literature has often termed the “immigration surplus” (IS). The standard approach for measuring this variable in a competitive economy, confined mostly to the destination country, is based on a static framework in which the capital stock is a given constant, labor is homogeneous, and aggregate production is subject to CRTS. The “surplus” is then necessarily positive in destination, provided that wages fall. Specifically, if the derived-demand for labor is downward-sloping, the increased labor supply due to migration causes an increase in total output but a fall in the wage bill of native workers. At the same time, the positive returns to capital in destination more than outweigh the fall in the wage bill so the average native wins. By the same analysis, the wage bill in the source country rises with emigration, which results in a negative surplus in that country.

Variations in this “static approach” allowing for heterogeneous skills of natives and migrants and adjustments in the economy’s capital stock affect the magnitude of the IS in the destination country, but generally not its sign. Since migration is treated as an exogenous event, most measures of IS in the standard approach evaluate the effect of immigration starting with an equilibrium state with zero immigration. The IS thus measured is typically found to be less than 1% (see Borjas, 1995).

The IS measurement differs in our model for two reasons: it treats migration as an endogenous variable and accounts for the way immigration interacts with the economies of both destination and source countries when both move dynamically along balanced growth equilibrium paths. In this context, as our analysis in item (ii) of section IV.2 part b has shown, the SBTS-induced rise in composition of skilled migrants can generate a differential increase in both the average human capital and wage levels in the economy over the transitional dynamic phase following the shock, as well as along the steady state growth equilibrium path in the destination country. The existence of a positive immigration surplus in the destination country no longer requires, therefore, a simultaneous reduction in the average wage rate and even in the wage rate of skilled workers in the long-term.

We compute two measures of the long-term IS based on the two models simulated in sections IV.2 and V – the benchmark model in which there is no interaction between natives and immigrants in knowledge production, and in the extended model which allows such interaction. To emphasize the comparison with the traditional measures of IS we focus below on IS measurement in the destination country.

Since immigration is an endogenous variable, we first compute it starting from an initial global equilibrium in which total migration and its skill composition are positive, not zero. It is simulated as the percentage difference in the full income per capita experienced by natives in D and S following a skill-biased technological shock (SBTS) under 2 scenarios (similar to the method we use in part B of section

IV.2): a. when the skill composition of migrants is free to adjust following the SBTS; b. when the skill composition is confined by an immigration policy restricting it to remain fixed at its initial level. The difference (a-b) represents the net benefit from the *unrestricted* scenario. The IS thus measured is "partial" in the sense that it captures the net benefits from free immigration in D just over the transitional dynamic path following the SBTS. Note that since a new steady state can occur only if immigration is *unrestricted* – under the restricted case the economy cannot attain a balanced growth equilibrium – the IS measurement must be limited to a finite number of generations following the SBTS.

In our benchmark model, the resulting estimated values of IS in the destination country are summarized in part A of Table 3 after 5, 10, and 15 generations following the technological shock. The results are presented for alternative per-capita welfare indicators: human capital formation, full income, consumption, and individual utility. The highest measure amounts to an increase of 1.48% in the natives' full income per-capita (FIPC) after a period of 15 generations. This long period is selected because it gets closer to the period in which the economy approaches a new steady state under the unrestricted immigration case. In part A of Table 4 the same IS measure is illustrated in terms of a 0.003 (=4.142-4.139) percentage points reduction in the average annual growth rate of FIPC following the SBTS in the restricted, relative to the unrestricted, migration case.

Alternatively we provide quantitative measures of the "full" immigration surplus under two different scenarios: a. when the share of skilled migrants among all migrants in D is freely determined at an initial steady state of balanced growth; b. when either skilled or unskilled migration is disallowed. These estimates are presented in parts B and C of Table 3. If skilled migration is disallowed altogether, the difference in full income per-capita between the restricted and unrestricted cases is more pronounced than in the benchmark case, amounting to IS = 79.8% of the FIPC after 15 generations or a persistent 0.376 percentage points (=4.142-3.766) gain in the latter's annual growth rate over the 15-generations period (see part B of Table 4). The opposite outcome occurs, however, when the destination country disallows any unskilled migration. Here natives experience a gain of 33.0% in FIPC after 15 generations (IS = -33.0%) or, alternatively, a gain in the FIPC annual growth rate of 0.068 percentage points (=4.142-4.200) from the *restricted* relative to the unrestricted immigration case over a 15-generations period (see part C of Tables 3 and 4).

Larger estimates of IS are computed in our extended model, which allows for positive complementarities or "diversity effects" in knowledge production across natives and immigrants of the same skill groups as modeled in section V. By this model, the IS in the case where all migration is disallowed in the destination country amounts to a persistent gain of 0.593 percentage points (=4.803-4.210) in the annual growth rate of full income per-capita after 15 generations (see part E of Table 4).

In the last columns of Tables 3 and 4 we report the IS estimates for the *source* country for each of the scenarios we implemented in the destination country. In two cases – when the ratio of skilled migration is frozen over the transition (parts A and D), the IS for the source country is of an opposite sign to that of the destination country, i.e., natives in S gain whereas those in D lose from restrictions on the proportion of skilled workers that can migrate to D. We may thus have a zero sum net gain globally in this case. It is interesting, however, that in the extreme case where skilled migration is disallowed altogether, the natives in both destination and source countries are net losers. Moreover, when all migration is disallowed in our extended model where we allow for complementarity between natives and migrants in knowledge creation (part E), there is a positive sum net gain for both destination and source countries, essentially because diversity effects raise the growth rates in both countries.[15]

Clearly, the immigration surplus estimates in tables 3 and 4 are theoretical and subject to limiting assumptions. The benefits from diversity may be more modest, but our model understates the net benefits in the sending country by assuming that a SBTS, which generally occurs first in the more technologically developed destination country, is simultaneously available to the sending country. Migrants may be an important channel speeding up the pace of innovation adoption in the sending country. In the main, the estimates in Tables 2 and 3 indicate that the long-term dynamic immigration surplus could far exceed its static estimates both on the up side and the down side, which opens up opportunities for immigration policies that could enhance the benefits of migration to both destination and source countries.

VII. Empirical Analysis

In this section, we test empirically two basic implications of the model: (i) higher levels of human capital of specific skill groups in the destination country will increase the immigration flows of corresponding skill groups from the source country, conditional on the other variables entering (18a) and (19) remaining unchanged. These include the population levels and goods production technologies in D and S, and mobility and adjustment costs for immigrants (Proposition 2); and (ii) a skill-biased technological shock affecting both the destination and the source country will raise the ratio of skilled migrants in the total migrant flow from source to destination countries (Proposition 3). To test both

[15] We stress the cases where both countries benefit from unrestricted immigration, since the global growth "equilibrium" paths we derive in the model in these cases would also be stable equilibria in the sense that no country would have an incentive to resist immigration.

propositions we use a comprehensive panel data on immigration from about 200 countries into five destination countries over the period 1975-2000. The underlying assumption behind the second test is that this sample period captures the predictions of proposition 3 due to the information technology revolution that has taken a significant step forward during the 1970s and has had a profound effect on the returns to knowledge and skill. Both propositions are tested via fixed effects regression models specified below. Note that the regression models we develop to test these propositions are estimated via an OLS estimation method because the regression analysis does not test for any presumed direction of causality: all of the variables entering equation (18a) are simultaneously determined in equilibrium.

1. Variables used

A. *Stock levels of skilled migrant populations (SM)*. Data on international migration are available from the World Bank's Panel Data on International Migration 1975-2000 (Schiff and Sjoblom, 2011). These data contain information about the total number of migrants by educational attainment from 190 source countries to 6 key destination countries in the OECD: Australia, Canada, France, Germany the UK and the US. We do not utilize data for Germany in our regression analysis because of the East-West division in that country over the sample period. The World Bank data are estimated to represent approximately 77 percent of the world's migrant population. Both the total number of migrants [TOM] and the number of skilled migrants [SM] are defined as *stock* variables. For example, [SM] is defined as the number of immigrants with at least some college education, i.e., 13+ years of schooling residing in a destination country by the country of birth.

