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THE ECONOMIC CONSEQUENCES OF 'BRAIN DRAIN' OF THE BEST AND BRIGHTEST: MICROECONOMIC EVIDENCE FROM FIVE COUNTRIES*

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This article presents results of innovative surveys that tracked academic high achievers from five countries to wherever they moved in the world to directly measure at the micro level the channels through which high-skilled emigration affects sending countries. There are high levels of emigration and of return and the income gains to the best and brightest from migrating are an order of magnitude greater than any other effect. Most high-skilled migrants from poorer countries remit but involvement in trade and foreign direct investment is rare. Fiscal costs vary widely but are much less than the benefits to the migrants themselves.

Two narratives drive discussions of the development impact of high-skilled migration. The first is the idea of a brain drain, whereby the departure of doctors, teachers, engineers, scientists and other highly skilled workers decimates the human capital and fiscal revenues of sending countries (Bhagwati and Hamada, 1974). Such fears lead to calls for policies to restrict the flow of highly skilled workers, such as demands that developed countries stop recruiting doctors from developing nations and efforts by developing nations to restrict the ease of their highly skilled individuals migrating.[1] Contrasting with this is the view of a highly educated diaspora as a potent force for developing the local economy through remittances, trade, foreign direct investment (FDI) and knowledge transfers, with the experience of India and China in setting up technology firms as a result of diaspora working in Silicon Valley a prominent example (Saxenian, 2002). Economists have also emphasised that the possibility of migrating may spur human capital accumulation, potentially leading to a net increase in the education levels of those in the home country.[2]

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[1] For example, in 2009 the Algerian Government said it would restrict study abroad scholarships granted to high achievers in baccalaureate examinations in an effort to stem a worsening brain drain, and Uganda began requiring doctors who wish to pursue further studies abroad to make a written commitment to return to Uganda. On the receiving side, the World Federation of Public Health Associations adopted a resolution in 2005 supporting ethical restrictions on international recruitment of health professionals from developing countries.

[2] See Mountford (1997), Vidal (1998), Stark *et al.* (1997) and Schiff (2006) for this theoretical debate, Beine *et al.* (2008) for cross-country empirical evidence and Chand and Clemens (2008) for a case study in Fiji. Kapur and McHale (2005) and Docquier and Rapoport (2010) provide good recent reviews of the literature.

What is sorely lacking in such discussions is empirical evidence as to what the experience has been in practice for countries facing high rates of high-skilled emigration. Recent large-scale data efforts provide a much improved evidence base for describing the scale of high-skilled emigration (Docquier and Marfouk, 2006; Beine *et al.*, 2007) and in Gibson and McKenzie (2011) we have used data from three island countries to investigate the determinants of migration and return migration decisions by the highly skilled. Yet quantitative evidence on the extent to which the many theoretical channels operate in practice in determining the consequences of high-skilled emigration is almost non-existent. In particular, it is unclear whether it is common for highly skilled emigrants from high migration countries to actually be engaging in knowledge transfers, trade and FDI, or whether the experience of Chinese and Indian IT companies is so famous because it is the exception, not the rule. We also do not have empirical evidence as to what the size of the fiscal effect is, and how the magnitudes of these different channels compare with the size of the gains experienced by the migrants themselves.[3]

The purpose of this article is to provide the first systematic empirical evidence on these issues. Given the complete lack of micro-level empirical evidence for most of the channels through which migration of high-skilled individuals is hypothesised to have impacts, the goal in this article is to provide a comprehensive view of these impacts. Some of the channels, such as the gain in income from migrating, are more easily measured and quantified than others, such as the role of the diaspora in knowledge sharing. Our goal is to quantify what we can, and for the cases where we cannot provide a dollar amount on the impact, at least provide quantitative evidence as to whether this channel appears to be operating for many migrants in practice or not. Taken together, the evidence in this article provides a detailed and innovative look at the many channels through which high-skilled emigration can have an effect.

To do this we chose five countries which represent a range of the types of countries experiencing very high rates of high-skilled emigration. Tonga and the Federated States of Micronesia (hereafter Micronesia) are small island states, which Beine *et al.* (2008) show to have the highest 'brain drain' rates in the world.[4] Papua New Guinea is a larger developing country in the Pacific with much lower overall levels of migration but also a high brain drain rate. Ghana was chosen as one of the best-known examples of a sub-Saharan African country grappling with high brain drain and New Zealand as the Organisation for Economic Cooperation and Development (OECD) country with the highest brain drain rate. If we care about brain drain, it is precisely the experiences of countries like these, which have the highest rates, which should be informative, rather than the experiences of India and China, for which fewer than 5% of the tertiary educated population are living abroad.

[3] Nyarko (2010) provides illustrative calculations of the internal rates of return to tertiary education in Ghana that a social planner would face, allowing for both permanent emigration of the tertiary educated ('brain drain') and emigration followed by return ('brain circulation'). The net present value from those who permanently emigrate exceeds that of the returnees and the stayers because the assumed value of remittances outweighs the value of extra output created by the tertiary educated who never leave. But the values used for earnings, remittances and migration propensities are based on reworking of existing data, rather than new empirical evidence, and also ignore distributional issues such as to whom the benefits accrue.

[4] These brain drain rates measure the share of adults with tertiary education born in a particular country who are living abroad.

In each of these countries we pursue an innovative survey methodology, which consists of identifying a well-defined target sample frame of interest – individuals who were the top academic performers in the country at the time of their high school graduation – and then tracking down these individuals wherever they currently live in the world and surveying them. Altogether this involved collecting data on individuals living in 45 different countries, and asking them detailed questions about their migration and educational histories, and the channels through which they interact with their home countries while abroad. We then form counterfactuals for what these individuals would be doing at home through also surveying academically similar non-migrants and return migrants, and through direct elicitation.

Through this approach, the main contribution of the article is to measure and quantify for the first time a number of the key economic effects of high-skilled emigration. We estimate that the best and the brightest stand to gain $40,000–75,000 per year from emigrating from these five countries.[5] This gain to the migrants swamps by an order of magnitude any of the other measured impacts: annual remittances of $2,000–7,000, trade and FDI effects which are infrequent and at most of similar gross value to remittances, and annual fiscal impacts which are at most $1,000 for Tonga and Micronesia, $6,000 for Ghana, $10,000 for New Zealand and $17,000 for Papua New Guinea. We also find migration to lead to large increases in human capital of the migrants; little evidence of net knowledge transfers to home governments or business but significant provision of knowledge about study and work opportunities abroad by highly skilled emigrants. Our assessment of the likely size of possible negative externalities from the absence of these individuals suggests that such externalities are small relative to the magnitude of the benefits from emigration.

A crucial issue in interpreting our findings is whether gains to the migrants are counted when calculating net benefits and costs for the sending countries. Place-based measures of economic welfare, such as gross domestic product (GDP) per resident, exclude the gains to people who emigrate. This exclusion is based on the statistical convenience of national accounts rather than on welfare-theoretic grounds (Clemens and Pritchett, 2008). Another argument for ignoring welfare gains to emigrants when adding up costs and benefits to sending countries is based on the belief that governments only consider welfare of current residents rather than of all those born in their country. But this introduces a dynamic inconsistency, as the best and brightest are current residents at the time of their schooling and at the time of their emigration decision. Moreover, this belief ignores the trend for countries to allow external votes from those living abroad. Currently, external voting is allowed by 115 countries and territories, although in some cases with restrictions on the types of elections and for how long they can be abroad before losing the right to vote at home (IDEA (International Institute for Democracy and Electoral Assistance), 2007). Moreover, a smaller number of countries even allow their citizens abroad to elect their own representatives to the national legislature. The view taken in this article is that citizens of high emigration countries include those who emigrate, so we include the benefits to the emigrants when adding up overall costs and benefits for the sending country.

[5] All values are expressed in current US dollars as of January 2010.

The remainder of the article is structured as follows. Section 1 discusses our unique survey and the incidence of high-skilled emigration among the best and brightest; Section 2 estimates the impact of migration on the incomes and human capital of the highly skilled; and Section 3 attempts to measure the value of impacts on trade, FDI and fiscal balance, as well as to provide evidence on the extent of various knowledge transfers. Section 4 concludes.

1. Surveying the Best and Brightest

The small existing microeconomic empirical literature on the brain drain has generally focused on individuals from a selected profession. For example, Hunter *et al.* (2009) consider Nobel Prize winners and highly cited scientists, Ben-David (2007) Israeli economists, Clemens and Pettersson (2008) African health professionals, Commander *et al.* (2004) doctors in the UK and Constant and D'Agosto (2008) Italian researchers and scientists abroad. However, in addition to these studies lacking detailed micro-data on the interactions migrants have with their home countries, there are several concerns with such occupation-specific studies when it comes to looking at the consequences of high-skilled migration. First, the initial decision to become a physician, scientist, economist or other such occupation may be closely tied to the desire to migrate – with skill-selective criteria for immigration to many countries, high talent individuals who wish to emigrate may select the occupations that offer the best prospects for doing so, while similar individuals who do not wish to emigrate may choose other occupations. Second, training for the occupation may itself only occur through migration. This is particularly the case in small countries, which do not have Ph.D. programmes or medical schools. Finally, whether or not individuals remain in an occupation may depend on whether they emigrate or not – low-paid professionals who do not emigrate may move to more remunerative private sector jobs while emigrants may have trouble getting certified to work in their home country professions. For all these reasons it seems unlikely that the right counterfactual for a high-skilled individual abroad is necessarily someone in the same occupation in the home country.

1.1. *Our Methodology*

Instead, the methodology we propose is to define a target sample of interest that can be identified *before* migration has occurred and then to survey these individuals regardless of their subsequent emigration and occupational choices. In our case, we specify the target sample of interest as individuals who were the 'best and brightest' in terms of their academic performance at the end of high school in their home countries. This can be objectively measured in terms of top performance in national examinations, or in terms of being named as one of the top academic performers in the school such as a valedictorian or Dux, salutatorian or proxime accesit. Moreover, it can be measured *ex post*, with the target sample then set as individuals who were top of their high school classes in earlier years who are surveyed in the present. In our application that follows, we focus on students graduating high school between 1976 and 2004, which gives a compromise between the better records on more recent students and the longer work histories for earlier students.

We are not claiming this is the only population of interest for looking at consequences of brain drain. But it is one important subgroup of interest – the academic high achievers. These individuals go on to work in many of the occupations that countries worry about in terms of brain drain: our sample contains individuals who have become doctors, engineers, computer scientists, academics, scientists and business leaders. These academic high achievers also go on to occupy a high earnings rank (e.g. our average sample member is at the 93rd percentile of the New Zealand earnings distribution), highlighting the fiscal consequences of their mobility for countries with progressive income taxation. Moreover, it is a subgroup whose composition is likely less affected by desire to emigrate than studies focusing on a specific occupation.

Our focus on the best and brightest is also justified by the stress in the literature that it is likely to be the migration of the most skilled and talented individuals for which any negative effects are greatest. Kapur and McHale (2005, p. 97) write that 'clearly people of exceptional talent have a highly nonlinear impact'. But little empirical evidence is available on the migration of the 'best and brightest'. The only study which exists is a simple descriptive exercise which examines the emigration rates of graduate students of IIT Mumbai, one of India's most prestigious tertiary institutions, in the 1970s, finding 31% settled abroad, compared with an estimated migration rate of 7.3% for engineers in the country as a whole (Sukhatme, 1994).

