill composition of immigrants rather than the total number of immigrants. The experiment is therefore to increase the fraction of skilled immigrants γ while holding the migration rate, m , and birth rate b constant

It is useful to consider these changes in proportion to the relative stocks of students and skilled workers in Australia. The model is calibrated to an assumed steady state path in 2000. One stylized fact regarding Australian stocks of graduates is that it is not on a steady state. As documented by Dolman, Parham and Zheng (2006) LS/P in Australia is approximately 20% while in the USA it is 30%. In Australia's case however the stock is growing with more younger aged workers having bachelor degrees than older workers. With retirements Australia

should reach a steady state similar to that of the USA in about 2030. This means that the ratio H/LS in Australia is falling as the stock is accumulating. Thus the steady state ratios in the benchmark are calibrated using current USA ratios which differ slightly from the current Australian ratios.

It is unclear whether the increase in immigrant flows represents a temporary or a permanent policy change. We therefore first consider the implications of a temporary increase in γm and latter consider the implications of a permanent change. We begin by exploring the impactions of an unannounced increase in skilled immigrants which lasts 15 years, and is phased out by year 20.

5. Results

5.1 Unanticipated increases in skilled migrant quota.

Table 2 reports the effects of an unanticipated increase in skilled immigrants, but with no population change, for a variety of key variables. Further summary graphs showing the full transitional responses are presented in Figure 3. It can be seen that the increase has a fairly substantial effect on consumption and GDP, with GDP rising by 2% over 10 years and consumption by 2.5%. It is widely recognized that these are poor welfare measures however since they average over the impact on natives and the immigrants. In particular much of the “gains” in GDP will be captured by the migrants as payments to their labour services. Likewise it has often been pointed out that the gains to natives will also depend upon the composition of foreign debt and the structure of the tax system and distribution of public assets and public debt. The aim of the current analysis is therefore not to consider the welfare impacts but to consider the impacts different groups within the economy.

Bearing these factors in mind it can be seen that, nevertheless, the impact on GDP mainly reflects the increase in factor supplies. First note that there is a 5% increase in the supply of skilled labour. This is presumably the aim of policy and this increase reflects the skill level of the migrants, all of whom may be thought of as *Professionals* in this experiment relative to the domestic labour force. Following Krusell et al (2000) we assume a relatively high degree of capital skill complementarity based on their estimates. Hence exogenous increases in the supply of skilled labour are assumed to raise the marginal product of each type of capital. It can be seen in Figure 3 that the 5% increase in skilled workers results in a 2.5-3% increase in *Machinery and Equipment* capital and *Structures*. Hence it can be seen the increase in GDP

reflects substantial accumulation decisions of domestic residents. Thus while it is difficult to make welfare inferences it is clear that skilled immigration generates economic growth.

This accumulation of capital delivers benefits to skilled and unskilled labour in the longer term. In particular unskilled wages rise by 2% over the twenty year period, though skilled wages fall by 3.5%. This is very much in line with studies such as the Productivity Commission (2006) and EconTech (2006). For example the Productivity Commission found that a doubling of the skilled visa intake would call a 10% fall in the wages of Professionals. The experiment carried out here differences in a number of respects the broad number of skilled immigrants relative to the labour force base is similar.

However there is a very important difference. In this experiment the expansion of skilled immigration does not raise the skilled labour supply proportionally. For example the cumulative effect of the skilled migration increase is to introduce approximately 260 thousand professionals after 20 years. In this experiment however the skilled labour supply has increased only by 187 thousand workers above what it would have been otherwise. This shortfall is due to the cumulative effect of the fall in education investment with student enrollments falling. As can be seen in Figure 3 there is, upon announcement of the policy, an immediate fall in enrollments of approximately 5% which represents approximately 30 thousand students or 7 ½ thousand graduates per year.

Thus although there is still substantial accumulation of human capital and only a modest “crowding out” of domestic human capital formation this still represents a substantial adjustment for the education sector.¹⁰

5.2 Adjustment costs in the Skilled labour Market.

For the education sector the story from here on only gets worse. The preceding results suggest a small crowding out effect of education. This depends significantly on the on-the-job-training costs that occur in integrating newly skilled workers into their professions. The adjustment process is assumed to be relative to a steady state normal. Thus under normal working conditions flow of graduate recruits is planned for each year, If there is a large flow however then there are real costs in dealing with the excess. Intuitively, if these training costs

¹⁰ The analysis has only considered the arrival of offshore migrants. Recently there has also been a large increase in onshore migrants, most of which are foreign students studying in Australian universities. Thus the increase in foreign students in Australian universities is likely to be an important mitigating factor for the education sector.

are large, firms will resist having large changes in their graduate recruitment programme. If these adjustment costs are small however firms will be more willing to undertake transitional adjustments. These costs are fully anticipated by households in the education decisions.

In Figure 4 and Table 3 we report the results when the level of adjustment costs is reduced by a $\frac{1}{4}$ of the preceding results. With lower adjustment costs there is much more adjustment. Hence it can be seen that the effects with respect to education and the stock of skilled workers is now very substantial. In the low adjustment cost case there is a 8% fall in the stock of students on impact which falls to over 9.5% after 10 years. Consequently the effect on skilled labour stocks is now only half as much - 2.5% increase relative to the 5% increase in Figure 1. Likewise there is less accumulation of capital and much smaller changes in returns to labour. That is, with smaller adjustment costs the factor supplies tend to adjust more rather than factor returns.

The overall economy wide results are similar therefore except for the education sector which now bears the brunt of the redistribution impacts of immigration, as opposed to the incomes of skilled workers (professionals). Given the reduction in education outputs the wages of skilled workers only falls approximately 2.3 percent relative to 4.3 percent in the high adjustment cost scenario. Nevertheless the loss of enrollments of nearly 10% represents a truly massive adjustment for the education sector

5.3 A Permanent increase in Skilled Migration.

An alternative way to model the increase in migration flows is to consider a permanent increase in the volume of skilled migrants. In particular this is perhaps a more reasonable way to model expectations in so far as there is no announced plan to limit immigration flows in the future.

With a permanent change however the steady state value of σ , in equation (5.), will change. Thus, given an increase in the skilled worker fraction of the labour force of γm , there will be a long run reduction in H/LS by the amount $-\gamma M \zeta$. This is an important difference to the preceding temporary cases where the temporary increase in immigration had no impact on the parameters of the adjustment costs function. In this case the function itself must shift. The questions remain however as to whether H adjusts or LS adjusts and how quickly the economy reaches this long run target.

Figure 5 and Table 4 report summary results for the case of a permanent immigration shock. For this experiment we again assume that adjustment costs are relatively large, as in the case 1 presented in Figure 1. It be seen that there is substantial crowding out of the education sector which falls by 12%, and very little change in LS . Moreover this 12% fall is almost all attained on impact! Essentially this is because the adjustment costs cannot be avoided and are incurred immediately due to the shift in the adjustment cost function. Hence there is nothing to gain by delaying the adjustment of the size of the education sector.