B. *Other correlates*: Data on real per capita GDP [GDPc] in source and destination countries are taken from the Penn World Table sample (Heston et al., 2012). These variables are used as proxies for missing data on the average human capital (education) levels of skilled natives and migrants in destination and source countries. We also use as correlates other variables that have been used in the literature to account for mobility and adjustment costs to migrants. Data on such proxies as distance between countries [DIST], language similarity [COMLANG], colonial experience [COLONY] and contiguity between the destination and the source countries [CONTIG] are collected from the GEODist dataset (Mayer et al., 2011). We use fixed-effects regression models to account for differences in production technologies in destination and source countries. Summary statistics are given in Table 5.

1. Model specification

a. Testing proposition 2

The regression specification we develop to test proposition 2 using our panel data links the equilibrium flow of skilled immigrants over the sample period 1975-2000 with the equilibrium values of its associated correlates in equation (18a). Since our data include stock measures of the migrant populations in receiving countries, rather than flow measures, we first need to convert the stock measures into a flow-equivalent form. The regression model thus involves two steps:

In the first step we adopt a conversion method used in Ehrlich and Kim (2007) to specify migration stock values as functions of past migration flows using a growth regression format. In this format the observed stock of the skilled migrant populations (SM_{sdt}) in the destination country at any year t is expressed as a function of its initial value in year 0 and the average growth rate of the net migration flows that accumulated over the period 0-t, g(t), as follows:

(22) $SM_{sdt} = (SM_{sd0}) \exp[g(t)\cdot t] \exp(\varepsilon_{sdt})$,

where subscripts s, d, and t denote source country, destination country, and year, respectively, and ε_{sdt} stands for a random error.

The average growth rate thus estimated accounts for the average annual migration flow that accumulated over the preceding t periods. Since the WB sample does not report the average migration flows through t, g(t), we estimate the latter as a function of the determinants of the equilibrium migration flows as specified in proposition 2, including proxies for the migration "tax" variable, the average human capital levels of skilled migrants, and the goods-production technology parameters in destination and source countries. Empirically we define skilled migrants in the WB panel as those with at least college education. But there are no international panel data on the human capital or per-capita real income levels of this group in the destination and source countries. We have used instead real per capita GDP levels in destination and source countries as proxies. The function g(t) is thus specified to take the following form:

(23) $g(t) = \beta_1 + \beta_2 \ln GDPc_{dt} + \beta_3 \ln GDPc_{st} + \beta_4 X_{sdt}$,

where X_{sdt} includes the other measurable determinants of migration stocks in equation (18a), which approximate our theoretical "migration cost" variable.

Taking a log transformation of equation (22) and combining it with equation (23) we link the stock of skilled migrants from S to D at time t to its flow determinants through their interaction with the time period elapsing from the stock's initial value at t=0 as follows:

(24) $\ln SM_{sdt} = \beta_0 + \beta_1 t + \beta_2 t\cdot \ln GDPc_{dt} + \beta_3 t\cdot \ln GDPc_{st} + \beta_4 t\cdot X_{sdt} + \beta_5 \ln TOM_{sdt} + u_{st} + \nu_{dt} + \varepsilon_{sdt}$.

In equation (24) the interaction terms of the time trend variable with any regressor estimates the impact of that variable on the average growth rate of skilled migration flows through year t, and u_{st} and ν_{dt} account for country-specific fixed effects in the source and destination countries. We include as an additional regressor the total number of immigrants (TOM) in order to control for the varying dimensions of the migration populations in different countries. Proposition 2 can be tested by its consistency with the qualitative values of the estimated regression coefficients of equation (24).

b. Testing proposition 3

We employ a different econometric specification to test proposition 3 by estimating the shape of the transitional dynamic path of skilled migrants following the SBTM, which is assumed to take place during our sample period. In this analysis we convert the stock of skilled migrants (SM) to a concurrent flow term by taking the first difference of SM over two consecutive periods:

(25) $\Delta SM_{sdt} \equiv SM_{sdt+1} - SM_{sdt}$.

For the resulting flow variable ΔSM serving as a dependent variable we use a standard linear model with country-specific fixed effects:

(26) $\ln\Delta SM_{sdt} = \gamma_0 + \gamma_1 \ln TOM_{sdt} + \gamma_2 T + \gamma_3 GDPc_{dt} + \gamma_4 GDPc_{dt}^2 + \gamma_5 GDPc_{dt}^3$

$$+ \gamma_6 \ln GDPc_{st} + \gamma_7 X_{sdt} + u_{st} + \nu_{dt} + \varepsilon_{sdt}.$$

In equation (26) we enter the proxies for the relative human capital levels in the destination countries – GDP per capita – in cubic form to estimate the trend of the skilled migration flows as predicted by proposition 3 and solved numerically in section IV.2. We also control for GDP per-capita in the source country using a linear as well cubic transformations, which yield similar results. To convert the dependent variable measuring the flow of skilled migration into its *share* in concurrent total flow of migrants, as defined in proposition 3, we enter as an additional variable the total number of immigrants in log form (TOM). We also add correlates comprising the X vector in equation (26), including language similarity, past colonial status, distance, and contiguity.

Note that the de-trended first differences are expected to pick up high frequency variations and this specification is therefore preferred for testing the model's implications over the transitional dynamic phase.

2. Results

The results of the regression specification in equation (24) are reported in Table 6. We find the following:

(i) The coefficient for the time interaction term with $\ln GDPc_{dt}$ indicates that higher per capita GDP in destination, as a proxy for the human capital level of the skilled, is associated with higher skilled immigration flows. This finding is consistent with the prediction in Proposition 2.

(ii) We also find that lower per capita GDP in S – a proxy for lower level of human capital of skilled workers in S – is associated with more skilled immigrants, as implied in Proposition 2.

(iii) The binary variable indicating whether the source country and the destination country share a common language (COMLANG) is shown to have a negative effect on the flow of skilled immigrants. In a separate regression we conducted, where we use the total flow of immigrants as a dependent variable instead of skilled migrants (not reported here), we find that COMLANG has a positive sign. This indicates that the language barrier may work as a migration cost factor only for unskilled workers. The binary variable (COLONY), indicating whether the source country and the destination country have ever had a colonial link would be expected to reduce the adjustment costs to skilled migrants, as shown.

(iv) Higher migration cost due to longer distance between the destination and the source country (DIST) reduces immigration by skilled migrants as it increases the mobility costs to migrants.

(v) We find that when the destination country is contiguous to the source country, skilled migration falls while unskilled migration rises (the regression with total immigrants as the dependent variable is not reported here). The reason may be that since distance is already controlled for in the regression, contiguity may pick up the influence of area-specific employment opportunities which are more likely to involve workers with low skills from contiguous areas, whereas the demand for skilled workers is wider in scope.

Table 7 reports the results of estimating equations (26) as a test of Proposition 3. Regression model 1 is a baseline model while model 2 includes a few extra regressors. The findings are:

(i) The per capita GDP levels in linear, quadratic and cubic forms are shown to be significant. The estimated regression line based on the results from Table 7 is shown in Figure 6. The graph indicates a steady increase in the skill composition ratio over the development process, as predicted in Proposition 3. It virtually duplicates the shape of the transition dynamic path of the skill composition of migrant flows as simulated in Figure 1, panel a.

(ii) Model 2 in table 7 confirms the negative association between immigration flows and DISTANCE as a factor accounting for the mobility costs of immigration that inhibit skilled migration between S and D along the transitional path linking the original growth equilibrium steady state with a more highly developed steady state in D, while contiguous destination countries attract less skilled immigrants.

VIII. Concluding Remarks

The distinct feature of the this paper relative to extant literature is the treatment of migration flows and their skill composition as endogenous variables within a balanced-growth equilibrium setting that accounts for the interaction between receiving and sending countries. The model extends the framework we used in our *JHC* paper (EK, 2007a) to analyze the joint determination of income growth and distribution in a closed economy into an open economy setting with free international labor mobility, in which migration flows remain positive even in a steady state of balanced growth.

To achieve the complex task, we resort to a number of simplifying assumptions. The only reproducible asset in the economy is human capital. We abstract from the separate role of physical capital and trade in goods by allowing for two segmented goods-producing sectors in destination and source countries that employ exclusively one of the two skill groups of natives and immigrants and produce high-tech or low-tech goods that are perfect substitutes in consumption. To obtain a balanced-growth equilibrium and interior solutions we also need to restrict the relative magnitudes of some structural parameters to be identical either across the two skill groups within an economy or across the two economies. This rigid structure enables us, however, to focus on the role of human capital not just in producing new knowledge, but also in generating external spillover effects that link together all the six groups of households and workers comprising the global economy. In this context we offer two versions of our general model: a benchmark model that abstracts from any complementarities in knowledge production between natives and immigrants; and b. an extended model in which such complementarities are recognized.