1.2. *Country Choice*

Brain drain rates, as measured by the share of tertiary-educated individuals born in a given country who are living abroad, are highest in small states and a few sub-Saharan African countries (Beine *et al.*, 2007, 2008) and it is in such places that concerns about the possible negative consequences of brain drain are most common. We therefore chose to focus our survey efforts in such countries. We began by choosing three developing countries in the Pacific – Micronesia, Papua New Guinea and Tonga, as the Pacific Islands are the region with the highest brain drain rate in the world (Docquier and Marfouk, 2006). We then also chose Ghana, which has one of the highest brain drain rates in sub-Saharan Africa and which has been one of the countries most involved in discussions about medical brain drain. Finally, we chose New Zealand, which is the OECD country with the highest tertiary brain drain rate. The population, gross national income (GNI) per capita in current US dollars,[6] and brain drain rate in the year 2000 for those who entered the destination country after age 18 (Beine *et al.*, 2007) are:

- *Ghana*: 23.4 million population, $US670 GNI per capita, 44.9% brain drain rate.
- *Federal States of Micronesia*: 107,000 population, $US2,340 GNI per capita, 36.9% brain drain rate.
- *New Zealand*: 4.3 million population, US$27,940 GNI per capita, 15.8% brain drain rate.
- *Papua New Guinea*: 6.4 million population, $US1,010 GNI per capita, 19.8% brain drain rate.
- *Tonga*: 110,000 population, $US2,560 GNI per capita, 65.1% brain drain rate.

[6] Population and GNI per capita are World Bank 2008 estimates.

These countries offer an interesting range of population sizes, levels of development and also opportunities for migration. Micronesia and New Zealand both have free mobility to an important migrant destination – Micronesia to the US and New Zealand to Australia – whereas in the other countries individuals can only migrate through satisfying the requisites of particular immigration categories.

1.3. *The Sample Frame and Survey*

In each country we assembled a sample frame of the top academic achievers in the country, for individuals graduating high school between 1976 and 2004, using a mixture of government and school records. Appendix A discusses the specifics of sample frame construction for each country. We then attempted to track down these individuals and survey them in their present country of residence. The tracking effort was extensive, involved visits to high schools and home communities, online and phone book search, the involvement of school alumni networks and asking located students to help identify others. Individuals were then administered a survey with detailed questions on their migration and educational histories, their current occupation and the channels through which they interact with their home countries when abroad. These surveys were carried out online, in-person and in some cases by phone.[7] The survey efforts began with the Tongan sample in late 2007, and finished with the Ghanaian sample in late 2009.

Table 1 summarises the results of this surveying effort. Our total sample frame consisted of 4,131 individuals from the five countries, of which we were able to interview 1,240 (30%). The survey interviewed individuals who are now living in 45 different countries. The survey success rate varied across source countries, ranging from 15% in Ghana to 73% in Tonga. This reflects both differences in our ability to track individuals from different countries, as well as differential survey response rates, with fears about identity theft making some high achievers reluctant to participate in an online survey. Even in cases where we could not survey the individual, we endeavoured to identify their current location, either directly from them or from friends and family. Current location is known for the majority of the sample frame from Tonga, Micronesia and New Zealand, and for 47% of the full sample.

We view these response rates as incredibly high, given the logistics of tracking individuals over multiple countries based only on a name (which may have changed for some women upon marriage) and the high school they attended. This is particularly the case given the sample of interest are individuals with very high opportunity costs of time, who typically have lower survey response rates. By way of comparison, Bertrand *et al.* (2010) had a response rate of 31% *conditional on having an email address* for their study of another group of high achievers, 1990–2006 Chicago GSB graduates. Nevertheless, we are sensitive to the possibility of potential bias caused by incomplete tracking. In particular, we can examine how sensitive the measured migration rates are to survey non-response, using both the known characteristics (age and gender) of the individuals not surveyed, as well as through comparison of the individuals who took

[7] The New Zealand surveys were all performed online. In the other countries not all top students had email addresses or easy online access, and so in-person and phone surveys were used as additional means to interview individuals. This is similar to the approach used with national censuses, whereby individuals who do not fill out the questionnaire and return it by themselves are followed up and interviewed in person.

Table 1

Sample Sizes, Response Rates and Migration Rates

Country	No. in sample frame	No. of survey respondents	Survey rate	Current location known: Number	%	% female	No. of current migrants	% of 22+ who ever migrated	% of 22+ who are current migrants
Ghana	1,851	283	15.3	605	32.7	36.6	106	59.9	37.6
Micronesia	472	157	33.3	319	67.6	59.2	65	84.1	41.4
New Zealand	851	371	43.6	476	55.9	39.9	155	67.8	44.4
Papua New Guinea	691	236	34.2	298	43.1	34.2	22	36.8	9.5
Tonga	266	193	72.6	245	92.1	52.3	98	85.7	48.2
Total	4,131	1,240	30.0	1,943	47.0	39.4	446	64.6	35.8

Notes. % female indicates number of current migrants; % of 22+ who ever migrated and who are current migrants pertains to the sample, not the population.

more effort to locate to those located more easily. The results suggest relatively little bias from non-response, at least with regard to migration status.[8] In terms of looking at the consequences of migration, we believe that if there is any bias, it will be towards not being able to locate the less successful individuals. To the extent this is the case, it should mean we are obtaining upper bounds on the extent to which migrants are engaging in certain activities such as trade and investment. Section 3.7 discusses robustness to sample non-response in more detail.

1.4. *Migration Rates*

Table 1 demonstrates that the incidence of migration is very high among this highly skilled population. In our sample, 65% of the best and brightest aged 22 and over have ever migrated overseas since graduating high school, and 36% are current migrants. Comparing these numbers also indicates a high rate of return migration. The highest rates of ever migrating are in Tonga and Micronesia, the two smallest countries. Both countries have very limited tertiary education options at home, and so migration is needed for education. The lowest current migration rate is seen in Papua New Guinea, whose citizens have rather limited options for migration. Educational scholarships which bond individuals to return are one additional factor limiting the extent to which individuals who go abroad to study can stay on and work afterwards in this case. Overall, the sample gives us sufficient migrants to examine the micro-level consequences of high-skilled emigration, along with individuals of similar ability who are located in the home country and can be used in forming counterfactuals.

2. Impacts on the Migrants Themselves

In general, the largest gains from migration accrue to the migrants themselves. Yet measurement of these gains has been relatively neglected in the literature, with the labour literature focusing on the impact of immigration on natives and the develop-

[8] See Gibson and McKenzie (2011) for details of this for New Zealand, Papua New Guinea and Tonga.

ment literature focusing on the impact of emigration on individuals remaining in the source country. Ignoring the impact on the migrants themselves will lead to a distorted view of the economic benefits and costs of migration for source countries, as the most major effect could be to make natives of these source countries considerably better off. Ignoring migrants can also give biased measures of the living standards of the best and brightest from developing countries.[9] We therefore begin with estimation of the gains in income and education that high-skilled individuals gain through migration.

2.1. *The Income Gains from High-Skilled Emigration*

Panel (*a*) of Table 2 presents the mean, standard deviation and median annual gross income earned by individuals who are currently non-students and employed abroad.[10] We convert all currencies to US dollars at the exchange rates prevailing at the time of the survey. The mean annual income earned by emigrants is $57,000 for Micronesians, $88,000 for Tongans, $93,000 for Papua New Guineans, $102,000 for Ghanaians and $116,000 for New Zealanders. These are many multiples of per capita income for the developing countries and considerably higher than the incomes being earned in the home country by return migrants and non-migrants (Table 2, panel (*b*)). A simple estimate of the income gain from migration is then just obtained by comparing these two means ($A - B$ mean in Table 2), and shows an annual income gain ranging from $US35,000 for the Micronesians to US$79,000 for the Ghanaians. At a discount rate of 5% per year, the gains from spending 30 years working abroad rather than at home would thus range from $532,000 to $US1.27 million.

Typically a simple comparison of migrants and those in the home country would not be very informative about the gains from migration because of concerns about selectivity. In our case, such concerns should be a lot less severe, as we are looking at a group of individuals who are all very similar in terms of ability (implicitly we are already matching individuals in terms of performance in high school). In Gibson and McKenzie (2011), we have used these same data for New Zealand, Papua New Guinea and Tonga to examine the determinants of migration and return migration. Our analysis finds migration decisions to be largely because of preference variables such as family and lifestyle reasons and risk preferences, and not related to the income opportunities available. To a first order the non-migrants and return migrants may therefore be a reasonable counterfactual for what the migrants would be earning were they in the home country. Nevertheless, we employ several approaches to examine how robust these estimates are. The first is to control for observable differences through a regression:

$$INCOME_i = \alpha + \beta CURRENTMIGRANT_i + \gamma' \boldsymbol{X}_t + \varepsilon_i. \tag{1}$$

We control for age, sex, country of birth (as some of the top students were themselves immigrants), mother's and father's education and self-assessed family wealth at the end

[9] See Beegle *et al.* (2011) for related evidence that failure to track internal migrants dramatically understates progress in living standards in Tanzania. In contrast, Fuwa (2010) finds negligible effects of failing to track internal migrants on well-being measures in the Philippines – which is likely attributable to a setting in which most internal migration is for non-economic reasons and to neighbouring rural areas.

[10] The employment rate is very high among our sample once we exclude students, so we ignore selection into employment.

Table 2

Annual Gross Income Gain from Migrating at Market Exchange Rates

Country	(*A*) Annual income abroad of current migrants (USD) Mean (SD)	(*A*) Median	(*B*) Annual income at home of return and non-migrants (USD) Mean (SD)	(*B*) Median	(*C*) Annual income current migrants expect to earn at home (USD) Mean (SD)	(*C*) Median	Estimate of annual income gain: $A - B$ mean	$A - C$ mean	Regression estimate 1 (SE)	Regression estimate 2 (SE)	2SLS estimate
Ghana	101,696 (87,543)	76,986	22,565 (30,468)	13,712	24,627 (38,159)	14,064	79,131	77,069	61,826 (10,735)	60,808 (11,049)	n.a.
Micronesia	57,261 (43,044)	44,200	22,286 (15,631)	18,200	17,205 (9,716)	20,000	34,975	40,057	36,799 (8,699)	38,083 (10,219)	40,773 (33,245)
New Zealand	115,505 (89,287)	83,707	75,139 (51,249)	61,077	65,614 (33,696)	60,753	40,365	49,890	44,788 (9,484)	46,155 (10,943)	n.a.
Papua New Guinea	92,660 (60,187)	73,500	24,623 (27,655)	13,710	43,061 (36,373)	28,599	68,038	49,599	43,902 (21,747)	50,294 (22,460)	n.a.
Tonga	88,156 (96,201)	60,991	12,593 (15,986)	8,772	11,325 (10,099)	9,640	75,563	76,832	67,982 (22,028)	53,631 (17,398)	n.a.