A second notable feature of this result is that, whereas the previous experiments revealed a small fall in the relative supply of unskilled workers (because the increased inflow of skilled immigrants is assumed to occur at the expense of unskilled immigrants) that there is now 1.2 percent *increase* in the stock of skilled labour on impact. This apparent paradox is explained by the fall in student enrollments. All of the students who decide not to undertake domestic education end up as unskilled workers thus increasing the unskilled labour force. Figure 5 thus shows that a rise in skilled immigration reduces the ratio of skilled to unskilled workers and this occurs immediately. In short there is full crowding of the education sector and the decline in higher education enrollments raises the stock of skilled labour and increases in the skill premium. In short the plan to raise skill levels and reduce demand pressure on wages in professional occupations is a spectacular failure.

5. Conclusion

To summarize we have examined the effects of a change in the composition of the flow of immigrants. The data reflect the increase in professionals entering Australia under the expansion of the skilled visa programme that has occurred since 2000. Our focus has been on the effects on factor markets and the accumulation of factor supplies. The main question of inters is, who bears the burden of adjustment to this policy change?

We found that in each case there is substantial crowing out of the domestic education sector. Intuitively skilled immigrants depress wages of skilled occupations. The dynamic analysis shows however that this also reduces the incentive to attain higher education.

In the case of a permanent policy change the increase in skilled migrant flows led to a 12% fall in the education enrollments, a decrease in the ratio of skilled to unskilled workers and an increase in the skill premium. These results contrast with the initial temporary migration policy

changes which indicated much more modest levels of crowding out of education, though even these represent substantial, adjustment costs to the education sector.

In each case the aggregate benefits of immigration are positive. In particular in the case of a permanent shock, there are large consumption gains initially. These essentially reflect the consumption of the savings from higher education tuition by domestic residents. The theme of this analysis however has been on the distributional impacts of skilled immigration as is well known that the redistributive effects are large relative to net welfare gains.

Our results contrast with the existing literature which emphasizes the effects of immigration on wages. The results here show that, with endogenous supplies of skilled labour, the effects of skilled immigration on skilled wages are mitigated. Rather there is a supply response with a reduction in domestic production of skilled labour. This implies however that the burden of adjustment falls on the education sector. Moreover we have found shows that this “crowding out” effect may be very large and represents a very large negative impact on the education sector. Indeed with a permanent shock this “crowding-out” may be so large that skilled immigration effectively reduces the skill intensity of the labour force.

The analysis indicates that skilled immigration programs may not have the desired effect of raising the skill intensity of the labour force, or may only do so in a limited way. Moreover it suggests that, in the absence of other policies, the burden of adjustment falls on the *Education* sector, rather than the wages of skilled labour.

Appendix 1: Symmetric Adjustment Costs.

As suggested above, the model of of-the job training so far assumes that graduates face training costs whereas migrants do not. An alternative assumption is that an increase in any skilled labour in to the Australian labour market, irrespective of whether the new worker is a migrant or a graduate, induces the same type of on-the-job training costs. This gives an adjustment cost function equal to,

$$C = \frac{\alpha(H_t + \zeta \gamma M - \zeta(b+m)LS_t)^2}{2LS_t}. \quad (13.)$$

Thus we now regard the level of training costs as dependent on the flow of graduates and immigrants relative to the flow required for skilled labour stocks to balance with population growth, $b+m$. In many respects this is a more natural approach than the former one. The demand function becomes

$$\frac{H_t}{LS_t} = \left(\frac{\hat{\Pi}_t / \zeta - u_{u,t} - p_{ed,t} A_{ed,t}}{\alpha u_{s,t}} \right) - \frac{\gamma M \zeta}{LS_t} + \zeta(b+m) \quad (14.)$$

Equation (14.) is the same as (8.) except that in (14.) transitory changes in skilled migration now also shift the demand for schooling function. Moreover for a permanent an unchanging shock to γ will have the same effect on both demand functions. We therefore restrict attention to a temporary shock. The results for a temporary skilled migration with the symmetric adjustment cost function increase are presented in Figure 6. Further results are given in Table 5.

It can be seen that the effect on the *Education* sector is similar to the case above where the shock was assumed to be permanent, as shown in Figure 5. This reflects the fact that in both cases the influx of skilled migrants has a similar effect on the demand for schooling. Thus the Education sector again contracts approximately 12 percent on impact reflecting the fall in demand by the household for Education. This lasts until the influx ceases after 15 years. As in the case of the permanent shock there is an immediate increase in unskilled labour due to the fall in university enrollments and a mild fall in wages and an increase in the skill premium. Thus allowing for symmetric adjustment costs tends to strengthen the conclusion that the Education sector bears most of the burden of adjustment from skilled migration.

Appendix 2: The Optimal Education Decision

The Household's objective is to maximize (6.) subject to (1.), (2.) and (3.) .The Lagrangian is

$$\sum_{t=0}^{\infty} \frac{1}{1 + \rho^t} \left[u_{s,t} LS_t (1 - C(H_t, LS_t)) + u_{u,t} LU_t - p_s A_{s,t} H_t - \hat{\Pi}_t (LS_{t+1} - E_t - \gamma M_t - (1-d)LS_t) \right]$$

where $p_{s,t} A_{s,t} H_t$ is the direct cost of schooling. The household takes the relevant prices and wage rates as given. These are determined in a general equilibrium model taking account of inter-temporal preferences, optimal investment decisions and factor supplies, trade flows and world prices. This appendix thus describes the optimal education investment decision part of this general equilibrium model.. A full description of the model is given in Harris and Robertson (2007).

The first order conditions associated with the preceding Lagrangian are:

$$\frac{\partial L}{\partial E_t} = -u_{s,t} C_H(H_t, LS_t) \zeta - u_{u,t} \zeta - p_{s,t} A_{s,t} \zeta + \hat{\Pi}_t = 0 \quad (15.)$$

$$\frac{\partial L}{\partial LS_t} = -\hat{\Pi}_t + \frac{1}{1 + \rho} \left(u_{s,t+1} (1 - C_{LS}(\zeta E_{t+1}, LS_{t+1})) - u_{u,t+1} + (1-d)\hat{\Pi}_{t+1} \right) = 0 \quad (16.)$$

The adjustment costs depend on deviations from the steady state level of schooling investment.

$$C = \frac{\alpha (H_t - \sigma LS_t)^2}{2 LS_t} \quad (17.)$$

This gives

$$C_H = \alpha (H / LS - \sigma) \quad (18.)$$

Rearranging the first FOC gives,

$$\frac{\hat{\Pi}_t}{\zeta} = u_{s,t} C_H + u_{u,t} + p_s A_{s,t} \quad (19.)$$

Now we substitute for C_H to get,

$$\frac{H_t}{LS_t} = \left(\frac{\hat{\Pi}_t / \zeta - u_{u,t} - p_{s,t} A_{s,t}}{\alpha u_{s,t}} \right) + \sigma \quad (20.)$$

which is the demand for schooling function.