The main new insights offered by both versions of the model concern the observed rising trends in both the skill composition of migration flows and in population share of skilled migrants relative to that of natives in major immigration-receiving countries over at least four decades when "skill" is indexed as the population share of adults with 13+ years of education. Our model forecasts both trends to be an outcome of demand "pull" factors resulting from a skill-biased technological shock (SBTS), such as the one generated by the IT revolution, which became widely spread over the 1970s, coinciding with a significant and continuing surge in migration in the US after 7 decades of decline.

Such immigration patterns do not apply as a general rule to other historical migration trends or waves – a current example being the immigration wave from the Middle East and Africa to EU countries, which appears to be the result of "push factors". The comparative dynamic predictions of our model can project alternative patterns of migration trends or waves that result from shocks in exogenous parameters that capture e.g., catastrophic events in sending countries. The more general insight offered by our model is that significant changes in the migration flows and stocks can be more fully understood if treated as endogenous outcomes of exogenous structural parameter shifts, including changes in government immigration policies, but at the same time reflecting behavioral responses by potential migrants in source countries, as well as equilibrating market forces that include interaction effects between destination and source countries.

In this context our model offers new insights concerning the long-term consequences of endogenous migration flows on major macroeconomic variables including the level and rate of growth of human capital formation, wage rates of workers with specific skills, and income growth and distribution in both receiving and sending countries, as summarized in sections IV and V. Our numerical analysis indicates that an SBTS-induced rise in the skill composition of migration flows and their relative population shares is expected to *enhance* the level (as in the benchmark model) or both the level and long-term rate of growth (as in the extended model) of human capital formation and full-income per-capita in destination countries, but at the same time exert an *ameliorating* effect on the growth in income inequality resulting from the SBTS itself.

Whether the same effects apply in sending countries, however, is ambiguous. While long-term rates of growth are expected to equalize along the balanced growth equilibrium paths by both versions of the model, the impact on the source country's level of human capital formation and income growth and distribution goes in an opposite direction in the benchmark version of our model, but in the same direction in our extended model which allows for complementarities in knowledge production across immigrants and natives in destination.

A similar ambiguity applies to the long-term impact of SBTS-induced rise in the skilled migration flows and relative population shares on the net benefits to natives in destination and source countries. Destination countries may always gain from such migration trends. Moreover, estimates of the "immigration surplus" to natives in destination are found to be significantly larger than those projected in static models, as summarized in section VI. But the consequences for receiving and sending countries go in opposite directions if measured over the transitional dynamic path of the economy following the skill-biased shock or by estimating what natives in each country stand to lose if skilled or unskilled migration is disallowed. Both countries stand to gain from unrestricted migration however in two major scenarios: when there are no restrictions (in the benchmark case) and when all migration is unrestricted (in the extended case allowing for diversity effects in knowledge production. Another insight that is supported by both versions of our model is that the long run positive immigration surplus produced by a skill-biased technological change comes about jointly with a rise in the average wage in the economy, even for skilled workers in the ultimate steady state. That is, the net benefits for natives in this case do not require a fall in the wage bill of natives in absolute terms. The immigration surplus is especially large for unskilled natives in destination since the SBTS generates spillover effects in knowledge acquisition that are especially favorable for his group.

Appendix A

Methodology of simulations

We calibrate the model by selecting the values of key parameters of the model to approximate the average levels of fertility and per-capita income growth in the set of major destination countries as well as the average fertility level of middle-income source countries, as reported in the international panel of the World Bank's data we explore in the regression analysis of section VII, subject to the sufficient parametric conditions for global equilibrium we need to impose in order to obtain balanced growth equilibrium paths for D and S. The parametric restriction that unit fertility costs be higher in destination relative to source country in equation (20c) is also justified by the higher labor market opportunities of females in the more developed destination, relative to source countries. We further restrict the fertility rate of immigrants to be of intermediate level between source and destination countries because we expect the opportunity costs of migration to exert an adverse income effect on migrant families' desired fertility.

The numerical solutions for the steady state values of the key control and state variables of our model in this case are derived in two steps. In the first step, we solve the three first-order conditions (FOCs) for n^{d1}_t, n^{s1}_t and n^{m1}_t in section III.5 and the arbitrage condition for M^{s1}_t (equation 17) to derive the steady state values of n^{d1}_t, n^{s1}_t, n^{m1}_t, and M^{s1}_t/N^{s1}_t.[16] The values obtained from the first step are then plugged in the next step where we solve for a related set of four equations (three first-order conditions for n^{d2}_t, n^{s2}_t and n^{m2}_t, and the arbitrage condition for M^{s2}_t) to derive the steady state values of n^{d2}_t, n^{s2}_t, n^{m2}_t, and M^{s2}_t/N^{s2}_t. These two steps can be performed sequentially because the spillover effects are assumed to flow in just one direction: from the skilled to unskilled groups in our model.

We have explicit solutions for optimal investments in human capital from equations (15) and (15a). The steady state values of all the other endogenous ratios in the model, such as N^{si}_t/N^{di}_t, and $\omega^{di}_t/\omega^{si}_t$, can be derived from equations 1, 2, 5, 6, 13 and 14 as well as the imposed condition that the stock levels of population and human capital are growing at the same rate in both countries.

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16 We do so by dividing both sides of the FOCs by $(\omega^{ki}_t H^{ki}_t)^{1-\sigma}$ and imposing the growth-equilibrium steady state conditions; e.g., $(\omega^{ki}_{t+1}/\omega^{ki}_t) = (N^{ki}_{t+1}/N^{ki}_t)^{-\phi} (H^{ki}_{t+1}/H^{ki}_t)^{\mu-\phi}$ in equation (5).

The comparative dynamics results reported in Table 1 are derived by exogenously changing the benchmark levels of the key parameters that can trigger a skilled-bias technological advancement and thus generate a shift in the economy's initial BGP to a higher level.

The simulations of transitional dynamics (shown in Figures 1 and 2) are conducted by tracing the transitional evolution paths of our key control variables, starting from their values at the initial growth equilibrium steady state and ending at the new growth equilibrium steady state. The major shock we introduce is a skill-biased technological innovation favoring the skilled groups in both D and S, by simultaneously raising A^{d1} and A^{s1} by the same proportion, with A^{d2} and A^{s2} held constant. The initial values of the state variables, H^{ki}_t and N^{ki}_t, are arbitrarily imposed without loss of generality, which can then give rise to dynamic paths of our basic state variables as well as derivative variables like the skill composition ratio of migrants and the Gini coefficient. In deriving the paths, we also use the three first-order conditions and the arbitrage condition as we do in the derivation of the steady state values, but without imposing any conditions that hold just in a steady state.

Explaining the "oscillations" in Figure 1 panels a and b of section IV.2

The assumption on parental forecast of children's wage invoked in our numerical analysis results in some oscillations in the transitional dynamic paths of the skill composition of migration flows and stocks along the transitional dynamic paths of these variables. In Figure 1, panels a. and b., for example, the simulated time paths of the skill composition of migration flows, as well as the ratios of the skilled population relative to the total population experience a dip following a skill-biased technological shock. Such dips can be rationalized as follows: Skilled parents aiming to migrate to D following a skill-biased technological shock forecast the differential wage level between the destination and source countries to remain the same as before the shock in D and S. This makes migration less gainful initially because potential migrants face significant mobility and adjustment costs due to loss of earnings in S. However, as the expanded difference between the wage levels in D and S is realized, the migrants' expectations adapt and the ratios of $[M^{s1}/(M^{s1}+M^{s2})]$ and (M^{s1}/N^{s1}) start moving upward. Oscillations may persist in future periods (a la the Cobweb model) but they become much smaller since the ultimate wage differential in the steady expands in the direction of D due to the higher endogenous growth of human capital in D relative to S over the dynamic transition phase. The upward trend in migration flows to D will thus persist until the actual growth rates in both D and S equalize as the economies converge on their new steady states. The assumed forecast by parents may then overstate the actual difference before D and S reach their steady states.