Notes. All estimates are for individuals currently employed and who are non-students. Regressions control for five-year age groups and sex, country of birth, mother's and father's education and self-assessed family wealth at the end of high school. Regression estimate 2 also contains a dummy variable for being a return migrant. All regressions apart from those for New Zealand also include school fixed effects. Instrumental variable in the two stage least squares (2SLS) estimate for Micronesia is experiencing a typhoon in their home region when aged 18–22 years, first-stage F-statistic is 3.63 ($p = 0.06$). n.a. indicates not available.

of high school (above average wealth, average wealth or below average wealth). We also control for school fixed effects in the four developing countries as the definitions of top students are school-specific in these countries. These variables control for family background characteristics and potential differences in school quality which might plausibly affect both income earned and migration choices. Note that this regression does not control for education or occupation as both are potential consequences of migration decisions – indeed two important channels through which emigration could affect income are by allowing individuals greater opportunities to attain education and possibilities to work in occupations that they were not able to at home.

The results are shown as regression 1 in Table 2. We also consider a second specification, which separates out the return migrants from the non-migrants:

$$INCOME_i = \alpha + \beta CURRENTMIGRANT_i + \delta RETURNMIGRANT_i + \gamma' X_i + \varepsilon_i. \quad (2)$$

This specification uses only non-migrants as the comparison group, rather than all individuals working in the home country. We discuss the coefficients on the return migrant dummy in a later Section of the article. Comparing the regression estimates with the simple comparison of means gives broadly similar estimates of the income gains, with the controls having most effect for Papua New Guinea and Ghana.

A second approach is to ask the migrants directly what income they would expect to earn if they were instead working at home. This approach has the advantage of setting the counterfactual as exactly what we would like: the identical individual working at home. These high-skilled individuals seem quite well informed about salary levels in their home countries, and we see, for example, someone who says they would be an academic in the home country reporting they would earn an income similar to those of people we actually observe in our data as academics in the home country. Panel (*c*) of Table 2 summarises these answers, while the difference ($A - C$) is the mean self-assessed income gain from migration. This difference is very similar to the regression estimates for three of the five countries. The exceptions are Tonga, where the regression estimates of \$54,000–68,000 are a little bit lower than the simple difference in means of \$76,000–77,000; and Ghana where the regression estimates of \$61,000–62,000 are lower than the differences in means of \$77,000–79,000. Nevertheless, the regression estimates still show large gains and the simple differences in means are still well within the confidence intervals for the regression estimates even in these cases.

Finally, we attempted to construct instrumental variables for migration. We examined three classes of potential instruments. The first was macroeconomic shocks and political events such as coups; the second was birth-order; and the third was shocks such as parental illness and extreme weather events that occurred when the individual was aged 18–22 years (the prime age for migration in the sample). The latter two categories of variables were only collected for Ghana and Micronesia. We found these types of variables had very low predictive power for predicting migrant status, with the only (weakly) significant first stage being in Micronesia, where individuals who experienced a typhoon in their home region when aged 18–22 years were more likely to have migrated (F-statistic of 3.63). The two-stage least squares estimate using this as an instrument gave a similar income gain to that obtained using the other two approaches.

Despite this lack of an instrument, we believe it is unlikely that self-selection could be driving the results obtained here. In particular, the $(A - B)$ and $(A - C)$ estimates give similar income increases whether comparing the migrants to the non-migrants or to what the migrants believe they themselves were earn at home. Moreover, the large gains in income are consistent with recent evidence from Clemens (2010), who finds Indian IT workers getting sixfold increases in income when working for the same company with the same technology and getting to migrate to the US as a result of being selected by lottery to have their H1-B visa processed.

The estimates in Table 2 give the gross income gain from migration at market exchange rates. In Table 3, we examine how these gains change once we allow for cost of living differences and for net, rather than gross, income. The first column repeats the estimate of the gross income gain in US dollars at the market exchange rate, based on regression estimate 2 in Table 2. We do not believe that the International Comparison Program (ICP) purchasing power parity (PPP) rates are the appropriate adjustment for cost-of-living differences among the countries in our study. First, Papua New Guinea, Tonga and Micronesia were not covered by the ICP and the model used to impute PPP rates for countries not directly surveyed takes no account of population size, remoteness or ruggedness of terrain, all of which serve to increase prices.[11] As a result, PPP rates understate the cost of living in remote, rugged, Pacific Islands. Second, the goods and services demanded by these high-earning individuals are likely to differ substantially from the basket of goods used for calculating PPP. For these reasons, we consider an alternative cost-of-living adjustment.

The cost-of-living adjustment we use comes from custom tables kindly provided by Xpatulator.com, a commercial service that collects cost of living in 276 global locations, which it uses to assist companies in determining expatriate pay levels and international salary levels in different countries. The overall cost-of-living comparison is based on a comprehensive set of consumption items. Relative to Washington, DC, the cost of living is estimated to be 38.1% cheaper in Tonga, 10.6% cheaper in New Zealand, 4.8% cheaper in Ghana, 14.6% more expensive in Micronesia and 27.7% more expensive in Papua New Guinea. The higher cost in Papua New Guinea and Micronesia reflects much more expensive communications, recreation, clothing, alcohol and tobacco and transport costs in these countries.

The second column of Table 3 shows the gross gain using this adjustment. The biggest change is seen for New Zealanders, whose adjusted gain is $25,329 compared with $46,155 without cost-of-living adjustments. This reflects the fact that New Zealand is relatively cheaper to live in than the US, while Australia and the UK, the other two main destinations for this group, are more expensive.[12] The adjustments are smaller for

[11] International Comparison Program (2008).

[12] By way of comparison, using PPP exchange rates would give a gain of $43,375, reflecting that market exchange rates for the New Zealand dollar happened to be near PPP levels at the time of the survey but that the PPP comparisons which had taken place several years earlier do not reflect changes in prices that occur as the exchange rate changes. Xpatulator data is based on more recent comparisons, so we take it as more accurate. For the Pacific Island developing countries, PPP data will tend to give smaller estimates of the income gain than Xpatulator data, because of the PPP data understating the cost of living in these locations. For example, the PPP income gain for Tonga is 41,577, compared with the gain of 50,697 in column (2) of Table 3. Regardless of which is used, this gain is still large.

Table 3

Alternative Measures of Income Gain

	Gross gain from Table 2 regarding estimate 2	Gross gain adjusted for cost-of-living	Gross gain adjusted for cost-of-living and hardship	Net gain at market exchange rates	Net gain adjusted for cost-of-living and hardship
Ghana	60,808	45,045	48,971	41,382	34,615
	(11,049)	(9,726)	(9,272)	(7,938)	(6,662)
Micronesia	38,083	43,181	43,002	29,323	32,984
	(10,219)	(10,692)	(10,299)	(7,391)	(7,310)
New Zealand	46,155	25,329	32,771	33,536	21,258
	(10,943)	(11,749)	(11,131)	(7,126)	(6,899)
Papua New Guinea	50,294	33,047	35,556	66,545	38,697
	(22,460)	(10,186)	(8,964)	(32,033)	(14,003)
Tonga	53,631	50,697	45,267	44,863	31,860
	(17,398)	(24,495)	(22,534)	(12,260)	(14,245)

Notes. Cost-of-living adjustment and hardship adjustments provided by Xpatulator.com. See text for details on what these measure. Net gains reflect reported income tax paid by survey respondents in each country. Standard errors are given within parentheses.

the four developing countries, and in some cases high costs-of-living at home are offset by higher costs-of-living in the main destination countries.

These calculations make no adjustment for the relative quality of living conditions in different locations. Xpatulator also provides a second comparison, which incorporates both cost-of-living differences and the hardship experienced by lower quality living conditions in different locations. We asked them to calculate the amount in local currency that would give the same quality of living as someone living on $US60,000 in Washington, DC, and use this to obtain a second measure of the gross gain. Column (3) gives these estimates, which are similar to those using only the cost-of-living adjustment.

Grogger and Hanson (2011) find that post-tax earnings are a stronger correlate of migration than pre-tax earnings. It is therefore instructive to also examine the size of the net income gains, despite the fact that we are unable to measure the government benefits that might accrue to migrants in different locations from paying different tax rates. Column (4) provides the net income increase at market exchange rates, and column (5) adjusted for cost-of-living. The net income gains are less than the gross gains in absolute terms but are still considerable. Even after adjusting for cost-of-living differences and taxes, we still estimate the annual gain in income to be $32,000–$39,000 for each of the four developing countries and $21,000 for the New Zealanders. There is thus a large economic benefit to the high-skilled individuals from migrating, and the magnitude of this will provide a point of reference for the impacts through other channels seen in the remainder of the article.

There is long-running debate in economics about how much of the gaps in incomes across nations and regions are because of differences in factor endowments versus differences in the productivity of those factors; for a summary, see Clemens (2010). The large increases in income for skilled workers here are consistent with the view that there are large differences across the world in earnings for workers of the same skill (Rosenzweig, 2006) and that much of this difference arises from specific features of the location (Glaeser and Resseger, 2010).

2.2. *Human Capital Formation*

In addition to the gain in income, another important benefit of migration for the migrants is the additional education they can gain abroad. The income gains reported before already provide one measure of the economic benefit to the migrants from this additional education but it is also of interest to look directly at the extent to which education is accumulated through migration. Panel A of Table 4 summarises the educational levels of the migrants in our sample, focusing on individuals aged 22 and over, who might be expected to have finished their undergraduate studies. We see that almost all these individuals who were academic high achievers in high school have gone on to receive a bachelor degree, the exception being Micronesia, where two-year associates degree were the highest educational qualification of many. In Tonga and Micronesia, 100% of the migrants had received their bachelor's education abroad, reflecting the limited tertiary education options in these countries. It is also common for our sample to have continued onto more advanced degrees such as a masters or PhD, medical doctorate or law degree.[13] These advanced degrees are almost exclusively earned abroad: 100% of the Tongan, Micronesian and Papua New Guinean migrants in our sample with advanced degrees earned them abroad, as did 86% of the Ghanaians and 75% of the New Zealanders. This is despite Ghana, Papua New Guinea and New Zealand having domestic education systems which offer the possibility of these degrees.[14]

Panel B summarises the corresponding educational achievements of the individuals currently resident in the five source countries. The proportion with a bachelor degree is similar to that of the migrant group but lower proportions in each country have an advanced degree. In Tonga and Micronesia the bachelor degrees were mostly earned abroad, whereas in the other three countries they are mostly earned domestically. With the advanced degrees, 28% of those in Ghana and 49% of those in Papua New Guinea had earned them abroad.

Panel C of Table 4 then reports marginal effects from probit estimation of (2), using having a bachelor degree and having an advanced degree as the outcomes of interest. The coefficients on the return migrant term will be discussed in the next Section. We confirm the association between current migration and higher levels of undergraduate degrees among Tongans and Micronesians, although the relationship for Micronesians is not quite significant. There is also a strong and significant positive association between being a current migrant and having an advanced degree for each of the five countries. While part of this might reflect selection, the more limited set of educational choices in the home countries suggests that if many of the individuals had not migrated, they would not have obtained the education that they now have. This is confirmed by directly asking the migrants who are currently studying what they would be doing now in their home country if they had not migrated: 0% of the Papua New Guineans, only 12% of the Ghanaians, 13% of the Tongans and 18% of the Micronesians aged 22 and older who are abroad and currently studying say they would be studying now if in the home country. In contrast, 37% of the New Zealanders say they would still be studying

[13] We classify a law degree as an advanced degree as in some countries it requires an undergraduate degree first, whilst in others it is a longer length undergraduate programme than arts or sciences bachelor degrees.