Steady state

On a balanced growth path the wage rates, $u_{u,t}$ $u_{s,t}$, and hence $\hat{\Pi}_t$ will be growing at the growth rate of productivity. To make the system stationary we define $\hat{\Pi}_t \equiv \Pi_t A_{s,t}$. Equation (16.) becomes

$$A_{s,t} \Pi_t (1 + \rho) = \left(A_{s,t+1} u_{s,t+1} (1 - C_{LS}(\zeta E_{t+1}, LS_{t+1})) - A_{u,t+1} u_{u,t+1} + (1 - d) A_{s,t+1} \Pi_{t+1} \right) \quad (21.)$$

On a steady state we have $\Pi_t = \Pi_{t+1}$, $u_{s,t} = u_{s,t+1}$, $u_{u,t} = u_{u,t+1}$ and $C_{LS} = 0$. Let the ratio of efficiency units of unskilled to skilled labour be $A_u / A_s \equiv \tau$. Further note that $A_{s,t+1} / A_{s,t} = 1 + g$. Hence

$$\Pi^* (1 + \rho) = (1 + g) u_s^* - \tau u_u^* + (1 - d)(1 + g) \Pi^*$$

Re-arranging gives

$$\Pi^* = \frac{1 + g}{(1 + \rho) - (1 - d)(1 + g)} [u_s^* - \tau u_u^*] \quad (22.)$$

or

$$\Pi^* = \Delta [u_s^* - \tau u_u^*] \quad (23.)$$

where

$$\Delta \equiv \frac{1 + g}{(1 + \rho) - (1 - d)(1 + g)} \quad (24.)$$

Similarly in a steady state, using (19.) or (8.) and (5.) we show that

$$\Pi_t / \zeta - \tau u_{u,t} - p_{s,t} = 0 \quad (25.)$$

so that

$$\Pi^* = \zeta (\tau u_u^* + p_s^*) \quad (26.)$$

Combining these expressions gives the steady state relationship between the skill premium and the price of education.

$$u_s^* \Delta - u_u^* \tau (\Delta - \zeta) = \zeta p_s^* \quad (27.)$$

For expositional purposes the parameter τ can be normalized to unity giving

$$u_s^* = \frac{(u_u^* + p_s^*)\zeta}{\Delta} + u_u^* \quad (28.)$$

Thus the skill premium depends on the number of years of schooling it takes to become “skilled” and the market price of education, which reflects firm’s unit costs and government taxes and subsidies, and the value Δ .

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Table 1: Key Parameter Values

Parameter Values	
<i>CET Revenue Function Parameters</i>	
Elasticity of substitution in CET revenue Functions - <i>Agriculture</i>	3.9
Elasticity of substitution in CET revenue Functions - <i>Minerals</i>	2.9
Elasticity of substitution in CET revenue Functions - <i>Low Tech</i>	2.9
Elasticity of substitution in CET revenue Functions - <i>Intermediate Manufactures</i>	2.9
Elasticity of substitution in CET revenue Functions - <i>Durables</i>	2.9
Elasticity of substitution in CET revenue Functions - <i>Traded Services</i>	0.7
<i>Nested CES Cost Function Parameters</i>	
Elasticity of Substitution between all Reproducible Capital types and <i>Unskilled Labour, Resources and</i>	0.67
Elasticity of Substitution between all <i>Machinery, Structures, and Housing</i> Capital	1.67
<i>CES Spending Aggregates</i>	
Elasticity of Substitution in Expenditure Functions - <i>Consumption</i>	1.2
Elasticity of Substitution in Expenditure Functions - <i>Government</i>	1.2
Elasticity of Substitution in Expenditure Functions - Investment in <i>Machinery and Equipment</i>	1.2
Elasticity of Substitution in Expenditure Functions - Investment in <i>Structures</i>	1.2
Elasticity of Substitution in Expenditure Functions - Investment in <i>Residential Housing</i>	1.2

Table 2: Temporary Increase in Skilled Migrant Flows – Low Adjustment Costs

Transitional Responses (% Change)				
	Year 1	Year 5	Year 10	Year 100
Real GDP per capita	0.1	0.6	1.1	0.1
Real Consumption per capita	0.0	0.1	0.6	0.1
Investment in Machinery and Equipment	1.2	1.5	1.6	0.0
Investment in Structures	1.2	1.4	1.4	0.0
Investment in Housing	0.5	0.6	0.6	0.0
Machines per unskilled worker	-0.5	1.0	2.7	0.1
Structures per unskilled worker	-0.5	0.8	2.3	0.2
Residential per unskilled worker	-0.5	0.4	1.5	0.1
Real return to Machine and Equipment	0.2	0.2	0.2	0.0
Real return to Structures	0.1	0.3	0.4	0.0
Real return to Housing	0.0	-0.1	0.2	0.0
Real Skilled wages	-0.1	-1.0	-1.9	-0.1
Real Unskilled wages	-0.2	0.5	1.2	0.1
Land rents	-0.1	0.1	0.4	0.0
Resource rent	0.1	0.5	0.8	0.0
Skill Premium	0.2	-1.5	-3.1	-0.2
Price of Education relative to w_u	0.2	-0.9	-2.0	-0.1
Students	-5.4	-5.0	-4.2	0.1
Ls/Lu	-0.5	1.6	3.9	0.2
Internal Exchange Rate (p_T/p_{NT})	0.1	0.2	0.3	0.0
Terms of Trade	-0.1	-0.1	-0.1	0.0
Trade Surplus	0.0	0.1	0.1	0.0
Openness	0.1	-0.1	-0.3	0.0

Transitional Sectoral Responses (% Change from Base Case Scenario)				
	Year 1	Year 5	Year 10	Year 100
Agriculture	-0.1	-0.3	-0.5	0.0
Minerals	0.0	0.4	0.6	0.0
Lowtech	0.6	1.2	1.9	0.1
Intermediate Manufacture	0.2	1.0	1.6	0.1
Durables	1.4	3.9	5.3	0.1
Traded_Services	0.2	0.7	1.4	0.1
Construction	0.7	1.2	1.6	0.1
Non Traded Services	0.2	0.5	1.0	0.0
Public	0.1	0.8	1.7	0.1
Housing	0.0	0.2	0.4	0.1
Education	-5.4	-5.0	-4.2	0.1