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Table 1: Simulating Comparative Dynamic Effects of Parameter Changes - Benchmark Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	$n^{d1} = n^{d2}$	$n^{s1} = n^{s2}$	$n^{m1} = n^{m2}$	h^{d1}	h^{d2}	$h^{s1} = h^{m1}$	$h^{s2} = h^{m2}$	Growth Rate*	$M^{s1}/N^{d1} = M^{s2}/N^{d2}$	$M^{s1}/N^{s1} = M^{s2}/N^{s2}$	$\Delta^{dd2} = \Delta^{ss2}$	$\Delta^{ds1} = \Delta^{ds2}$	$H^{d1}/H^{s1} = H^{d2}/H^{s2}$	$\omega^{d1}/\omega^{s1} = \omega^{d2}/\omega^{s2}$
(i) Initial steady state	2.0906	3.2207	2.5157	0.2	0.2	0.1333	0.1333	2	0.1803	0.2101	5.6569	4.8140	3.0820	1.5728
(ii) A^{d1} =12, A^{s1} =9.6	2.1198	3.2642	2.5508	0.2	0.2	0.1333	0.1333	2.4	0.1807	0.2094	8.9234	4.8140	3.1025	1.5785
(iii) A^{d1} =12, A^{s1} =9.6, A^{d2} =6, A^{s2} =4.8	2.1198	3.2642	2.5508	0.2	0.2	0.1333	0.1333	2.4	0.1807	0.2094	5.6569	4.8140	3.1025	1.5785
(iv) $\tau^1 = \tau^2 = 0.16$	2.0907	3.2208	2.6436	0.2	0.2	0.1333	0.1333	2	0.1664	0.2143	5.6569	4.8140	2.7713	1.4874
(v) v^d =.072	1.7462	3.2659	2.5287	0.24	0.24	0.1333	0.1333	2.4	0.2282	0.2886	5.6569	7.5938	4.0429	1.7247
(vi) v^d =.072, v^s =.048	1.7470	2.6912	2.1023	0.24	0.24	0.16	0.16	2.4	0.1804	0.2100	5.6569	4.8140	3.0861	1.5739

Note: Parameters for the benchmark case: A^{d1} =10, A^{s1} =8, A^{d2} =5, A^{s2} = 4, $\tau^1 = 0.2$, $\tau^2 = 0.2$, $v^d = 0.06$, $v^s = 0.04$, $\theta^{d1} = 1$, $\theta^{d2} = 1$, $\theta^{s1} = 1$, $\theta^{s21} = 1$, $\sigma = 0.9$, $\delta = 0.7$, $\beta = 1.3$, $\gamma 1 = 0.4$, $\gamma 2 = 0.4$, $\phi = 0.1$, $\mu = 0.6$, B = 1, $\Gamma^{d1} = 1$, $\Gamma^{s1} = 1$, $\Gamma^{d2} = 1$, $\Gamma^{s2} = 1$.

* The projected steady state growth rate is for human capital formation over 1 generation. Comparative dynamics in the GE steady state are simulated by decreasing τ^1, τ^2, or increasing A^{d1}, A^{s1}, A^{d2}, A^{s2}, v^d, v^s by 20 percent, holding other parameters constant at the benchmark values.

Table 2: Simulating Comparative Dynamic Effects of Parameter Changes – Extended Model Allowing for Diversity Effects in Knowledge Formation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	$n^{d1} = n^{d2}$	$n^{s1} = n^{s2}$	$n^{m1} = n^{m2}$	h^{d1}	h^{d2}	$h^{s1} = h^{m1}$	$h^{s2} = h^{m2}$	Growth Rate*	$M^{s1}/N^{d1} = M^{s2}/N^{d2}$	$M^{s1}/N^{s1} = M^{s2}/N^{s2}$	$\Delta^{dd2} = \Delta^{ss2}$	$\Delta^{ds1} = \Delta^{ds2}$	$H^{d1}/H^{s1} = H^{d2}/H^{s2}$	$\omega^{d1}/\omega^{s1} = \omega^{d2}/\omega^{s2}$
(i) Initial steady state	2.1109	3.2510	2.5401	0.2	0.2	0.1333	0.1333	2.2664	0.1537	0.2306	5.6569	6.5806	3.2198	1.5768
(ii) A^{d1} =12, A^{s1} =9.6	2.1401	3.2945	2.5752	0.2	0.2	0.1333	0.1333	2.7203	0.1540	0.2300	8.9234	6.5846	3.2413	1.5825
(iii) A^{d1} =12, A^{s1} =9.6, A^{d2} =6, A^{s2} =4.8	2.1401	3.2945	2.5752	0.2	0.2	0.1333	0.1333	2.7203	0.1540	0.2300	5.6569	6.5846	3.2413	1.5825
(iv) $\tau^1 = \tau^2 = 0.16$	2.1098	3.2493	2.6677	0.2	0.2	0.1333	0.1333	2.2501	0.1429	0.2334	5.6569	6.4631	2.8921	1.4909
(v) v^d =.072	1.7663	3.3017	2.5575	0.24	0.24	0.1333	0.1333	2.7811	0.1887	0.3188	5.6569	10.976	4.2373	1.7319
(vi) v^d =.072, v^s =.048	1.7640	2.7164	2.1226	0.24	0.24	0.16	0.16	2.7198	0.1537	0.2305	5.6569	6.5814	3.2241	1.5779

Note: Parameters for the benchmark case: A^{d1} =10, A^{s1} =8, A^{d2} =5, A^{s2} = 4, τ^1 = 0.2, τ^2 = 0.2, v^d = 0.06, v^s = 0.04, θ^{d1} = 1, θ^{d2} = 1, θ^{s1} = 1, θ^{s21} = 1, σ = 0.9, δ = 0.7, β = 1.3, $\gamma 1$ = 0.4, $\gamma 2$ =0.4, ϕ = 0.1, μ = 0.6, B = 1, Γ^{d1} = 1, Γ^{s1} = 1, Γ^{d2} = 1, Γ^{s2} = 1.

* The projected steady state growth rate is for human capital formation over 1 generation. Comparative dynamics in the GE steady state are simulated by decreasing τ^1, τ^2, or increasing A^{d1}, A^{s1}, A^{d2}, A^{s2}, v^d, v^s by 20 percent, holding other parameters constant at the diversity model's benchmark values.

Table 3: Immigration Surplus: Percentage Change in Welfare Measures' Level When Migration is Restricted (Positive Values = Loss from Restriction= IS Gain)

	Destination			Source
	5th generation after a SBTS	10th generation after a SBTS	15th generation after a SBTS	15th generation after a SBTS
A. Skill composition held constant				
Human capital	0.63	1.10	1.53	-26.4
Full income	0.67	1.15	1.48	-23.7
Consumption	0.67	1.15	1.47	-23.8
Utility	0.18	0.32	0.43	-7.36
B. skilled migration disllowed				
Human capital	33.1	62.6	81.4	98.7
Full income	28.9	59.9	79.8	99.9
Consumption	42.2	67.5	83.6	99.9
Utility	10.0	23.1	35.2	49.8
C. Unskilled migration disallowed				
Human capital	-12.8	-21.2	-28.7	98.4
Full income	-14.6	-24.1	-33.0	98.5
Consumption	-13.4	-22.6	-31.2	98.5
Utility	-3.65	-5.68	-7.30	60.9
D. Diversity: Skill composition held constant				
Human capital	0.86	1.43	2.05	-14.5
Full income	1.07	1.77	2.40	-2.44
Consumption	1.07	1.77	2.38	-2.75
Utility	0.19	0.36	0.49	-5.35
E. Diversity: All migration disallowed				
Human capital	52.9	74.8	86.6	99.9
Full income	61.7	83.7	93.0	99.9
Consumption	61.3	83.5	92.9	99.9
Utility	9.08	16.5	23.3	69.8

Note: We show the percentage changes in four welfare measures when a migration restriction is imposed, relative to the unrestricted migration case. Negative values thus indicate gains from the migration restriction relative to the unrestricted migration case. Parts D and E correspond to our extended model allowing for diversity effects.