[14] The Micronesians with masters earned at home had earned masters in theology by remote study.

Table 4

Human Capital Formation of Individuals aged 22 and Older

	Bachelor's degree		Master's, law, medical doctor or PhD degree		
	Proportion who have this qualification	Proportion of those with this qualification who earned it abroad	Proportion who have this qualification	Proportion of those with this qualification who earned it abroad	Proportion who took actions due to prospect of migration
Panel (A): Migrants					
Ghana	0.99	0.39	0.73	0.86	0.29
Micronesia	0.50	1.00	0.18	1.00	0.19
New Zealand	1.00	0.13	0.77	0.75	0.07
Papua New Guinea	0.91	0.25	0.64	1.00	0.10
Tonga	0.84	1.00	0.42	1.00	0.14
Panel (B): Individuals in home country					
Ghana	0.98	0.06	0.49	0.28	0.32
Micronesia	0.40	0.90	0.16	0.83	0.16
New Zealand	0.99	0.01	0.57	0.19	0.08
Papua New Guinea	0.86	0.10	0.30	0.49	0.16
Tonga	0.69	0.95	0.34	1.00	0.20

Panel (C): Estimates of the impact of being a current migrant on educational attainment

	Likelihood of having a bachelor's degree		Likelihood of having an advanced degree	
	Coefficient	Standard error	Coefficient	Standard error
Ghana	n.a.		0.280***	0.070
Micronesia	0.251	0.157	0.848***	0.057
New Zealand	n.a.		0.259***	0.057
Papua New Guinea	0.092	0.058	0.451***	0.117
Tonga	0.551***	0.129	0.805***	0.049

Notes. Panel C estimates are marginal effects from probit estimation for the sample aged 22 years and above, with five-year age groups, gender, country of birth, parental education and family wealth while in high school as controls. *, ** and *** indicate significances at the 10%, 5% and 1% levels, respectively. n.a. indicates estimate not available due to almost everyone having a bachelor's degree.

even if they had not migrated. This leads us to believe that most of the measured difference in education rates in Table 4 (panel C) is indeed the true impact of migration on human capital attainment for the individuals from developing countries.

Finally, the recent literature on brain gain (Mountford, 1997; Stark *et al.*, 1997; Vidal, 1998) suggests that the mere prospect of migration can induce individuals to undertake additional human capital investments, even if they do not end up actually migrating. If individuals are obtaining bachelors' or advanced degrees for this purpose, then comparing migrants with non-migrants will understate the gain in education attributable to migration. More generally, there may be other improvements in human capital aside from degrees. Our survey asked whether people had taken additional classes or changed subjects studied during high school to improve their prospects of being able to work or study overseas. The last column of Table 4 shows some evidence of people undertaking such actions, particularly in Ghana, and to a lesser extent in the other developing nations. The main actions taken were to take private lessons, study a language and take test preparation classes to help pass tests such as the SAT. That is, among our sample, any effect is more in terms of what is studied, rather than how much schooling takes place.

3. Empirical Evidence on the Channels Through Which High-Skilled Emigration Affects the Sending Country

We now turn to measuring the economic impacts of migration on the sending countries, attempting where possible to quantify these impacts and evaluate them relative to a counterfactual of what the individual would have been doing had they not migrated.

3.1. *Return Migration*

Developing countries are believed to benefit from return migration, whereby individuals returning with physical and human capital earned abroad are more productive (Dustmann and Kirchkamp, 2002; Mesnard, 2004). Return migration is also hypothesised to have broader payoffs to others in the home country through transfer of skills and knowledge gained abroad (Dos Santos and Postel-Vinay, 2003). Whilst much of this literature has focused on return migration in general, rather than return migration of the highest skilled, Zucker and Darby (2007) show high rates of return migration to Brazil, China and Taiwan (at least for sojourns) of top scientists and Gundel and Peters (2008) show that high-skilled migrants are more likely to remigrate from Germany than low-skilled migrants, although return migration is lower for migrants from non-EU countries.

Table 5 presents our estimates of the impacts of return migration in the five countries studied here. The first column presents the income gain estimated relative to non-migrants through the regression in (2). If return migrants are more productive (either as entrepreneurs or in wage jobs) we should expect them to be earning higher incomes. But we do not find statistically significant gains in any country. The point estimates are negative in Ghana and Tonga, and positive, but not significant, in Micronesia, Papua New Guinea and New Zealand and always much less than the large income gains to be had from remaining abroad (Table 2). The standard errors are generally large relative to the mean, reflecting considerable heterogeneity in the wages earned by these high-skilled individuals in their home countries. Therefore, we cannot rule out income gains from return migration but there is not strong evidence for this.

In contrast, we do see return migrants accumulating additional human capital relative to non-migrants. Columns (2) and (3) of Table 5 present the marginal effects from probit estimation, as in Table 4 (panel C). Increased educational attainment is highest for Micronesian and Tongan returnees, for whom educational options at home are most limited and lowest for the New Zealanders.

In light of these significantly higher levels of education, it may strike the reader as surprising that we do not see more significant positive income gains from return migration. We believe there are two reasons for this result. First, the main determinant of return for many high-skilled migrants is family and lifestyle reasons, rather than employment opportunities (Gibson and McKenzie, 2011). High-skilled migrants may

Table 5

Impacts of Return Migration

	Income gain (USD)	Having a bachelor's degree	Having an advanced degree	Repatriated savings mean (USD)	Trade deals (USD)	Invested in business start-up (USD)	Advise government	Advise company	Advise on work abroad	Advise on study abroad
Ghana	−1,998	n.a.1.	0.210**	24,639	574	3,641	0.05	0.19**	0.33***	0.28***
	(12,956)		(0.078)		(616)	(2,306)	(0.07)	(0.09)	(0.10)	(0.10)
Micronesia	1,507	0.206	0.686***	3,384	27,320	364**	0.34***	0.32***	0.21	−0.08
	(8,124)	(0.152)	(0.054)		(34,237)	(179)	(0.12)	(0.11)	(0.13)	(0.15)
New Zealand	2,871	n.a.1.	0.101	53,707	n.a.2	n.a.2.	0.08	−0.07	0.34***	0.14*
	(8,877)		(0.066)				(0.05)	(0.07)	(0.08)	(0.08)
Papua New Guinea	10,107	0.056	0.333***	4,697	9,912**	6,065	0.28***	0.01	0.35***	0.51***
	(7,949)	(0.060)	(0.096)		(4,307)	(4,766)	(0.07)	(0.10)	(0.09)	(0.09)
Tonga	−8,670	0.455***	0.957***	7,828	2,499	482	0.23	0.29**	0.11	0.43***
	(21,788)	(0.097)	(0.025)		(3,202)	(410)	(0.14)	(0.12)	(0.16)	(0.16)

Notes. Standard errors are provided within parentheses. n.a.1. denotes not available due to almost all having a bachelor's degree. n.a.2. denotes not available due to values not being asked.

be prepared to return to no higher incomes after experiencing some time abroad, to be near ageing parents or to be able to raise their children in the local culture. Second, in our open-ended survey questions, many high-skilled migrants complained about local pay systems which reward tenure rather than productivity. This is particularly common in the public sector, which is an important source of employment in the home country for high-skilled doctors, nurses, teachers and other professionals. This is not unique to our study; in a review of nurse migration Haour-Knipe and Davies (2008, p. 28) lament that

> Although they have new skills, rather than being greeted with open arms, they find themselves in effect demoted to the bottom of the career ladder. They receive lower salaries, lose any accrued benefits and are denied prestige and professional recognition.

The fact that migrants do not return to earn a lot more in their home countries is also consistent with the evidence in Clemens (2010) and suggests that the gain in income from migrating arises because local attributes of the country of work make individuals more productive while they are abroad, rather than the alternative theory that workers learn how to be much more productive when working abroad.

The fourth column of Table 5 provides the mean level of repatriated savings that individuals say they earned abroad and brought back with them when they returned. We do not have absolute savings levels, so cannot compare with a counterfactual of what they would have saved had they remained in their home countries. In Tonga, Micronesia and Papua New Guinea, the amounts are roughly similar in magnitude to annual remittances, and do not suggest migrants are returning with large accumulated wealth that they can use to make sizeable investments in the home country. The amounts are higher in Ghana and New Zealand.

The last columns look at whether return migrants are more likely to be engaging in trade deals, investing in business start-ups and sharing knowledge than are non-migrants. The point estimates are almost all positive, and are significant in a number of cases, providing some evidence to support the idea that return migration has benefits in these areas. Nevertheless, the monetary values of the trade deals and start-up investments are again generally not that large, particularly if we were to consider only the profit or value added of such transactions. Return migrants are more likely to be advising companies, and to be advising others about work and study opportunities abroad.

3.2. *Remittances*

Remittances are the most salient and researched contribution of emigrants to their home countries. However, there is debate as to the extent to which highly skilled emigrants remit. Economic theory provides a number of reasons for remitting (Rapoport and Docquier, 2006). Some of these theories would predict high remittances among the highly skilled – they have high incomes which would predict more remittances in altruism models, and they may be repaying family members for education loans, leading to remittances in an exchange model. However, the high-skilled may also be less likely to need to insure their family members back home and more likely to be able to migrate with close family members, both of which theory predicts would reduce remittances. Cross-country studies based on macro-data have been used to claim the high-skilled remit less (Faini, 2007) whilst recent microeconomic evidence based on surveys of immigrants in a number of destination countries suggests that more educated individuals remit more, with tertiary-educated migrants from poorer countries being more likely to remit than those from richer developing countries (Bollard *et al.*, 2011).

Panels A and B of Table 6 show the incidence and level of monetary and goods remittances that the non-student migrants in our sample are sending to their home countries. Our survey data show a high incidence of remitting among the migrants from developing countries, with migrants from New Zealand being much less likely to remit.[15] For the Ghanaian sample, we can compare our results with the remitting patterns of all Ghanaian migrants in the OECD (Bollard *et al.*, 2010). Eighty-six per cent of all Ghanaian current migrants are remitting, which increases to 93% if we exclude current students. This can be compared with a remitting rate of 66% among all Ghanaian migrants in the OECD. The mean annual amount remitted in monetary remittances conditional on remitting for Ghanaians in our sample is US$4,314, compared with US$3,614 for all Ghanaian migrants in the OECD. Thus, the high-skilled migrants in our sample are remitting more frequently and sending more when they do remit than average migrants, even if the amount remitted as a share of income is lower.