Table 3: Temporary Increase in Skilled Migrant Flows – Low Adjustment Costs

Transitional Responses (% Change)				
	Year 1	Year 5	Year 10	Year 100
Real GDP per capita	0.2	0.6	0.8	0.0
Real Consumption per capita	0.0	0.4	0.8	0.0
Investment in Machinery and Equipment	1.1	1.0	0.8	0.0
Investment in Structures	0.8	0.8	0.6	0.0
Investment in Housing	0.9	0.9	0.7	0.0
Machines per unskilled worker	-0.8	0.3	1.1	0.0
Structures per unskilled worker	-0.8	0.0	0.7	0.0
Residential per unskilled worker	-0.8	-0.1	0.5	0.0
Real return to Machine and Equipment	0.4	0.2	0.1	0.0
Real return to Structures	0.2	0.3	0.3	0.0
Real return to Housing	0.0	0.1	0.3	0.0
Real Skilled wages	-0.1	-0.6	-1.0	0.0
Real Unskilled wages	-0.3	0.1	0.4	0.0
Land rents	0.0	0.3	0.6	0.0
Resource rent	0.3	0.5	0.5	0.0
Skill Premium	0.2	-0.7	-1.4	0.0
Price of Education relative to w_u	0.2	-0.4	-0.8	0.0
Students	-8.0	-8.7	-8.9	0.0
Ls/Lu	-0.8	0.4	1.4	0.0
Internal Exchange Rate (p_T/p_{NT})	0.1	0.1	0.1	0.0
Terms of Trade	0.0	-0.1	-0.1	0.0
Trade Surplus	0.1	0.1	0.1	0.0
Openness	0.1	0.0	-0.2	0.0

Transitional Sectoral Responses (% Change from Base Case Scenario)				
	Year 1	Year 5	Year 10	Year 100
Agriculture	0.2	0.2	0.2	0.0
Minerals	0.1	0.4	0.4	0.0
Lowtech	0.7	1.2	1.5	0.0
Intermediate Manufacture	0.5	1.1	1.3	0.0
Durables	2.3	3.4	3.6	0.0
Traded_Services	0.3	0.8	1.2	0.0
Construction	0.7	1.0	1.2	0.0
Non Traded Services	0.3	0.6	1.0	0.0
Public	0.2	0.7	1.2	0.0
Housing	0.0	0.2	0.5	0.0
Education	-8.0	-8.7	-8.9	0.0

Table 4: Permanent Increase in Skilled Migrant Inflows

Transitional Responses (% Change)				
	Year 1	Year 5	Year 10	Year 100
Real GDP per capita	0.3	0.4	0.6	0.7
Real Consumption per capita	0.9	0.7	0.8	1.1
Investment in Machinery and Equipment	0.4	0.4	0.3	0.3
Investment in Structures	0.1	0.2	0.1	0.0
Investment in Housing	1.1	1.0	0.8	0.6
Machines per unskilled worker	-1.1	-0.7	-0.4	0.0
Structures per unskilled worker	-1.1	-0.9	-0.6	-0.2
Residential per unskilled worker	-1.1	-0.7	-0.4	0.4
Real return to Machine and Equipment	0.3	0.2	0.0	0.0
Real return to Structures	-0.1	0.1	0.1	0.0
Real return to Housing	1.2	0.4	0.2	0.0
Real Skilled wages	-0.3	-0.1	0.0	-0.1
Real Unskilled wages	-0.7	-0.5	-0.4	-0.2
Land rents	0.9	0.6	0.6	0.7
Resource rent	-0.4	0.2	0.3	0.4
Skill Premium	0.4	0.3	0.3	0.0
Price of Education relative to w_u	0.4	0.3	0.3	0.0
Students	-12.4	-12.3	-12.3	-12.3
Ls/Lu	-1.1	-1.0	-0.9	-0.4
Internal Exchange Rate (p_T/p_{NT})	-0.1	0.0	0.0	0.1
Terms of Trade	-0.2	-0.1	-0.1	-0.2
Trade Surplus	-0.3	0.0	0.1	0.0
Openness	-0.2	-0.1	-0.1	-0.2

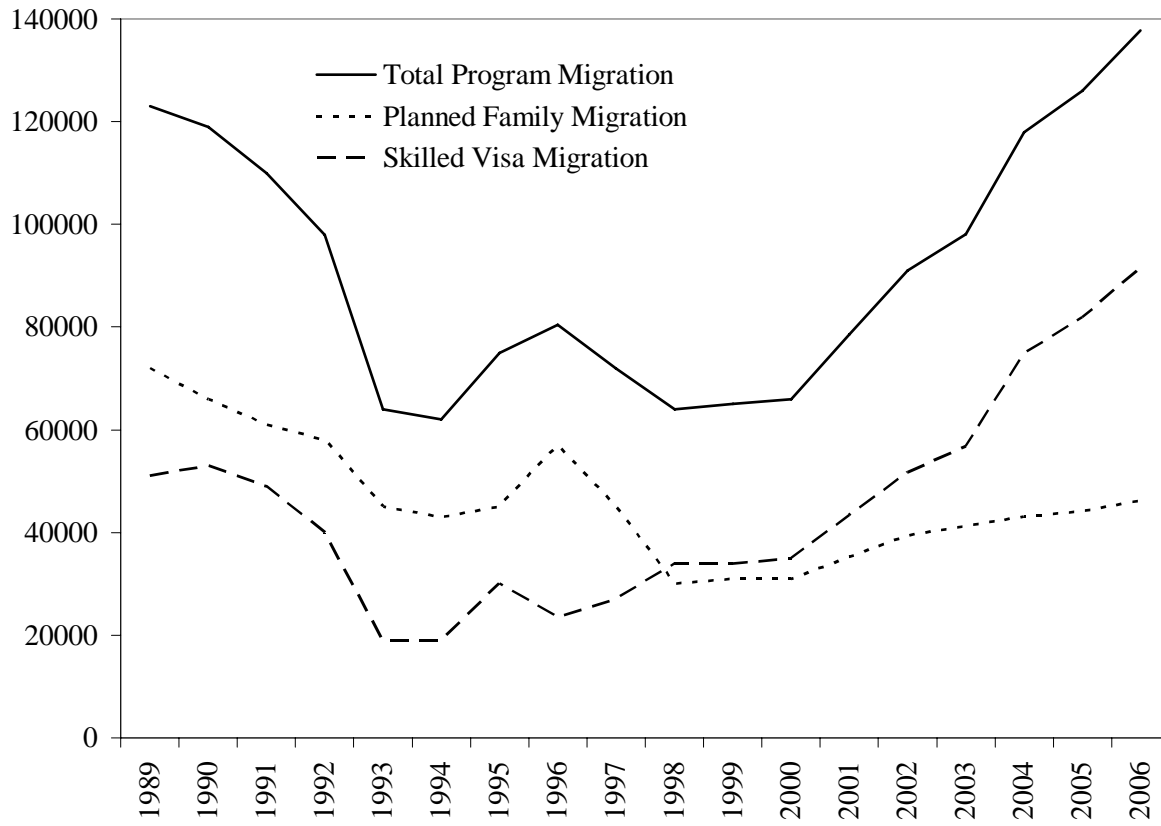
Transitional Sectoral Responses (% Change from Base Case Scenario)				
	Year 1	Year 5	Year 10	Year 100
Agriculture	0.4	0.6	0.7	0.7
Minerals	-0.4	0.2	0.4	0.5
Lowtech	0.8	1.0	1.2	1.3
Intermediate Manufacture	0.1	0.8	1.0	1.1
Durables	0.2	2.1	2.2	2.1
Traded_Services	0.8	0.8	1.0	1.2
Construction	0.7	0.8	0.9	1.0
Non Traded Services	0.8	0.8	0.9	1.1
Public	0.6	0.6	0.7	0.9
Housing	0.2	0.3	0.6	1.0
Education	-12.4	-12.3	-12.3	-12.3