Table 4: Immigration Surplus: % Change in Welfare Measures' Growth Rates When Migration Is Restricted

	Destination			Source
	Avg. annual growth rate within 5 gen. with immigration restriction [unrestricted]	**Avg. annual growth rate within 10 gen. with immigration restriction [unrestricted]**	**Avg. annual growth rate within 15 gen. with immigration restriction [unrestricted]**	**Avg. annual growth rate within 15 gen. with immigration restriction [unrestricted]**
A. Skill composition held constant				
Human capital of natives	2.943 [2.947]	2.950 [2.954]	2.953 [2.956]	3.008 [2.955]
Full income of natives	4.132 [4.137]	4.137 [4.141]	4.139 [4.142]	4.189 [4.140]
B. Skilled migration disallowed				
Human capital	2.694 [2.947]	2.628 [2.954]	2.580 [2.956]	1.967 [2.955]
Full income	3.878 [4.137]	3.813 [4.141]	3.766 [4.142]	2.543 [4.140]
C. Unskilled migration disallowed				
Human capital	3.013 [2.947]	3.011 [2.954]	3.008 [2.956]	2.057 [2.955]
Full income	4.207 [4.137]	4.204 [4.141]	4.200 [4.142]	3.222 [4.140]
D. Diversity: Skill composition held constant				
Human capital	3.374 [3.378]	3.381 [3.385]	3.383 [3.387]	3.417 [3.386]
Full income	4.792 [4.798]	4.796 [4.801]	4.798 [4.803]	4.807 [4.801]
E. Diversity: All migration disallowed				
Human capital	2.947 [3.378]	2.954 [3.385]	2.956 [3.387]	1.713 [3.386]
Full income	4.204 [4.798]	4.208 [4.801]	4.210 [4.803]	2.192 [4.801]

Note: The numbers in brackets correspond to the benchmark model (parts A to C) and the extended model which recognizes diversity effects (parts D and E) if no restrictions are placed on immigration.

Table 5: Summary Statistics

Variable	Description	Mean [Std. Dev.]
SM	Total number of skilled immigrants with at least some college education (13+ years of schooling) from any source country residing in a destination country	11281 [43570]
TOM	Total number of immigrants from source country residing in destination country	32821 [156277]
$GDPc_d$	Real per-capita GDP in destination	25906 [5573]
$GDPc_s$	Real per-capita GDP in source	8652 [10965]
COMLANG	Dummy variable accounting for whether source country and destination country share a common language	0.3527 [0.4779]
COLONY	Dummy variable accounting for whether source country and destination country have ever had a colonial link	0.1279 [0.3340]
DIST	Distance between the capital cities of source country and destination country (in kms)	8580 [4406]
CONTIG	Dummy variable accounting for whether source country and destination country are contiguous	0.0128 [0.1125]

Table 6: Linking the equilibrium stocks of skilled migrants with the equilibrium levels of their associated determinants by proposition 2

Dependent Variable: lnSM

	Coefficient	Std. Err.
lnTOM	.75392577***	.0055785
T	.07275002***	.0218764
T*lnGDPc_d	.00772416***	.0021126
T*lnGDPc_s	-.0035206***	.0004502
T*COMLANG	-.00672696***	.0009544
T*COLONY	.01199498***	.0009419
T*lnDIST	-.01022738***	.0004741
T*CONTIG	-.00459365***	.0012139
Adj. R2	0.9777	
N	4684	

Note: * p<0.1; ** p<0.05; *** p<0.01.

Table 7: Testing the predicted dynamic path of skilled migration flows following a SBTS over the period 1975-2000

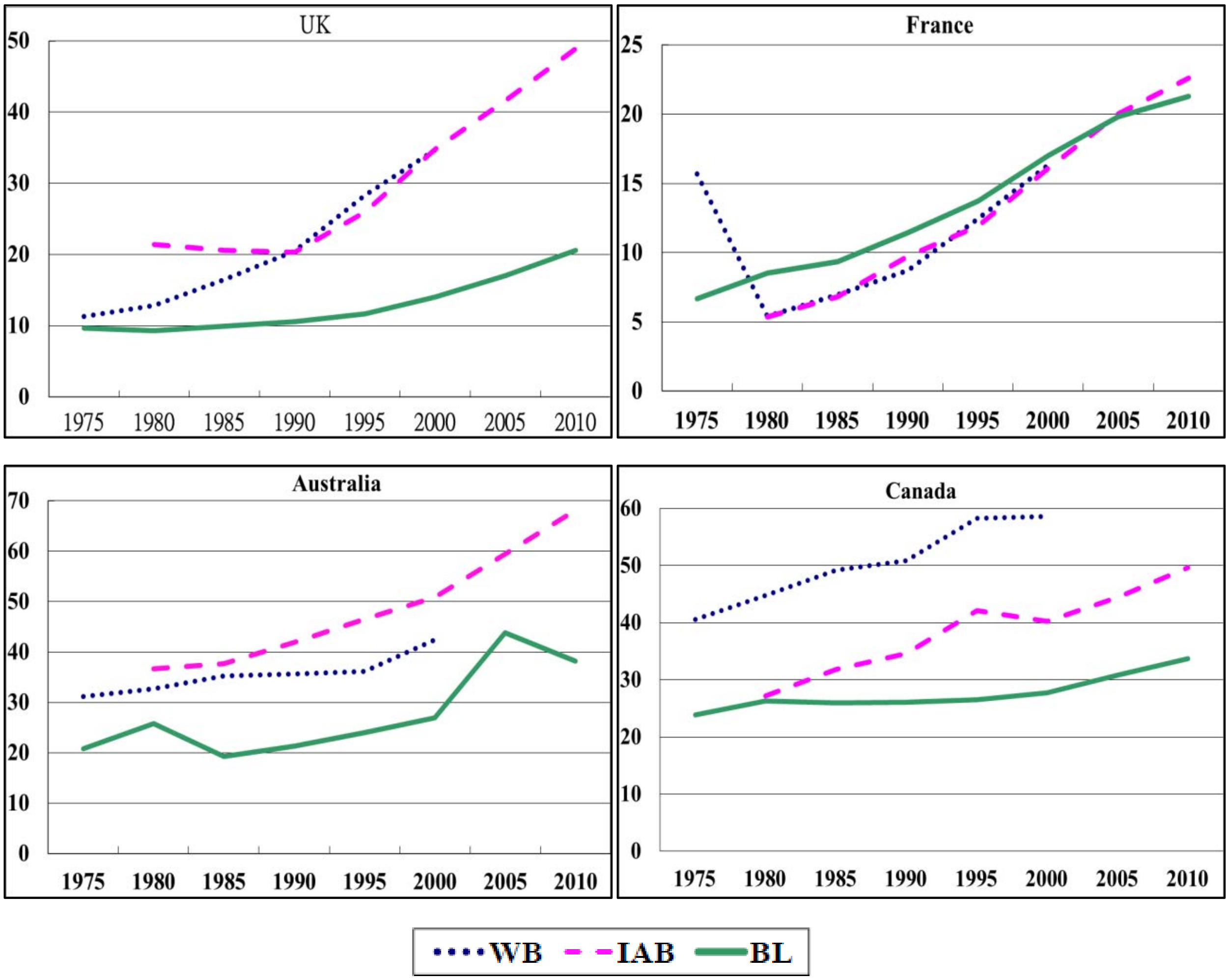
Dependent Variable: ΔSM (= $SM_{t+1} - SM_t$)

	Model 1		Model 2	
	Coefficient	Std. Err.	Coefficient	Std. Err.
lnTOM	.65347373***	.0169951	.64110331***	.0196877
T	0.014404	.0097158	-0.01034	.0087563
$GDPc_d$	.00056973***	.0001830		
$GDPc_d^2$	-1.809e-08**	7.33e-09		
$GDPc_d^3$	1.893e-13**	9.64e-14		
$lnGDPc_d$			1.7264526***	.4221798
$lnGDPc_s$	-0.05114	.0827502	-0.00274	.0818038
COMLANG			0.056032	.0990314
COLONY			-0.01778	.0773399
lnDIST			-.27162541***	.0372899
CONTIG			-.34716462***	.0889654
Adj. R2	0.8491		0.8506	
N	3427		3427	

Note: * p<0.1; ** p<0.05; *** p<0.01.