The unconditional mean and median amount remitted then include the zero remittances for those not remitting. The appropriate counterfactual here is that these individuals would not be remitting if they had not migrated. So the net effect of migration on remittances is simply the unconditional mean. Adding together the monetary and goods remittances gives a total impact of $5,000 annual remittances for Ghanaians, $2,100 for Micronesians, $625 for New Zealanders (monetary remittances data only), $7,232 for Papua New Guineans and $4,300 for Tongans. These amounts are significant relative to the per capita incomes of the developing countries, with Ghanaian and Papua New Guinean remittances equivalent to about seven times per capita GDP. Nevertheless, the amounts remitted are only a fraction of what the migrants would have been earning at home (Table 2).

3.3. *Involvement in Trade and FDI*

After remittances, the financial channels through which high-skilled emigrants are often thought to have most positive economic benefits for their home countries are through their involvement in trade and FDI. The experience of Indian, Taiwanese and Chinese information technology firms has been used to suggest that a highly skilled diaspora can use their knowledge of the destination country to lower the costs of transacting across countries (Rauch and Trindade, 2002; Kugler and Rapoport, 2005; Javorcik *et al.*, 2011), and that emigrants can provide venture capital for starting new firms (Saxenian, 2001, 2002). However, such studies and anecdotal evidence tend to

[15] The survey asked the value of monetary remittances and the value of any goods sent as gifts to the home country in the past year separately. The New Zealand version of the questionnaire was designed first, and did not have the question on goods or a question on nostalgic trade included. Apart from this, the content of the questionnaires was identical across countries.

Table 6

Annual Monetary Flows from Migrants to Home Country

	Proportion who sent flow		Annual value in USD				
	All current migrants	Non-student current migrants	Conditional mean	Conditional median	Unconditional mean	Unconditional median	Net effect after subtracting mean for non-migrants (USD)
Panel (A): Monetary remittances (annual)							
Ghana	0.86	0.93	4,334	2,109.6	3,732	1,758	3,732***
Micronesia	0.69	0.68	2,187	1,000	1,359	500	1,359***
New Zealand	0.24	0.26	2,476	486	625	0	625***
Papua New Guinea	0.89	0.90	6,099	2,681	6,085	2,681	6,085***
Tonga	0.63	0.76	4,682	2,651	3,122	1,446	3,122***
Panel (B): Goods and in-kind remittances (annual)							
Ghana	0.74	0.75	1,935	703	1,290	352	1,290***
Micronesia	0.67	0.68	625	450	577	400	577***
New Zealand	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Papua New Guinea	0.90	0.91	1,355	536	1,232	357	1,232***
Tonga	0.63	0.61	2,506	1,446	1,319	482	1,319***
Panel (C): Help a home country firm make a trade deal or exported goods from home country to overseas in last year							
Ghana	0.02	0.03	100,734	25,666	5,596	0	5,436
Micronesia	0.07	0.04	2,918	325	307	0	−147
New Zealand	0.04	0.06	n.a.	n.a.	n.a.	n.a.	n.a.
Papua New Guinea	0.14	0.10	250,244	250,244	25,024	0	24,939
Tonga	0.03	0.04	2,555	2,555	91	0	91
Panel (D): Invested in a business start-up in the home country in last year							
Ghana	0.17	0.22	18,002	2,110	3,750	0	2,445
Micronesia	0.04	0.05	30,050	30,050	1,582	0	893
New Zealand	0.02	0.02	n.a.	n.a.	n.a.	n.a.	n.a.
Papua New Guinea	0.14	0.08	537	537	45	0	−5
Tonga	0.05	0.04	4,844	4,844	404	0	404

Notes. Values are for sample of migrants not currently students. Goods remittances, trade deals and value of business start-ups were not asked of the New Zealand sample. *, ** and *** indicate that net impact is significantly different from zero at the 10%, 5% and 1% levels, respectively.

focus on the cases where these linkages have occurred and do not provide any information as to how common such experiences are, or to whether the experiences of high-skilled IT workers from large economies are translatable to the types of countries where brain drain rates are much higher and domestic markets are much smaller. In particular, remote countries with small populations are unlikely to have large manufacturing sectors, making technology transfer to manufacturing less likely.

Our survey asked emigrants directly whether, in the past year, they had helped a home country firm make a trade deal and, if so, the value of this deal, and whether they had themselves directly exported goods from their home country to sell overseas, and the value. Panel C of Table 6 summarises the results. We see that involvement in trade is very uncommon for this group of the best and brightest, with 3% of the Ghanaians, 4% of the Micronesians and Tongans and 6% of the New Zealanders being involved in trade – the 10% figure for Papua New Guinea represents only 1 of the 10 non-student migrants from this country who answered this question carrying out such activities. One might argue that a low incidence of involvement may still have large overall impact if the occasions where deals are made involve large transactions. For example, one of the Ghanaian migrants in the sample facilitated a 500,000 cedi ($350,000) trade deal with a Ghanaian company, using his knowledge of Ghana to carry out due diligence on the company and his own company abroad to provide concessionary terms in the deal. A second example is the case of a migrant from Papua New Guinea, who met entrepreneurs in China during his work visits there and informed them about the possibilities of importing vanilla from Papua New Guinea. He then contacted vanilla exporters in Papua New Guinea he knew, and linked them up, with an initial order of $250,000.

We therefore report the conditional mean and median value of these transactions, although it is noted that these are based on only one transaction for Papua New Guinea, four transactions in Micronesia and six transactions in Ghana. There are a couple of large transactions, one in Papua New Guinea and one in Ghana, which push the conditional means up for these countries. Nevertheless, when we look at the unconditional means, the low frequency of such transactions reduces the means considerably.

Given how rare such trade transactions are, we do not attempt to formally construct a counterfactual through regression analysis for what trade transactions these individuals would have been doing had they not migrated.[16] Instead, we asked the non-migrants the same questions about trade deals, and take the mean values among non-migrants as the counterfactual. The last column of Table 6 then presents our estimate of the net impact of being a high-skilled emigrant on trade from the home country. For Tonga and Micronesia this net effect is negative but close to zero: trade was uncommon among the non-migrants and the migrants but the mean among non-migrants was slightly higher than the migrants. For Ghana, the mean effect is $5,346, although we cannot reject equality to zero. For Papua New Guinea, the one migrant making a trade

[16] We are interested in measuring the impact on international trade, which is the focus of discussions in the literature. There are conceivably impacts on internal trade as well. For example, a New Zealander in the wine sector, if abroad may convince a US store to import New Zealand wine, if at home can convince a local store to buy the same wine from the producer. From a national perspective, the former is much more likely to increase total demand for New Zealand wine than the latter (which may largely just change which wine local consumers purchase) and so we focus on international trade creation.

deal made a large deal but again we cannot reject equality to zero. Moreover, the value added of this trade creation will depend on the profit margin of the trade deals – if this is only 10–25% of the transaction value, then the mean effect reduces to $500–1,000 in Ghana.

Panel D provides the related answers for whether migrants are providing the capital to start up enterprises at home. Again this is infrequent, with 5% or fewer of the emigrants from New Zealand, Micronesia and Tonga doing this and 8% of the Papua New Guineans. It is more common in Ghana but the amounts invested are relatively small – a conditional mean of $18,000 and median of $2,100 for Ghana, suggesting that most of the businesses being invested in are very small, or that the migrant is not providing the main source of financing. Nevertheless, migrants are more likely to be making such investments in most countries than non-migrants are and so our net effect in the last column, after taking out the mean for non-migrants, is typically positive, although we cannot reject that it is zero.[17] In addition, in answer to a separate question, none of the developing country migrants in our sample reports holding shares in home country firms, showing that they are not making large investments in existing formally established companies.

In contrast, high-skilled emigrants are much more likely to be consumers of traded products from their home countries, often through what Orozco *et al.* (2005) term nostalgic trade. Eighty-seven per cent of Ghanaian non-student migrants in our sample report having purchased Ghanaian food, drink or goods in their destination country, or having ordered goods directly from a Ghanaian retailer for their personal consumption. However, the mean (unconditional) value of goods ordered directly is only $183 and that of Ghanaian products purchased by migrants abroad is $443. Such nostalgic trade is also common among the New Zealand sample, with 87% of emigrants engaging in it,[18] but less common amongst migrants from the small island nations: 47% of Micronesians engaged in such trade, with an unconditional mean value of such transactions of $337 and only 13% of Tongans did, with an unconditional mean value of $36. Given the small numbers of high-skilled migrants in any particular emigrant destination and the small size of these transactions, these high-skilled emigrants are therefore unlikely to spur trade by serving as a significant export market in and of themselves.

3.4. *Non-Financial Flows of Knowledge*

In addition to providing financial support to households and firms in their home countries, high-skilled emigrants are often argued to benefit their home countries through knowledge transfer (Saxenian, 2002; Newland, 2004; Kugler and Rapoport, 2005; Kerr, 2008). Although we are unable to place a monetary value on this knowledge transfer, our surveys at least allow us to provide empirical evidence on how common different types of knowledge flows are among the best and brightest, and to ask whether in fact emigrants engage in more of these types of knowledge flows than they would be doing had they not migrated.

[17] We formally test for equality to zero by regressing the unconditional amount invested on a dummy for being a current migrant, restricting analysis to the current migrant and non-migrant samples of non-students.
[18] The value of such trade was not asked for the New Zealand sample.

Table 7

Annual Non-Financial Flows

	Ghana	Micronesia	New Zealand	Papua New Guinea	Tonga
Panel (A): Proportion of current migrants who are not students engaging in activity in last year					
Provided advice to national Government	0.04	0.13	0.04	0.08	0.13
Advised a home country company	0.16	0.10	0.06	0.25	0.08
Provided advice about study abroad	0.53	0.54	0.26	0.58	0.36
Provided advice about work abroad	0.42	0.44	0.42	0.83	0.44
Sponsored home country national to work/study abroad	0.08	0.13	0.04	0.08	0.20
Carried out research with people in home country	0.14	0.08	0.16	0.25	0.04
Acted as an official representative at an overseas event	0.10	0.08	0.05	0.25	0.16
Advised people overseas about a holiday in home country	0.66	0.44	0.91	0.75	0.56
Panel (B): Net impact relative to non-migrants					
Provided advice to national Government	−0.16***	0.18	−0.08*	−0.26**	−0.01
Advised a home country company	−0.13	0.08	−0.29***	−0.26	0.02
Provided advice about study abroad	0.18**	−0.03	0.13**	0.36**	0.04
Provided advice about work abroad	0.14	−0.10	0.28***	0.62***	0.09
Carried out research in a home/abroad collaboration	0.04	0.03	0.02	0.13	−0.12
Acted as an official representative at an overseas event	0.07	−0.11	0.01	0.10	0.11
Advised people overseas about a holiday in home country	0.29***	−0.03	0.41***	0.51***	0.16

Notes. *, ** and *** indicate significance of net impact at the 10%, 5% and 1% levels, respectively. Net impact is coefficient on current migrant in a linear regression of the outcome on migration status, sex and five-year age group.