Table 5: Temporary Increase in Skilled Migrant Flows – Symmetric Adjustment Costs

Transitional Responses (% Change)				
	Year 1	Year 5	Year 10	Year 100
Real GDP per capita	0.3	0.5	0.5	0.0
Real Consumption per capita	0.1	0.6	0.9	0.0
Investment in Machinery and Equipment	0.9	0.4	0.1	0.0
Investment in Structures	0.4	0.1	-0.2	0.0
Investment in Housing	1.2	1.0	0.7	0.0
Machines per unskilled worker	-1.1	-0.6	-0.4	0.0
Structures per unskilled worker	-1.1	-0.8	-0.7	0.0
Residential per unskilled worker	-1.1	-0.7	-0.3	0.0
Real return to Machine and Equipment	0.7	0.1	0.0	0.0
Real return to Structures	0.4	0.2	0.1	0.0
Real return to Housing	0.1	0.4	0.4	0.0
Real Skilled wages	-0.3	-0.1	-0.1	0.0
Real Unskilled wages	-0.5	-0.4	-0.4	0.0
Land rents	0.2	0.5	0.7	0.0
Resource rent	0.5	0.3	0.2	0.0
Skill Premium	0.2	0.3	0.3	0.0
Price of Education relative to w_u	0.3	0.3	0.2	0.0
Students	-12.2	-12.3	-12.3	0.0
Ls/Lu	-1.1	-1.0	-0.8	0.0
Internal Exchange Rate (p_T/p_{NT})	0.1	0.0	0.0	0.0
Terms of Trade	0.0	-0.1	-0.1	0.0
Trade Surplus	0.2	0.1	0.0	0.0
Openness	0.2	0.0	-0.1	0.0

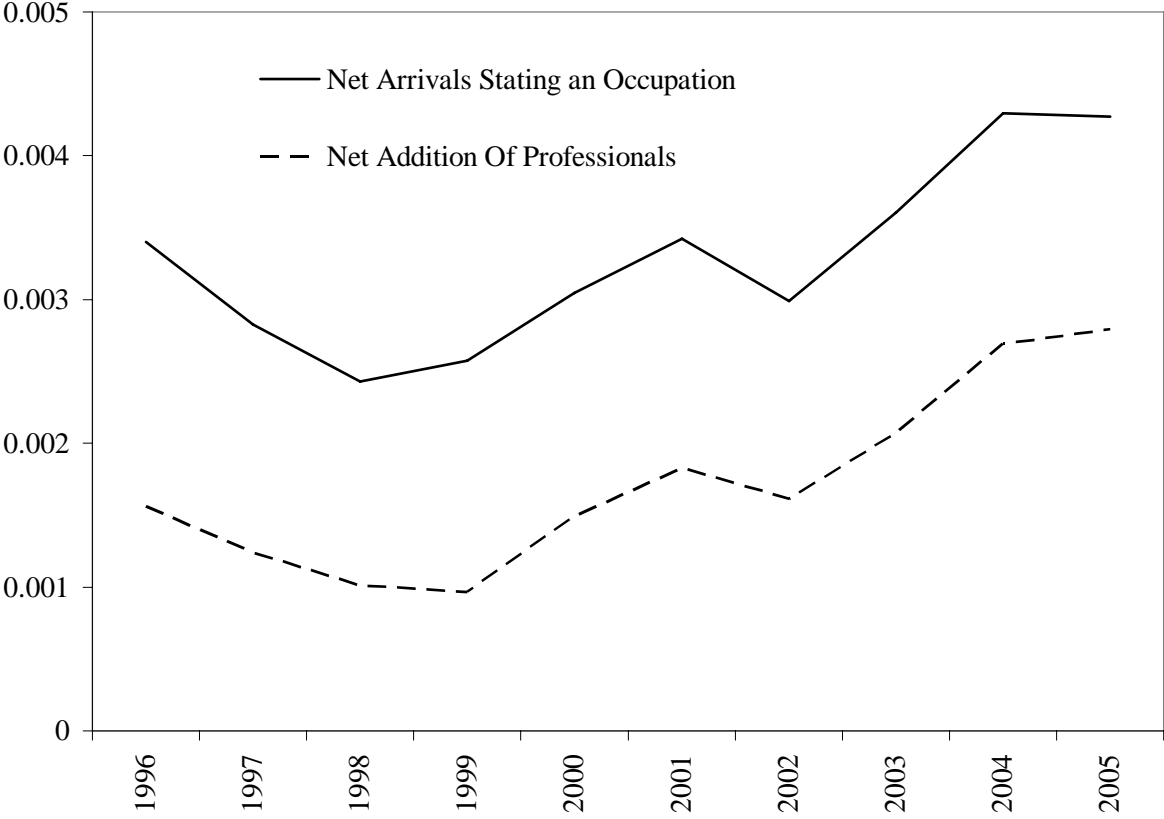
Transitional Sectoral Responses (% Change from Base Case Scenario)				
	Year 1	Year 5	Year 10	Year 100
Agriculture	0.5	0.6	0.7	0.0
Minerals	0.4	0.3	0.2	0.0
Lowtech	1.0	1.1	1.1	0.0
Intermediate Manufacture	1.0	1.0	0.9	0.0
Durables	3.6	2.5	1.8	0.0
Traded_Services	0.5	0.8	1.0	0.0
Construction	0.8	0.9	0.8	0.0
Non Traded Services	0.4	0.8	0.9	0.0
Public	0.4	0.6	0.7	0.0
Housing	0.0	0.3	0.6	0.0
Education	-12.2	-12.3	-12.3	0.0

Figure 1. Program Immigration Flows



Source: Productivity Commission 2006, DIMIA 2003, DIMIA 2006.