Figure 1

Weighted averages of the skill composition of the migrant population vs. total domestic population in major destination countries Population age 25+ with 13+ years of education



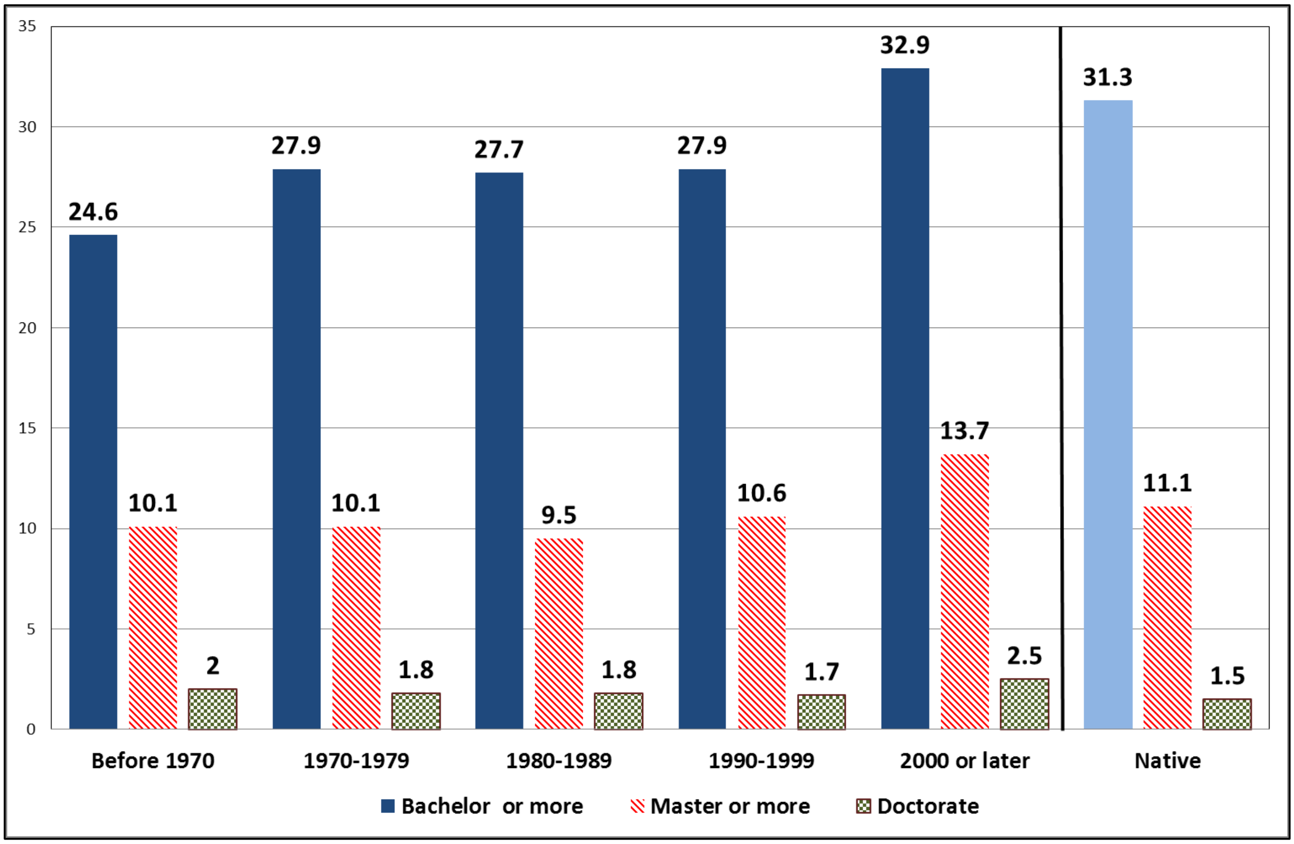
Note: Weighted averages (by population shares) of the skill composition of migrants in a destination country are measured as the share of all skilled migrants (those with some tertiary education) in the total migrant population from all source countries in the destination country.

Sources:

1. WB data are from Schiff and Sjoblom (2011), including 190 source countries. The WB path is based on a World Bank panel including Census data from sending and receiving countries over the period 1975-2000.
2. IAB data are from Brucker, Capuano, and Marfouk (2013). The IAB path is based on a somewhat larger data panel covering more countries over the period 1980-2010.
3. BL data are from Barro and Lee (2013). The benchmark figures used are collected from census/survey information, as compiled by UNESCO, Eurostat, and other sources. The BL path reflects the comparable skill composition data of the *total* population in receiving countries assembled by Barro and Lee.
4. All data sets are based essentially on Census reports in destination countries (see text).

Figure 2

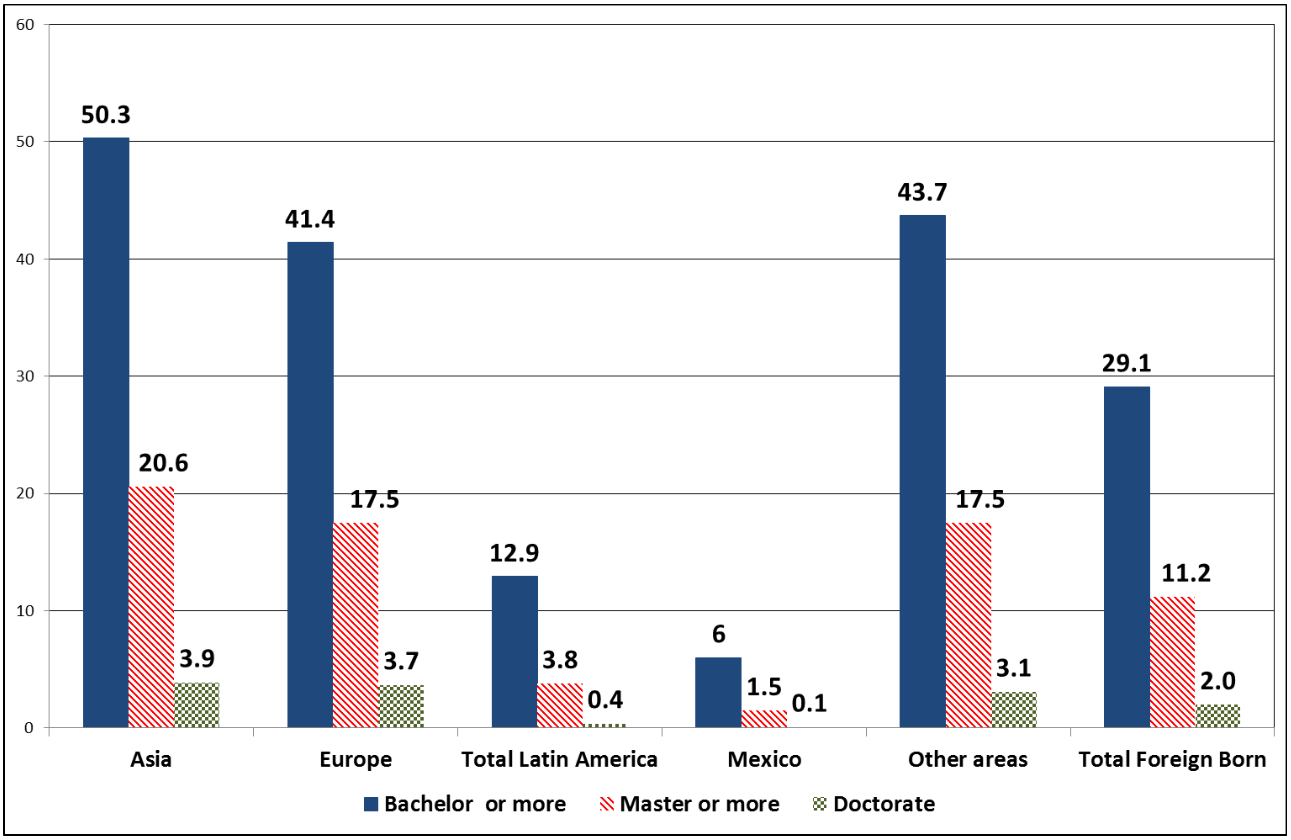
Educational Attainment of the Foreign-Born Population (in %) 25 Years and Over vs. Total Native Population by year of Entry: 2012



Source: U.S. Census Bureau, Current Population Survey, Annual Social and Economic Supplement, 2012, http://www.census.gov/population/foreign/data/cps2012.html (Tables 1.5 and 2.5)

Figure 3

Educational Attainment of the Foreign-Born Population (in %) 25 Years and Over by World Region of Birth: 2012



Source: U.S. Census Bureau, Current Population Survey, Annual Social and Economic Supplement, 2012, http://www.census.gov/population/foreign/data/cps2012.html (Table 3.5)

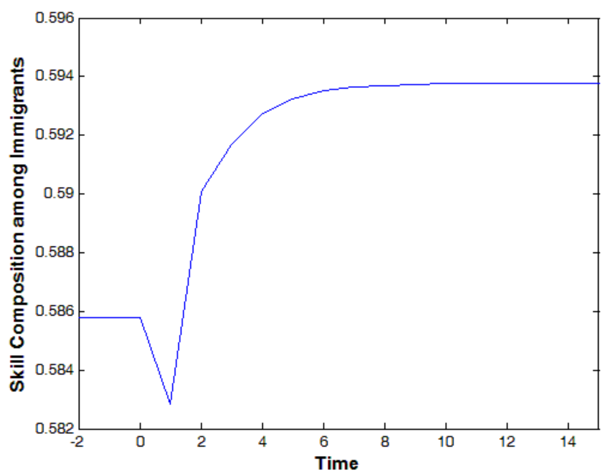
Notes:

1. Immigrants born in 'Total Latin America' are from all sub-regions of Latin America (Central America, South America, and the Caribbean), including Mexico.