Panel A of Table 7 presents the results of questions which asked current migrants whether they had engaged in each of a number of different knowledge transfer activities in the past year. The same questions were asked of non-migrants, and panel B therefore presents the net impact, taking non-migrants of the same age range and gender as the counterfactual for what the migrants would be doing had they not migrated. The first two rows of each panel look at knowledge transfer to the national Government and to home country companies. It is not very common for the best and brightest migrants to be providing this advice: only 4% of Ghanaian and New Zealand emigrants, 8% of Papua New Guineans and 13% of Micronesians and Tongans had advised their governments. The greater incidence in the smaller countries may reflect the greater likelihood of migrants directly knowing policy makers in these small countries, rather than a greater tendency of these governments to reach out actively to their high-skilled emigrants. In panel B, we see the net effect is significantly negative in Ghana, New Zealand and Papua New Guinea, showing that migrants engage in such interactions with the home government less often than non-migrants. There is no significant effect in Tonga or Micronesia. Knowledge transfer to home companies through migrants advising them is similarly infrequent, and has a negative net effect in three of the five countries, which is significant for New Zealanders.

A more common form of knowledge transfer involves migrants informing others about opportunities to study and work abroad. Between 30% and 50% of high-skilled emigrants from these countries had advised someone in their home country about such opportunities in the past year, thereby aiding others in their migration decisions. Migrants are significantly more likely to be doing this than similar non-migrants from most countries. A more intensive form of migration facilitation is to act as the sponsor for a home country national wishing to work or study abroad. This is most common amongst Tongans, with 20% acting as a sponsor. It is least common amongst New Zealanders, with only 4% doing this. As this is something that can only be done when abroad, the net effect of sponsoring is the same as the gross effect.

Another frequent form of knowledge transfer involves migrants using their knowledge of their home country to advise people abroad about taking a holiday in their home country. Ninety-one per cent of New Zealanders, 75% of Papua New Guineans, 66% of Ghanaians, 56% of Tongans and 44% of Micronesians have done this. Although our surveys do not permit quantification of the value of new tourism created by such advice, they do show migrants engaging in this type of tourism promotion much more frequently than non-migrants (with the exception of Micronesia).[19]

Finally, we can examine whether migrants are transferring knowledge to home country researchers through research collaborations. This is not common for Tonga (4%) and Micronesia (8%), where there is little tertiary infrastructure and thus not a large local research community. However, it is somewhat common in Ghana (14%), New Zealand (16%) and Papua New Guinea (25%), showing that there is some evidence of this knowledge transfer. However, of course it is also possible for domestic researchers to work with researchers abroad, and panel B shows that migrants are not significantly more likely to be engaged in a research collaboration involving researchers in the home country and an abroad country than are non-migrants.

3.5. *Fiscal Impacts*

In one of the first academic studies on the brain drain, Bhagwati and Hamada (1974) drew attention to the possible fiscal cost. They noted that highly skilled emigrants take their education with them, which was funded by taxes on existing residents but then do not contribute back into the tax system. We would argue that whether or not education is publicly funded is *ex post* immaterial, as it is a sunk cost when it comes to the time of making a migration decision – what matters is whether the country loses more in the tax revenue (the return on the investment in tertiary education) it would collect from these individuals than it would spend on them going forward in terms of public services.[20] This depends on how progressive the income taxation and benefits systems of

[19] Owing to the importance of emigration in these countries, even non-migrants are likely to have networks of contacts overseas. Non-migrants are likely to have an information advantage over migrants in terms of being able to supply current information on places to stay, new attractions which have opened, new restaurants to eat at etc., but also to know fewer people overseas with whom to share this information.

[20] Nyarko (2010) shows the typical annual cost per student in tertiary education is roughly twice per capita income. So for Ghana, the cost of funding four years of tertiary education would be approximately 8×670 = US$5,360 – or just slightly more than one year's taxes at the mean for these top students in our sample. The ongoing tax revenues lost by absence are therefore far more important for this group than the initial costs of funding their education.

the countries are. We attempt to provide some indication of the likely range of such costs for the countries in our study.

Table 8 details our attempts to calculate the first-order fiscal impact of emigration of the best and brightest. We begin by calculating the income tax that these individuals would be paying if at home. To do this we take the counterfactual income which migrants tell us they would be earning if at home (which we have seen appears to be reasonably accurate) and then use each country's income taxation schedule to calculate the tax per migrant, after which we present the mean and median tax in the Table. The countries differ substantially in both tax rates and in the progressivity of their tax schedules. The lowest taxed and least progressive are Tonga and Micronesia. Tonga has a flat tax rate of 10%, and Micronesia has a tax rate of 6% on the first $11,000 and 10% thereafter. Ghana, Papua New Guinea and New Zealand all have higher tax rates with more steps and progressivity. Ghana has five tax rates, with a top tax rate of 25% on income above $6,700. Papua New Guinea has six tax rates, with the first step beginning at 22% and with a top tax rate of 42% on income above $89,000. New Zealand has four tax rates, with a top tax rate of 38% on income above $57,000. As a result of these low tax rates and low home country incomes, the loss in income tax revenue is only $1,000–1,200 for Tonga and Micronesia per high-skilled migrant. It is higher in the other three countries: $5,000 in Ghana, $14,000 in Papua New Guinea where the migrants believe they would be earning relatively high incomes at home and getting charged high tax rates, and $17,000 in New Zealand.

This calculation assumes that there is no tax evasion. To check this assumption, we compare the difference between reported gross and reported net incomes in each of our five countries to what we would calculate the tax payment to be based on the national tax tables. The actual tax reported by non-migrants and return migrants in their home countries are very similar to what we calculate as the tax they should be paying according to the tax rates. It therefore seems reasonable to assume that migrants would also pay the amount of tax we estimate if they were working in their home countries.

Next, we calculate the sales tax these migrants would have paid if they were consuming these counterfactual incomes in their home country. All five countries have sales taxes or goods and services taxes (GST), with rates ranging from 5% in Micronesia, 10% in Papua New Guinea, and 12.5% in Ghana and New Zealand to 15% in Tonga. The Tongan government estimates that its goods and services taxes apply to approximately 60% of household consumption.[21] We assume the same coverage in the other developing countries and to 90% of consumption for New Zealand, and that all income is spent to arrive at the sales tax figures in the next two columns of Table 6.[22] This is highest in New Zealand at $7,055 per migrant, reflecting the higher incomes and greater coverage of the sales tax net in this country, and lowest in Micronesia where the low tax rate and lower incomes means the lost sales tax revenue is only $383 per migrant.

Few individuals in this sample are owners of businesses, and so we ignore corporate profit taxes in these calculations. We also ignore property taxes – such taxes are typically small in these countries and either the property would be occupied by

[21] '*Utoikamanu (2006)* 'Consumption tax: The Tongan experience', available at http://archives.pireport.org/archive/2007/July/07-27-rp.htm.

[22] Statistics New Zealand estimates that GST applies to 91% of the consumer price index.

Table 8
Annual Fiscal Effects

	Fiscal costs of emigration				Fiscal benefits of emigration					Approximate net fiscal cost	
	Income tax migrants would pay if at home		Sales tax migrants would pay if at home		Sales tax if remittances consumed		Mean household size	Per-capita government expenditure	Per-capita government health and education expenditure	Using full government expenditure	Using health and education expenditure
	Mean	Median	Mean	Median	Mean	Median					
Ghana	4,999	2,430	1,655	791	280	132	3.12	290	20	5,469	6,312
Micronesia	965	600	383	300	41	15	3.08	1,378	259	−2,939	509
New Zealand	17,255	14,450	7,055	6,379	57	0	2.50	12,147	4,521	−6,115	12,950
Papua New Guinea	14,537	8,547	2,588	1,719	131	58	4.00	134	21	16,458	16,910
Tonga	1204	964	1,083	868	281	130	3.60	784	257	−815	1,081

someone else paying the tax, or if left vacant, the owner would still pay taxes on it while abroad.[23]

Offsetting these fiscal costs of high-skilled emigration are two main fiscal benefits. The first is that if monetary remittances are spent on consumption items and the government has a sales tax, then the government gains a share of these remittances. We assume that 100% of monetary remittances are spent, and that again 60% of this spending is taxable. Whilst there is debate in the literature as to the extent to which remittances are used for non-consumption purposes, surveys typically find that at least 80% of remittances are consumed, and even investments in items like materials for starting a business may be taxable. Nonetheless, because high-skilled migrants remit back considerably less than they would be earning in the home country, the effective sales tax revenues on remittances are quite small – ranging from only $56 in New Zealand and $41 in Micronesia, to $130–132 in Tonga and Ghana.

In most cases the larger fiscal benefit from emigration will be that the government does not have to spend on government services for individuals abroad or the family members accompanying them. Table 8 gives the mean household size for the emigrants, which ranges from 2.5 to 4. We then form an upper bound on the fiscal savings by taking the total per-capita government expenditure – this would be the savings if government expenditure was equally distributed across all households in the home country and all spending was variable costs. A possible lower bound on the fiscal savings in many countries can be obtained by taking the per-capita government health and education expenditure, which might be more variable in costs. This may be a lower bound because it ignores the possibility that children of the highly skilled may be more likely to use expensive higher levels of education, and that it ignores any deductions or exemptions that reduce the tax that the highly educated actually pay.

Comparing these costs and benefits leads to our estimates of the approximate net fiscal cost of high-skilled emigration, given in the last two columns of Table 8. We get quite tight ranges on the likely first-order fiscal effects for the four developing countries. In both Tonga and Micronesia the net fiscal cost is at most $500–1,000 per year, and would be negative if we used full government expenditure in the calculations. The fiscal costs are low in these countries because they have low income tax rates that are not very progressive, sales taxes are quite small because of low rates and low incomes and the government's per-capita spending is not much lower (Tonga) or greater (Micronesia) than the estimated income tax taken from even these highly skilled individuals. This reflects the reliance of Micronesia on grants from the US (tax revenue is only 21% of total government revenue) and of Tonga on indirect taxes and grants.

In Ghana we estimate a net fiscal cost of between $5,450 and $6,300 per high-skilled emigrant. These bounds are quite tight, as Ghana's per-capita government expenditure is so low – Ghana has a progressive income taxation system which collects far more in income taxes from the highly skilled than it is paying out in benefits. Our bounds are even tighter in Papua New Guinea, ranging from $16,500 to $16,900. Again in this case per-capita government expenditure is extremely low, and income tax rates on high incomes are quite high – so the fiscal cost greatly exceeds the fiscal benefits.

[23] For example, New Zealand has no land tax, no real estate taxes and no capital gains tax on selling property.

Our range of estimates is much wider for New Zealand, ranging from −$6,115 to $12,950, depending on how much of per-capita government expenditure actually goes to the highly skilled.[24] Crawford and Johnston (2004) provide a more detailed analysis of the receipt of government benefits by decile in New Zealand for the year 1997/8. As a result of New Zealand's highly progressive government spending patterns, households in the top three deciles were estimated to receive only approximately $6,700 per household. Health and expenditure spending approximately doubled between 1998 and 2008, so doubling this figure gives a per household expenditure of approximately $13,400 – which is relatively close to our proxy of $11,302 when using per-capita health and education spending. This gives our best estimate of the fiscal loss to New Zealand of high-skilled migration at $10,000 per high-skilled migrant who leaves.