Figure 2. Net Flows of Skilled Immigrants stating an Occupation



Source Birrell et al (2006)

Figure 3: Temporary Skilled Migration Policy Change – High on-the-job Training Costs

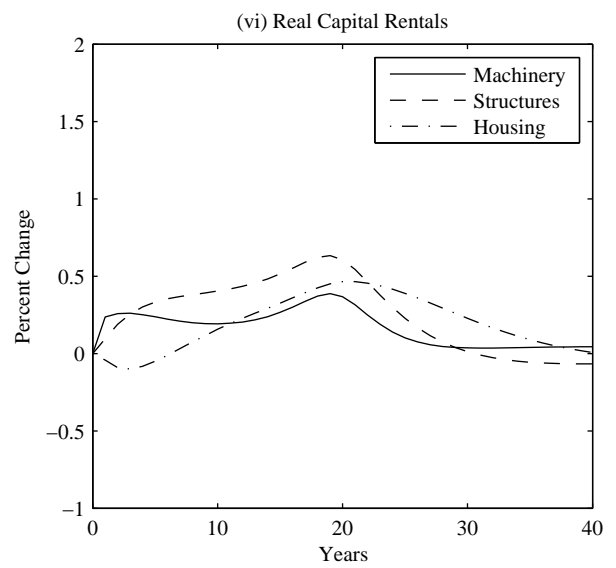
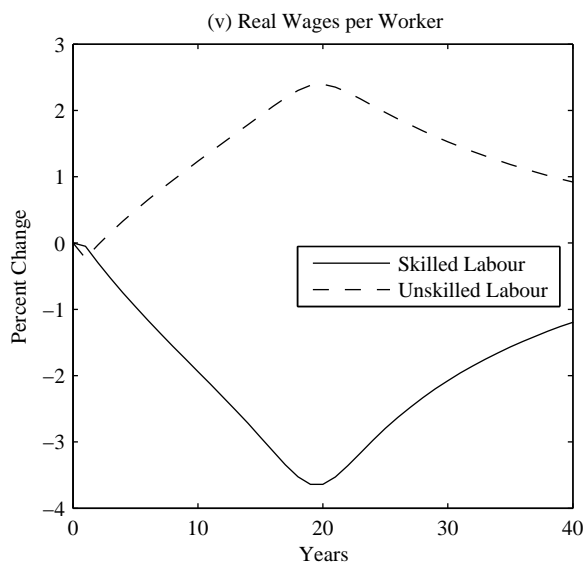
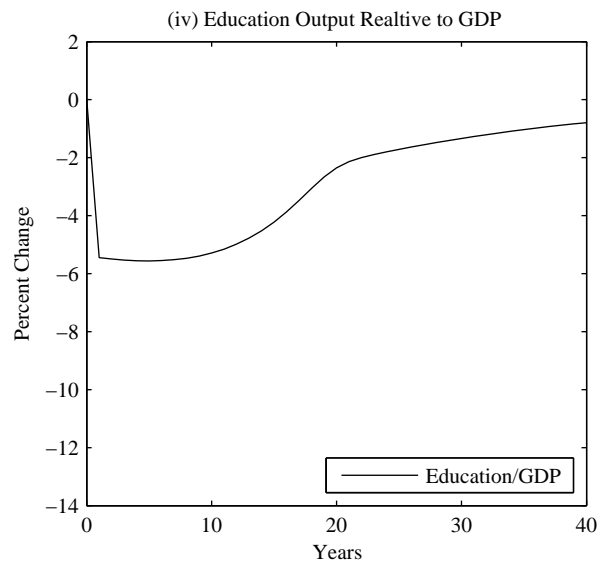
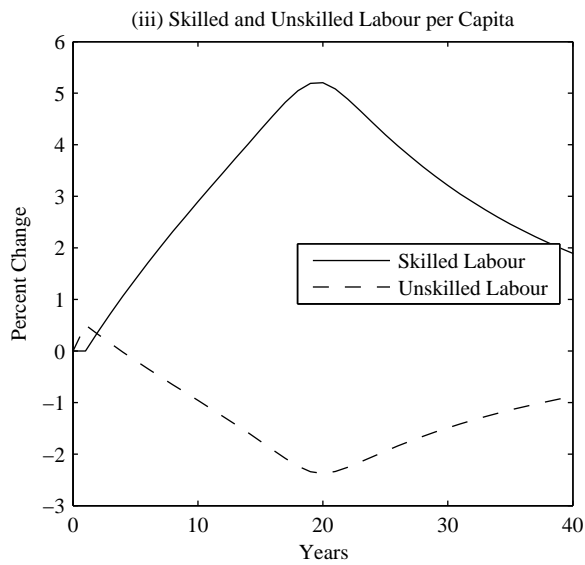
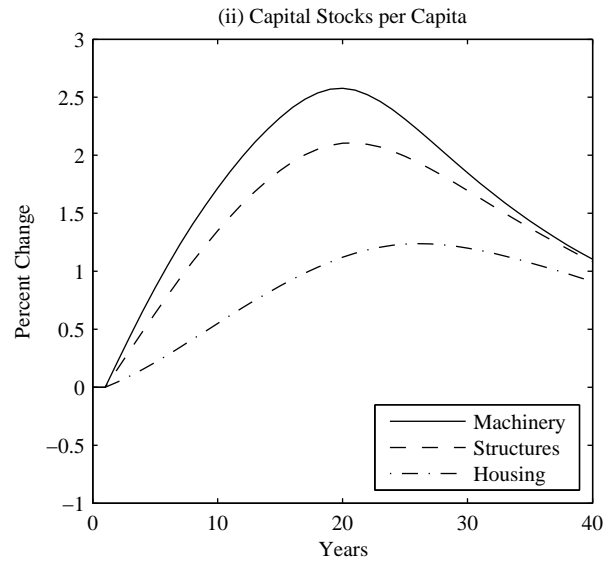
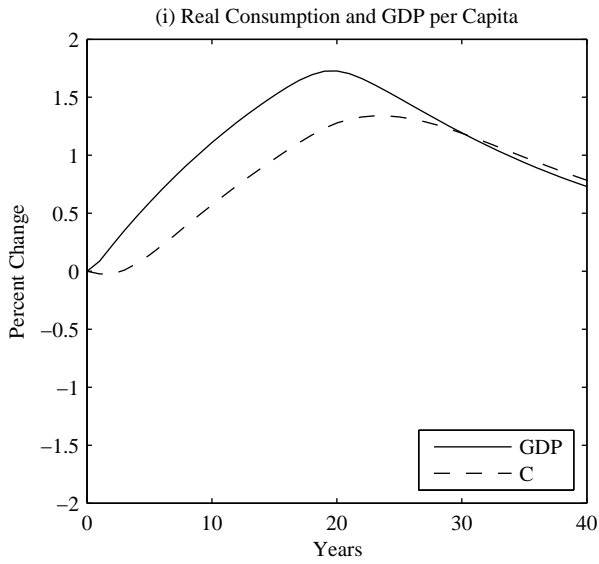