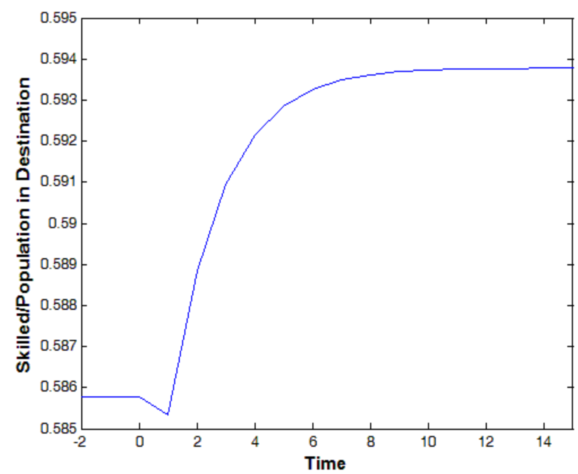
2. Immigrants born in 'Other areas' are from Africa, Oceania, Northern America, and Born at Sea.

Figure 4: Simulated Time Paths of the Evolution of Key Endogenous Variables: A Skill-biased Technological Shock Affecting Skill Group 1 in Both Countries Simultaneously

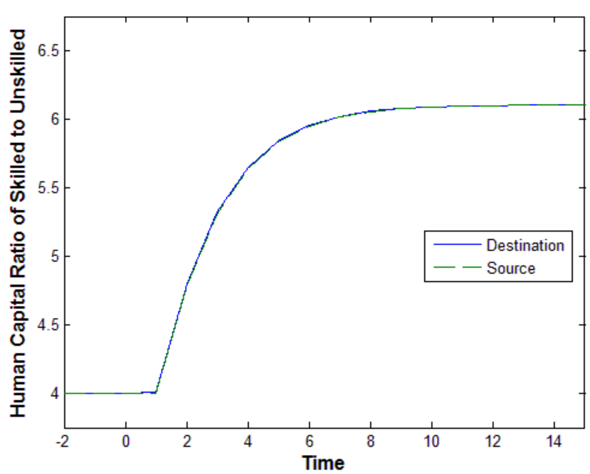
a. Skill Composition of Migration ($=M^{s1}/(M^{s1}+M^{s2})$)



b. Skilled Population Ratio in Destination ($= (N^{d1}+M^{s1})/ (N^{d1}+M^{s1}+N^{d2}+M^{s2})$)



c. Human Capital Ratio of Skilled to Unskilled Population ($=H^{k1}/H^{k2}$, k=d, s)



d. Average Fertilities of Skilled and Unskilled Population

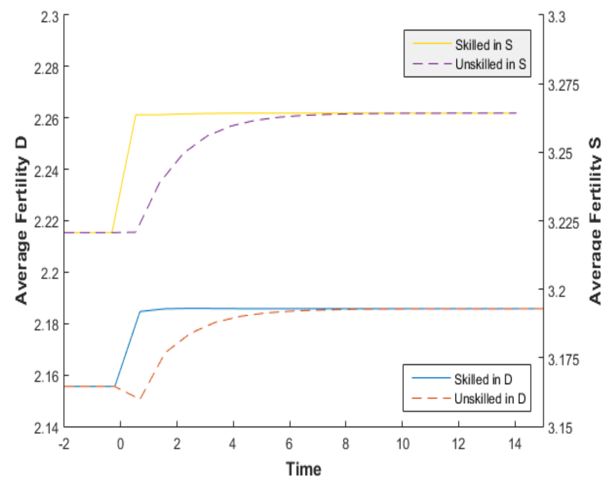
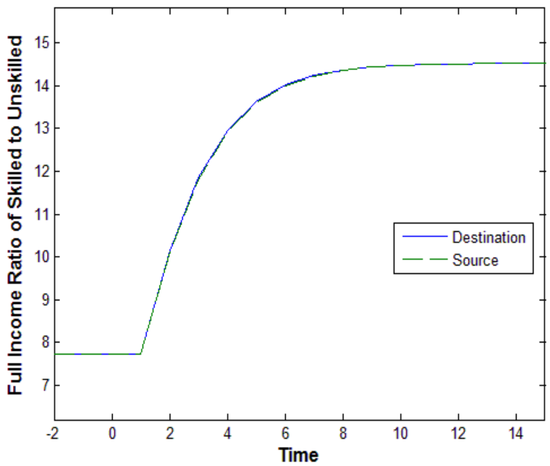


Figure 4 (continued)

e. Full Income Ratio of Skilled to Unskilled Population ($=\omega^{k1}H^{k1}/\omega^{k2}H^{k2}$, k=d, s)



f. Gini Coefficients

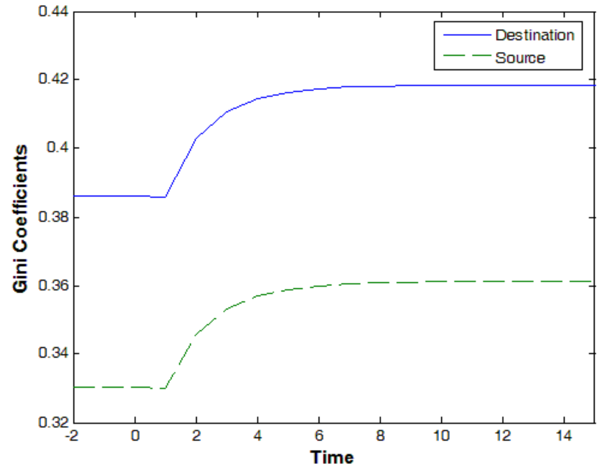


Figure 5: Comparing Simulated Time Paths in the Destination Country in two Scenarios:

(i) When Skill Composition is Held Constant; (ii) When it is unrestricted

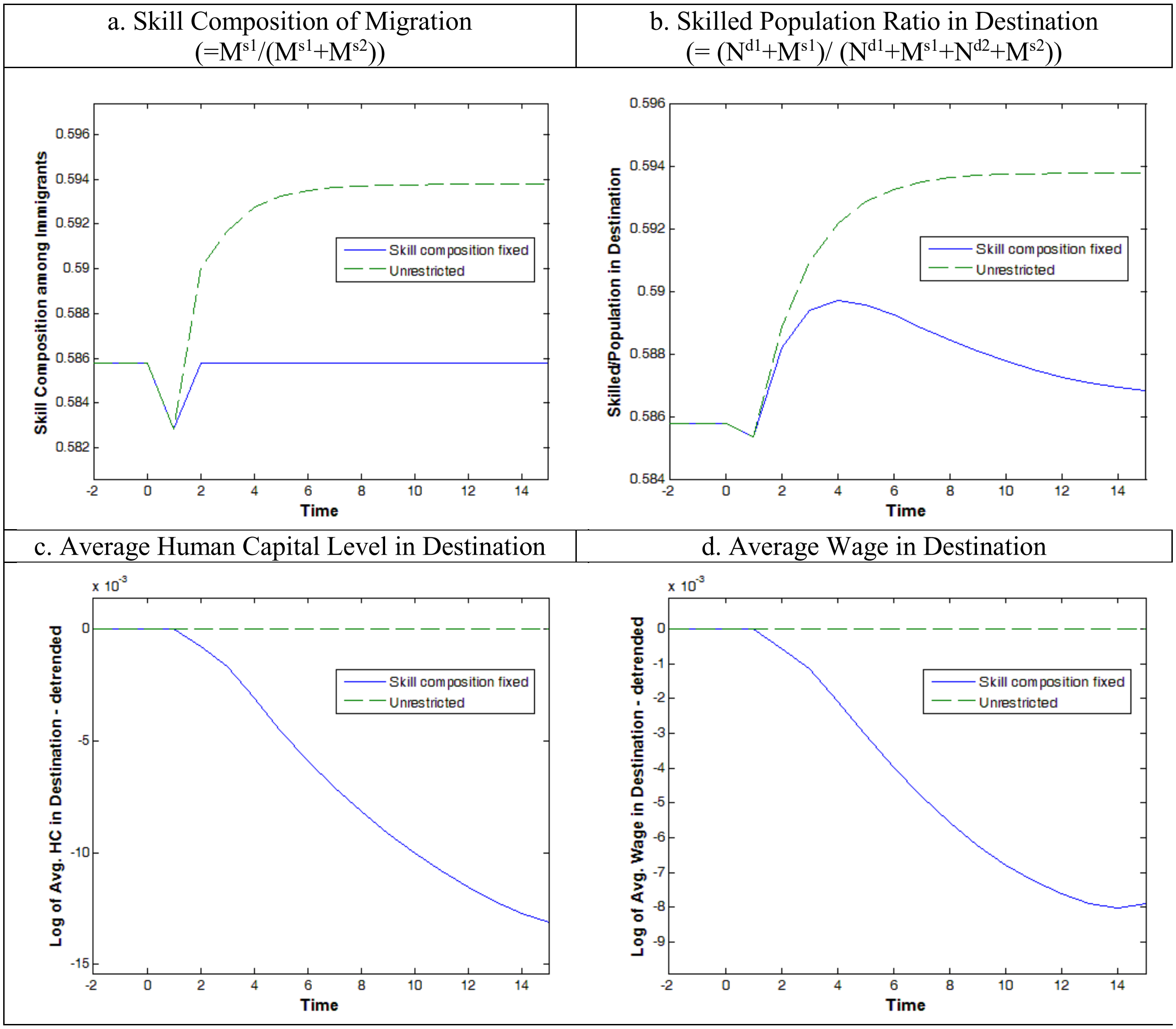
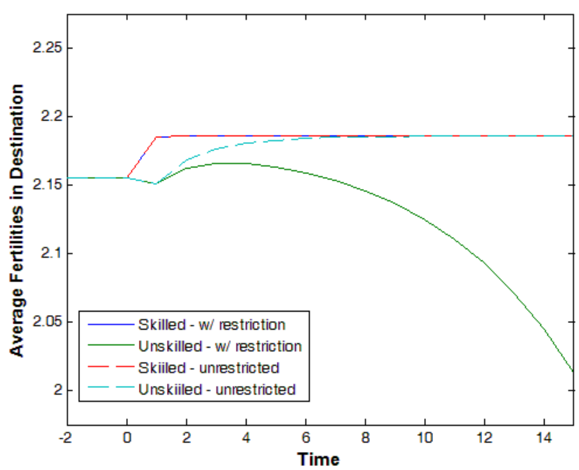
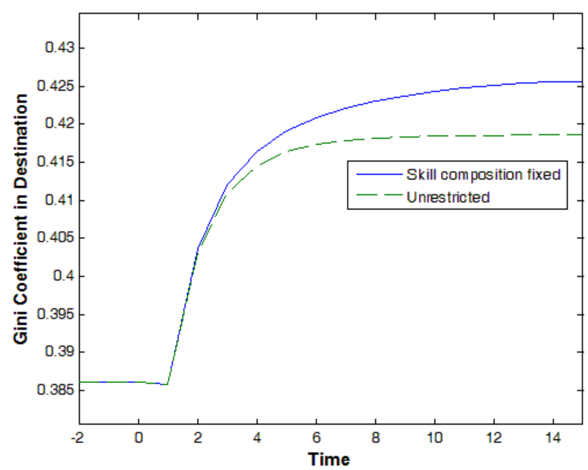


Figure 5 (continued)

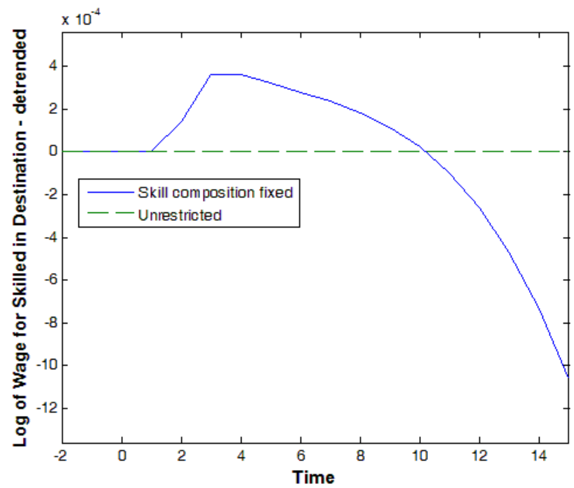
e. Average Fertilities in Destination



f. Gini Coefficient in Destination



g. Wage for Skilled in Destination



f. Wage for Unskilled in Destination

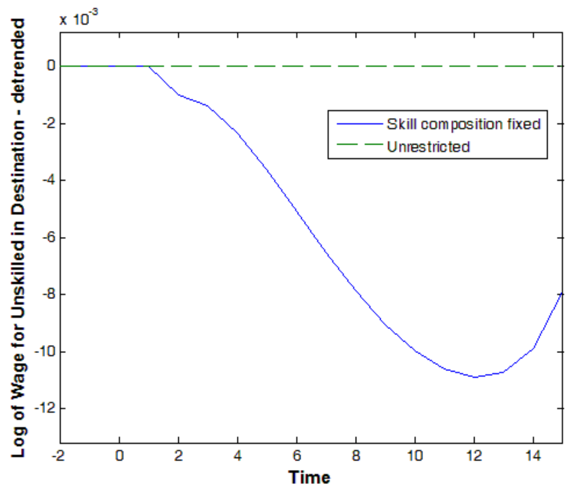
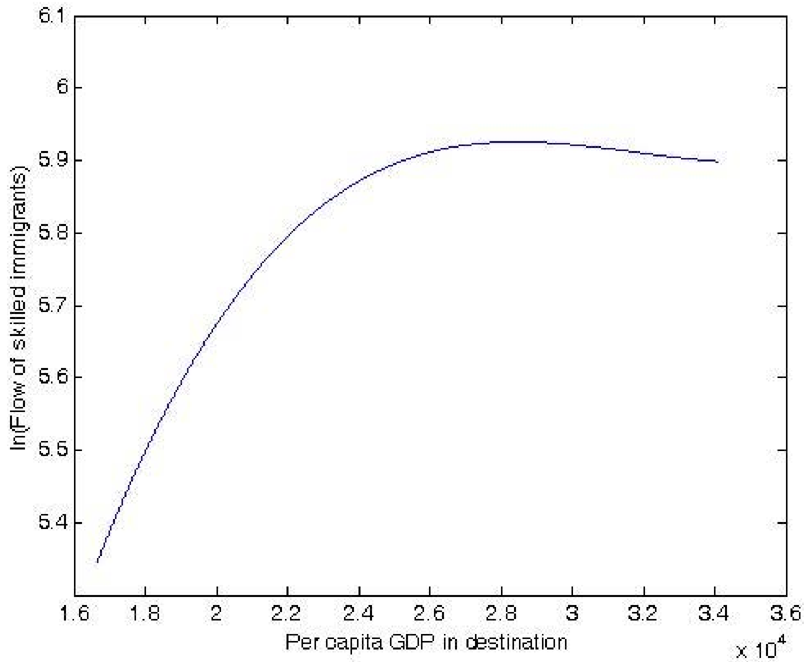


Figure 6: Fitted Regression Lines Linking Skilled Immigrants and Per Capita Income, Based on Regression Model 1 in Table 7



Note: This figure is based on the regression results of Model 1 in Table 7. The $GDPc_d$ values on the x-axes of all panels cover 95% of the observations on $GDPc_d$ used in our regressions.