We acknowledge that there are a number of simplifying assumptions in making these calculations, but we believe that they capture the first-order magnitudes.[25] They show how much the fiscal cost depends on the progressivity of the income tax system, the role of sales taxes in allowing migrant-sending countries to receive some fiscal benefit from remittances, and some sense of the fiscal benefits.[26] What is noticeable is how small these fiscal costs are relative to the income gains estimated for the migrants themselves in Table 2, and that they are smaller than the amount remitted in Micronesia and Tonga, and of roughly the same size as the amount remitted plus value of trade created for Ghana and Papua New Guinea.

3.6. *Externalities*

These findings enable us to come close to being able to estimate the first-order net economic effect of highly skilled emigration on individuals from developing countries.[27] The one key effect we cannot measure is the uncompensated externalities of high human capital. Such externalities have been at the heart of brain drain debate

[24] One might ask how it is possible that per-capita total government spending exceeds the income tax revenue coming from a household which would be in the top 10% of the domestic income distribution. There are at least two reasons for this. First, income taxes and goods and services taxes account for only about 60% of government revenue – the remainder comes from corporate taxes and other sovereign revenue which we are assuming are unaffected by migration. Second, we are ignoring any income taxes that would be paid by the spouse of the high-skilled migrant. As 35% of New Zealand migrants in relationships in our sample have a spouse or partner who is not a New Zealand citizen, calculating the effect of the spouse's income would require thinking about counterfactual spouses also. The overall effect is likely to be second order.

[25] In particular, it is an implicit assumption that taxes collected from non-migrants and return migrants would be unchanged if a current migrant had not migrated. But in small countries with limited opportunities to utilise specialised skills the labour demand curve may be quite steeply sloped. Hence, if emigrants returned or had never left there may be lower earnings for other workers and a lower tax take. Our estimated net fiscal costs of emigration are therefore likely to be an upper bound.

[26] Of course changes in the progressivity of the tax system may themselves lead to changes in the rate of high-skilled emigration, with individuals being more likely to leave places where their marginal tax rates are higher. We are not aware of any empirical evidence as to what this international emigration-progressive tax elasticity is.

[27] There are of course a large number of social impacts from migration, such as changes in access to cultural and travel opportunities, in access to amenities, in opportunities to consume certain products and in impacts on relationships with family and friends. We do not attempt to value these factors in this article, but acknowledge their importance in driving migration decisions. In addition, in equilibrium high-skilled emigration may have distributional effects: a reduction in the supply of high-skilled individuals could lead to an increase in the wages paid to those high-skilled individuals remaining, increasing prices for locals who consume their services. Our surveys do not yield information on these effects and so our analysis should be considered as giving the impact of a marginal change in high-skilled emigration.

since the beginning. Grubel and Scott (1966) noted that if labour markets are competitive and individuals paid their marginal product, then if there were no externalities, the departure of highly skilled emigrants would not reduce the welfare of those left behind.[28] Bhagwati and Hamada (1974), p. 19) made the case that such externalities could be important with 'doctors and exceptionally gifted academics about whose emigration typically the underdeveloped countries seem to worry', although Bhagwati (2000, p. 92) subsequently notes that externalities are the 'first refuge of the scoundrels' in policy debates, with the evidence as to their existence, let alone magnitudes, rather scant.

How big might these externalities be? Despite costly public subsidies to higher education that are often motivated by a claimed importance of human capital externalities, empirical evidence on these externalities is fragmentary and often contradictory. In a careful, balanced review, Davies (2003) considered the empirical evidence for dynamic externalities, static market externalities and static non-market externalities. In terms of percentage points of rates of return (to add on to Mincerian private rates of return of around 8–10 percentage points), the most credible estimates of dynamic externalities were 1–2 percentage points, the static market externalities were zero and the static non-market externalities around 3–4 percentage points.

The evidence for dynamic externalities, of whether schooling causes growth, is the most controversial in this literature. Positive human capital externalities should show up as higher macroeconomic returns to education (e.g. from an augmented Solow equation) than microeconomic returns (e.g. from a Mincer equation). Yet using this approach, Pritchett (2001) finds the estimated growth impact of education is consistently less than what would be expected from the individual impacts, suggesting negative externalities. Similarly, Bils and Klenow (2000) find that most of the observed aggregate relationship between schooling and growth runs from expected growth to schooling, rather than the opposite of schooling causing growth.

In terms of static market externalities, one approach has been to augment Mincer equations with a term for the average education of the city or state the individual lives in. For example, controlling for own education, Rauch (1993) finds an additional 3% increase in wages per year of average education in the metropolitan area an individual lives in. Acemoglu and Angrist (2000) instrument for average education, using variation in states' minimum school leaving ages and this apparent positive spillover disappears. But minimum leaving age laws bind more on the less schooled, so may not be informative about spillovers from the highly educated. Indeed, when Moretti (2004) includes the change in the fraction of college-educated workers in US cities in a plant-level production function, he finds higher productivity growth where the overall level of human capital rises fastest. But in line with the weak evidence for dynamic

[28] Bhagwati and Hamada (1974) note that when there is more than a marginal change in the number migrating, there can still be losses from individuals migrating even without externalities, but as they note (footnote 2), depending on the size of the emigration flow and nature of the production function, this loss can be very small. As we are unable to measure general equilibrium effects arising from large amounts of emigration, our analysis can be best thought of as examining what the impact of a marginal change in high-skilled emigration is, in which case these triangles will be small. This seems the more relevant case for policy in these high migration countries, as the choice is hardly likely to be a lot versus zero emigration but rather whether policy should try and deter or facilitate it at the margin.

externalities, Moretti (2004) estimates that human capital spillovers in the US were responsible for only 0.1% increase in annual output during the 1980s.

Other convincing micro-evidence on how proximity to highly skilled peers affects individual productivity comes from the random assignment of college roommates. One key study found significant peer effects only for students in the middle of the skills distribution (proxied by SAT scores) whose grade point average (GPA) would be raised by about 2% when they have a roommate in the top 15% rather than the bottom 15% of the skills distribution (Zimmerman, 2003). In a less selective setting, larger roommate effects were estimated for students in engineering, mathematics and natural sciences but not at all for students in humanities and social sciences (Brunello *et al.*, 2010). This possibly reflects the ease of copying homework for questions with 'right' answers in the hard sciences, which is an externality unlikely to generalise to the economy-wide level. Similarly credible evidence of productivity spillovers in workplaces is mainly limited to single low-skilled occupations where data on effort and output are reliably measured, such as check-out (Mas and Moretti, 2009) and data entry (Kaur *et al.*, 2010) operators. These studies find productivity spillovers to be very local and to be due to social pressure that leads to increased work effort rather than from greater output per time unit that may reflect learning.

Studies of non-market benefits of education, such as civic participation, crime, fertility, health, longevity and political stability, were first summarised by Haveman and Wolfe (1984). These authors concluded that if these non-market effects were counted, they may double the social rate of return to education. However, many of the studies could not adequately control for selectivity, in the form of family unobservables that cause both higher educational attainment and desirable social behaviour, and so likely overstate the benefits of education. More compelling approaches, using intra-twin differences to control for unobservables, find negative rather than positive effects of education (Gibson, 2001).

Thus, the existing literature suggests that the value of the externalities may be relatively small in terms of productivity spillovers and social benefits. However, the previous studies do not get at the externalities on health of medical professionals, which is the source of some of the strongest concerns about brain drain. In our sample, only 5% of current migrants from Papua New Guinea, 6.6% from Micronesia, 7.7% from New Zealand, 14.4% from Ghana and 15.5% from Tonga are in the health field. We do not know of any credible microeconomic study which identifies the externality of a health professional. At a more aggregate level, Clemens (2007) finds no evidence of a relationship between the rate of health professional emigration and health outcomes in Africa, although Bhargava and Docquier (2008) find an association between emigration and adult deaths from AIDS in high HIV incidence countries. Given the low incidence of health professional migration in our sample and that the HIV incidence rates in the countries studied are not in the high category, it therefore also seems likely that the health externalities from brain drain of the best and brightest are small.

Combining the different channels we have looked at, we see that the positive effects of remittances, trade creation and investment in business start-ups are typically of the same or larger magnitudes than the fiscal costs. Therefore, in order for externalities to make the overall net impact of high-skilled migration negative for people from the sending countries, we would need the externalities to exceed the $50,000 or more per year that migrants gain from migrating.

This would mean the externalities of high-skilled workers would have to be more than double or triple their private returns in the developing countries studied. Whilst conceivable, this would greatly exceed any measured externality we are aware of in the literature. Even taking the high range of externality estimates, of 5% per year of education, and applying them to 16 years of education, would still give an externality equal to 80% of the home country average unskilled wage – which is therefore in the order of $800 a year in the developing countries studied, or only 2% of the private gains.

3.7. *How Sensitive are these Results to Non-Response?*

Our unique data come from an exhaustive multi-year exercise in identifying and tracking top students. Nevertheless, in interpreting the results one would like to know how sensitive they are to survey non-response. In particular, is the reported rate of migration biased because of differences in survey response rates between migrants and non-migrants? More importantly, do the characteristics of the individuals we survey differ from those not surveyed, potentially leading us to understate or overstate the impacts of high-skilled migration.

We deal with the first issue, of whether our surveying is more likely to capture migrants than non-migrants or vice versa, in three ways. First, we note from a practical perspective that given the range of methods used to track people included searches in both origin and destination countries and that these high-skilled individuals are likely to have internally migrated since high school even if they do not migrate abroad, there should not be a systematic bias in tracking one or the other group. Second, we can use the data on the locations of individuals who we found but did not survey together with our survey data to obtain bounds on migration. The percentage of 22 and older individuals who are current migrants can be bounded at 52.2–65.3% for Tonga, 34.1–66.5% for Micronesia, 20.8–69.1% for New Zealand, 3.2–69.0% for Papua New Guinea and 13.4–80.7% for Ghana. These bounds show high levels of migration in all countries but PNG.

Third, we can see whether the surveyed individuals who required more effort to track down have different migration patterns from those who required less effort. The surveying process took place over up to one year after the sample frame was formed in each country and typically involved local survey firms who also had links to diaspora. The survey firms made a first pass through the entire frame, first interviewing the more easily tracked individuals (whether at home or abroad). More detailed efforts were then spent following up on those not initially tracked, often using specialists in online and social networking searches.[29] As the individuals interviewed later in the survey therefore required more attempts and more efforts to interview than those interviewed earlier we split the sample at the median in terms of interview date by country and then compare the migration status of those interviewed in the first half of the sample (who required less effort) with those interviewed in the second half (who required more

[29] The average cost per finally achieved sample member was approximately US$200 (excluding our own time) but was considerably higher for respondents who took more iterations to track and obtain their survey response.

Table 9

Are More Difficult to Find Migrants Different? p-values on Test of Difference in Estimates by Interview Date

	Impact of being a current migrant					Impact of being a return migrant		
Country	Table 2 Income gain	Table 4 Master's degree	Table 6 Amount remitted	Table 7 Advise work	Table 7 Advise company	Table 5 Income gain	Table 5 Advanced degree	Table 5 Advise work
Ghana	0.655	0.357	0.602	0.789	0.295	0.903	0.742	0.940
Micronesia	0.270	0.981	0.931	0.284	0.175	0.265	n.a.	0.368
New Zealand	0.715	0.282	0.197	0.484	0.984	0.119	0.387	0.802
Papua New Guinea	0.450	0.362	0.282	0.250	0.134	0.567	0.976	0.569
Tonga	0.144	0.172	0.475	0.045	0.577	0.240	n.a.	0.729

effort). Conditional on age and sex, we find no significant difference in the likelihood of being a current migrant for those who required more effort to those who required less effort to interview.