Figure 4: Temporary Skilled Migration Policy Change – Low on-the-job Training Costs

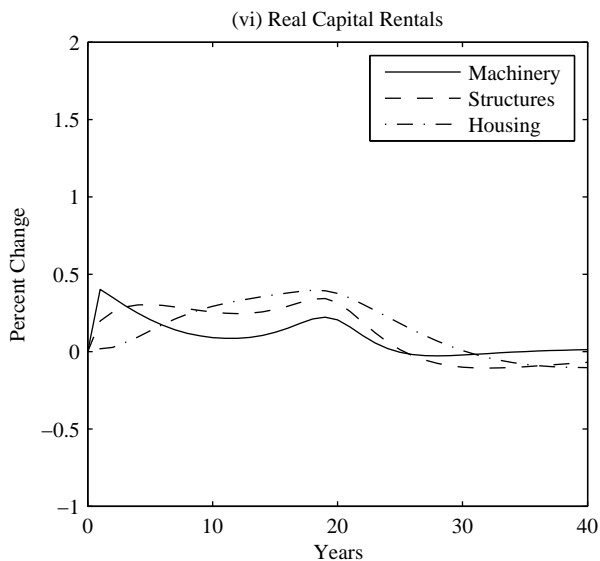
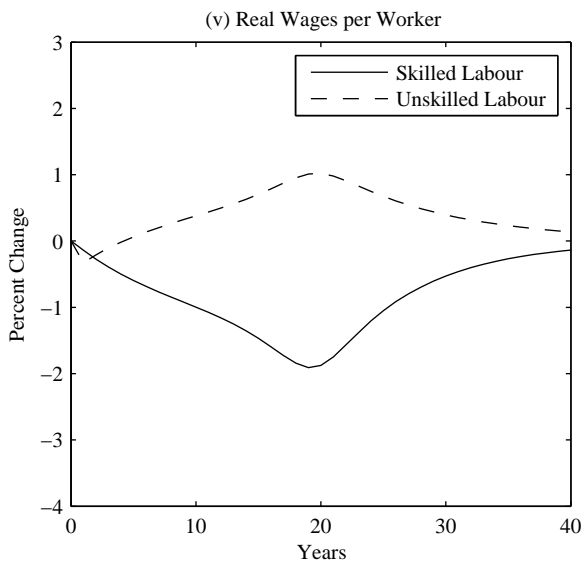
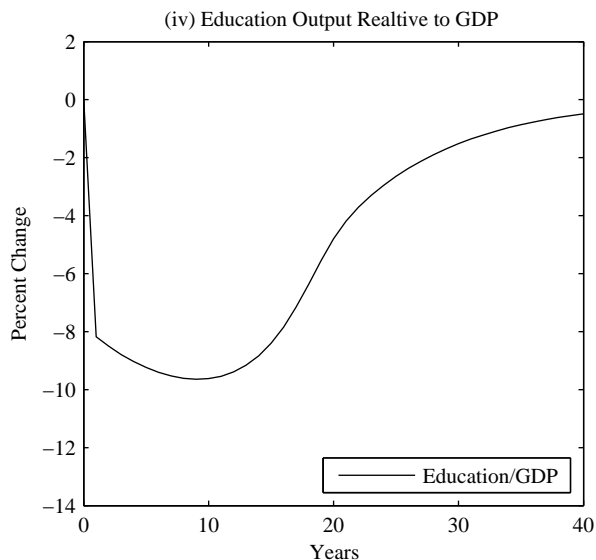
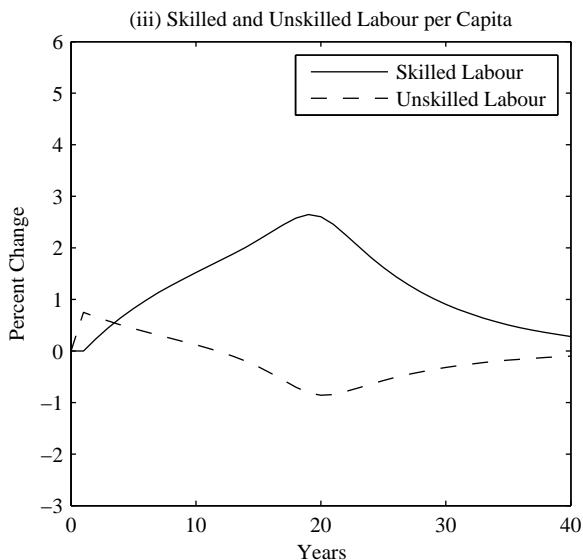
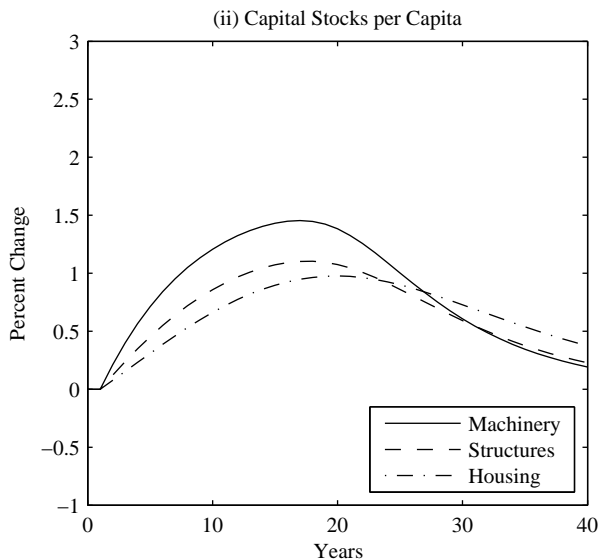
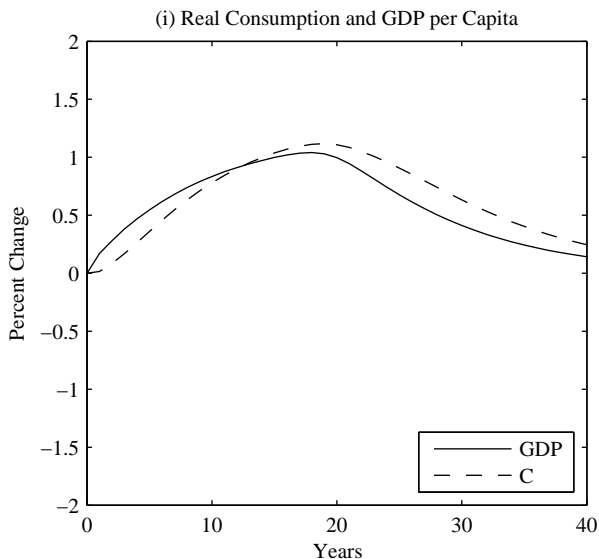


Figure 5: Permanent Skilled Migration Policy Change

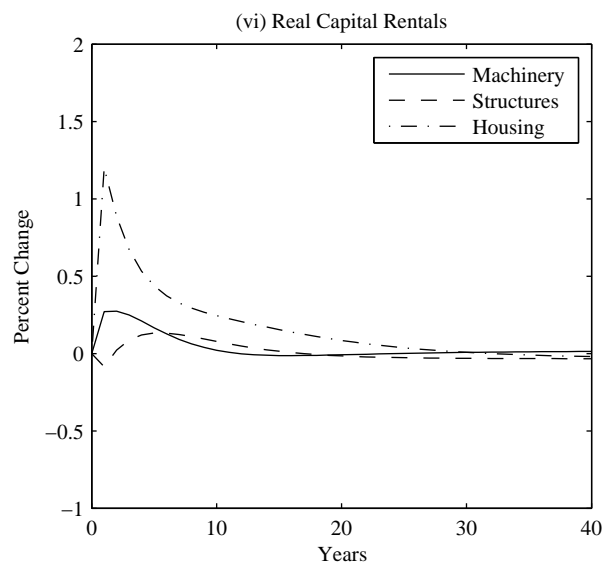
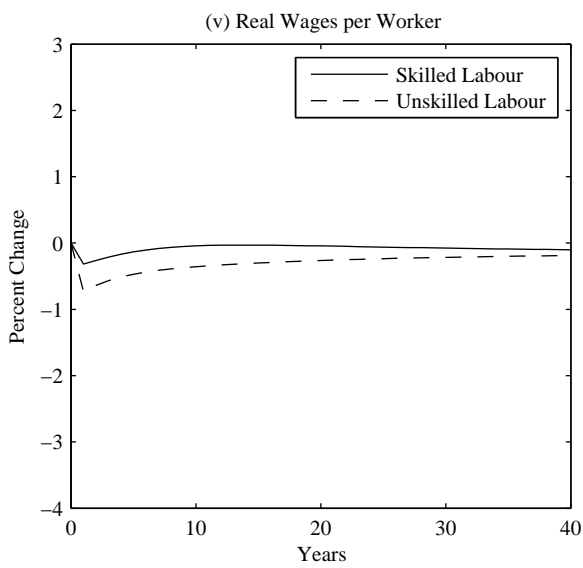
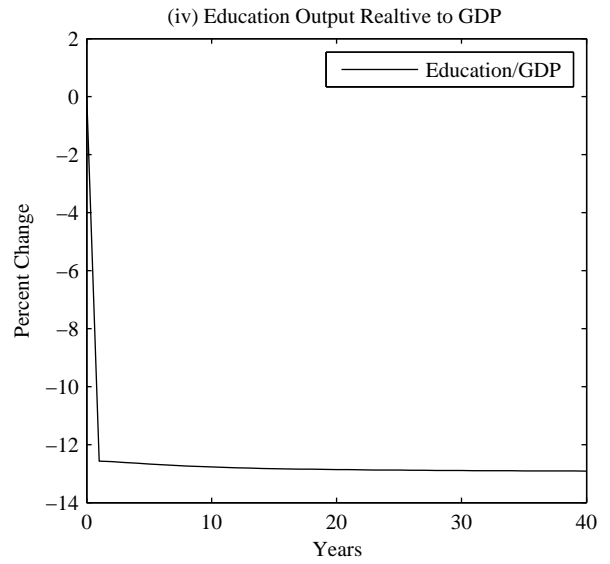
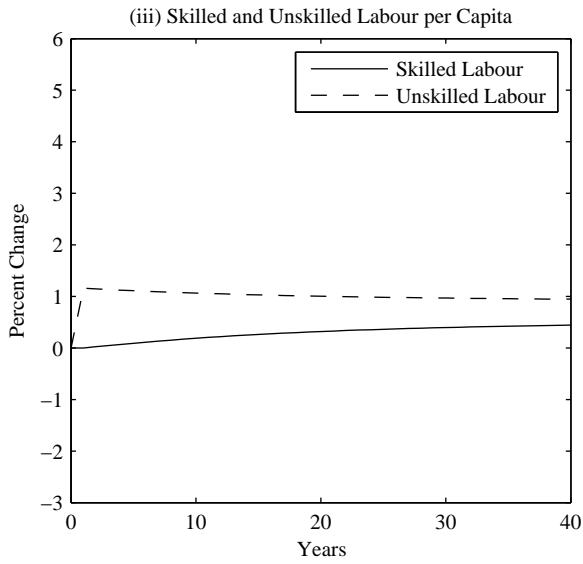
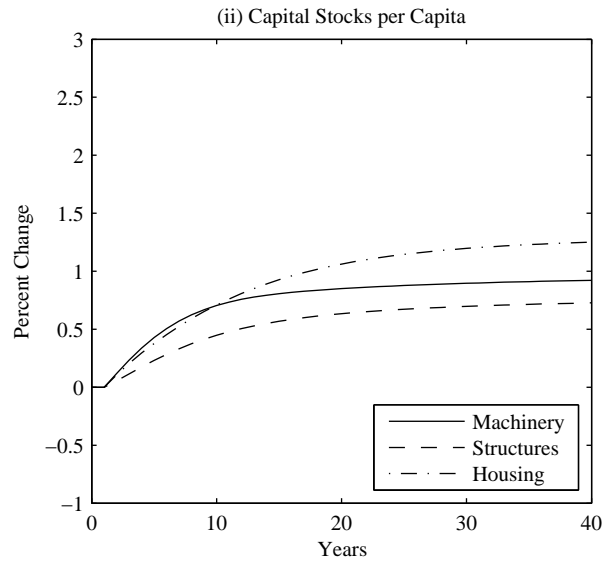
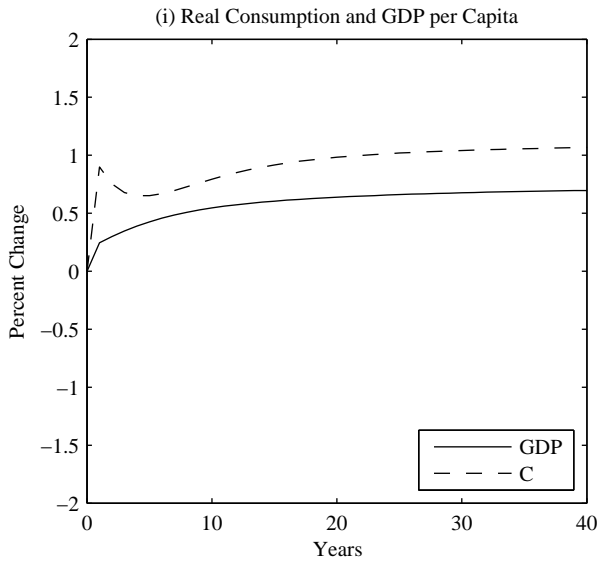


Figure 6: Temporary Skilled Migration Policy Change – Alternative on-the-job Training Cost Function