We use this same idea to examine the robustness of our estimates of the consequences of migration. For example, we augment (1) to be:

$$\begin{aligned} INCOME_i = \alpha + \beta CURRENTMIGRANT_i + \gamma' \boldsymbol{X}_i + \delta LATE_i + \theta LATE_i \\ \times CURRENTMIGRANT_i + \varepsilon_i, \end{aligned} \tag{3}$$

where $LATE_i$ is an indicator of whether individual i was one of the second-half of the individuals interviewed, who required more effort to get a response. The first column of Table 9 then reports the p-value by country for testing that $\theta = 0$, that is for testing that the income gain for migrants who require more effort to survey is the same for those who required less effort to survey. In Ghana and PNG the point estimates are positive, suggesting that it was those migrants earning more who took more effort to reach, while in the other three countries the point estimates are negative but in no case is the difference significant. This provides us with some confidence that we are not just reaching the most successful migrants, thereby overstating the income gains. One can think of reasons why the more successful will be easier to reach (more famous, perhaps more willing to discuss their experiences), but also reasons they will be harder to interview (higher value of time, may have broken off ties with people at home to avoid demands for money etc.). Given the likely heterogeneity in reasons for non-response, these reasons may cancel one another out on average, leading us to obtain reasonable estimates of the average effect.

The next columns of Table 9 show similarly that we cannot reject the null hypothesis of no difference between easier to interview and harder to interview individuals in terms of the impacts of current migration on educational attainment, remittances or advising a domestic company.[30] The only significant difference is that Tongans who took more effort to reach are more likely to be advising others about work abroad; this is only 1 out

[30] The specific outcomes examined here are some of the more important ones for our study. Given the extremely low number of individuals participating in trade and FDI, we do not attempt to look at these outcomes in smaller subsamples.

of 38 cells in the Table that is significant at the 5% level, so likely results from pure chance. The final columns of Table 9 similarly examine whether the impacts of return migration in Table 5 differ according to how hard it was to interview the return migrants, and again show no significant differences. Based on these results, it seems plausible to argue that survey non-response is not having a major impact on our results.

3.8. *How might these Results Differ in Larger Countries?*

We have argued that the results here are informative for the likely effects of high-skilled emigration in the types of countries for which high-skilled emigration rates are highest. It is therefore worth asking to what extent theory and existing empirical evidence suggest the results would differ in more populous countries. First, migration rates of skilled individuals are lower in larger countries (Docquier and Marfouk, 2006) and, to the extent that larger countries have a wider variety of job opportunities we would expect return migration rates conditional on migrating to be even higher than those for the countries studied here. Second, the finding that the gain in income is massive for the highly skilled appears to hold also for the largest countries – with Commander *et al.* (2008) reporting that Indian software workers earn US$71,000 more in the US than in India. The fiscal effects of high-skilled emigration, as discussed before, also appear similar in countries like India to those studied here.

Theoretically population size is not likely to be one of the prime determinants of remittance behaviour, except that more populous countries may offer more investment opportunities and therefore more remittances for this motive. Thus, our basic results on remittances are likely to extend to larger countries. The areas where existing case study evidence and theory suggest that the effects of high-skilled emigration may differ from our results lie in the areas of trade, FDI and knowledge flows to governments and businesses. The extent to which migrants engage in these activities is likely to be greater in countries with larger home markets, especially if, as is the case recently in China and India, those markets are experiencing significant economic growth and thus offering many new investment opportunities. These factors will make the overall impact of skilled emigration even more positive in larger countries than it is in the smaller countries studied here.

4. Conclusions

The number of highly educated emigrants from developing countries living in the OECD doubled between 1990 and 2000 (Docquier and Marfouk, 2006), and has continued to grow over the past decade as developed countries have increasingly made their immigration criteria more skill-selective. As policy makers in high emigration countries watch the departure of many of their most talented citizens, they both worry about the potential costs of this ‘brain drain’ for development in their country as well as wonder about the possibilities offered by having a diaspora of the elite who can send remittances and facilitate trade, investment and knowledge exchanges. Our goal in this article has been to provide the first systematic microeconomic empirical evidence as to how common these key channels of interaction between migrants and their home countries are, and what the economic costs and benefits appear to be in practice.

Our results show large positive benefits of high-skilled migration for citizens of high emigration countries. The largest benefits are to the migrants themselves, who benefit through massive gains in income and through greater human capital. High-skilled individuals from poorer countries do typically remit but it is rare for them to engage in trade or FDI. They engage in plenty of knowledge transfer in terms of helping others to learn about study and work opportunities abroad but do not frequently advise their local governments or businesses in their home countries. Return migration is common and we find return migrants more likely to be engaging in knowledge transfer than non-migrants but not to have higher levels of productivity. The main cost we measure is the fiscal cost of emigration. We show how this varies significantly with the progressivity of the tax system and size of government expenditure, with minimal tax implications in Tonga and Micronesia and possible fiscal losses from high-skilled emigration of $6,300 per high-skilled migrant per year for Ghana, $10,000 for New Zealand and $16,900 for Papua New Guinea. The measured benefits greatly exceed the measured costs, suggesting that on balance high-skilled migration is improving the living standards of individuals born in countries with high levels of emigration.

There are two caveats to this conclusion. The first is that we are not able to measure the distributional consequences of this high-skilled migration fully, as our sample is only of the best and brightest. Nevertheless, the size of the net gains is so large, that these distributional impacts are likely to be of second order importance in any welfare calculations. Second, our analysis is restricted to a set of relatively small countries which face high levels of emigration. However, the impacts of high-skilled emigration are likely to be even more positive for large countries such as China and India. Ours is the first comprehensive micro-level assessment of the channels through which high-skilled emigration operates, and we see it as a productive area for future research for this approach to be extended to other countries and, potentially, to other sample frames of interest than the top academic achievers.

Appendix A: Detailed Information on the Sample Frame in Each Country

In each country our goal was to obtain a sample frame of the top academic achievers graduating from secondary school in the country over the 1976–2004 period. Different educational systems and differences in record keeping mean that the definition of a top academic achiever varies slightly from one country to another, as we discuss here. The core defining characteristic used to determine eligibility for our sample is nevertheless the same across countries: an individual must either be one of the top achievers in nationwide examinations when they are held, or one of the top students in one of the best schools in the country in terms of academic performance. We are extremely confident that the resulting sample frame contains a population of high-skilled individuals whose emigration patterns should be of interest, even if there exist other students who would also be defined as top students by other metrics. As all our results are shown on a country-by-country basis, differences across countries in how individuals were drawn into the sample should not affect our ability to examine the behaviour of migrants from a given country, nor their comparison with similar non-migrants drawn from the same sample frames.

A.1. *Ghana*

We selected the following 13 secondary schools for the study: Aburi Girls, Accra Academy, Achimota, Adisadel College, Ghana National College, Holy Child School, Mfantsipim College, Opoku Ware Secondary School, Prempeh College, Presbyterian Secondary School, St. Augustine's College, Tamale Secondary School and Wesley Girl's High School. This list was based on performance in A-level and Senior Secondary School examinations over the past 30 years, and schools selected by *Africa Almanac* as being among Africa's top 100 high schools (http://www.africaalmanac.com/top20highschools.html), as well as schools which supplied the most students admitted to KNUST (a premier university of science and technology). In addition, we chose Tamale Secondary School to get students from the far north of Ghana, who might not otherwise make the sample. At each school we then worked with the school to obtain the names of the top five students graduating in each year between 1976 and 2004, using school records of which students received the most subject prizes in their senior year and of examination performance on the A-level or SSSCE examinations.

A.2. *Micronesia*

In the Federated States of Micronesia, the sample frame consisted of the valedictorian, salutatorian, and where available, third-placed student from high school classes graduating between 1976 and 2004. This sample frame was constructed by contacting 15 high schools on four islands of Micronesia: Chuuk, Kosrae, Pohnpei and Yap. Not all these schools had been in existence throughout the whole period, so for more recently established schools we just used the years in existence. Given this, the majority of the sample comes from the more prestigious, longer established schools of Xavier High School, Pohnpei Island Central School (PICS), Yap High School, Seventh Day Adventist High School and Kosrae High School, but the sample frame essentially covers almost all available secondary schooling on these islands. The names of the top students were obtained from school records.

A.3. *New Zealand*

The sample frame in New Zealand is comprised of four groups of individuals who excelled academically: members of New Zealand's Mathematical Olympiad team over the 1988–2004 period (73 individuals); members of New Zealand's Chemistry Olympiad team over the 1992–2004 period (48 individuals); top scholars in the University Bursary examinations over the period 1991–2004, which are the final year examinations taken by almost all students (484 individuals); and over the 1976–91 period, the Duxes of 16 secondary schools which had supplied many of the individuals in the first groups (271 individuals). The reason for these overlapping groups is that New Zealand only began participating in the Mathematical and Chemistry Olympiads in 1988 and 1992, respectively, and only publicly named and awarded prizes to the top performers in the Bursary examinations beginning in 1991. The Dux is the equivalent of the valedictorian in the US and is the student who has the highest academic performance amongst final year students in a school. These groups are discussed further in the appendix to Gibson and McKenzie (2011), which also provides additional information on the Papua New Guinea and Tonga samples.

A.4. *Papua New Guinea*

Papua New Guinea has the lowest secondary school enrolment rate of any country in our study, with net secondary enrolment less than 20%. Historically, there was a major winnowing of students first at grade 6 and then at grade 10. Grades 11 and 12 were only taught at four National High Schools. School records in Papua New Guinea were almost non-existent, with no school magazines or boards displaying the names of top students to provide a record of who the top students were. The only formal sampling frame came from the Office of Higher Education (OHE), which allocates slots and scholarships for tertiary study. It provided the names of the 264 students who had achieved a 4.0 GPA in their grade 12 national examinations during 1995–8 and 2000–4. On average only 0.7% of grade 12 examination entrants achieved this perfect GPA. For 1976–94, our sample frame consists of the Duxes and Proxime Accesits from the National High Schools. We obtained the names of 93 of the 152 potential individuals on this list by asking former students and teachers at these schools, and through radio and television advertisements.

A.5. *Tonga*

Our sample frame consists of the Dux and Proxime Accesit from the top three high schools on the main island of Tongatapu (Tonga High School, Tonga College and Queen Salote), and from two main schools in the Outer Islands (Vava'u High School and Taufa'ahau I Pilolevu College (TPC)) in Ha'apai. For each we take the top scholars over the 1976–2004 period, except for Va'vau High Schoo which only opened in 1985. Websites of these schools provided some initial information on the names of the top students. Each of the schools was then visited and school teachers and librarians helped to reconstruct the list, using school records and old school magazines.

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