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Economic Costs of the Malaysian Brain Drain: Implications from an Endogenous Growth Model

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Abstract: This paper provides a first estimate of the economic costs and benefits of the Malaysian brain drain. To this end, a human capital augmented labour production function is specified, with endogenous skill and knowledge spill-over effects. From this model, the overall costs of the emigration of skilled Malaysians since 1980 are estimated as 0.7 per cent to 1.6 per cent of income per capita in 2010. Further endogenising the skilled emigration rate, skilled emigration flows are found to decline by 21,000 workers from 2010-2020 (or -29 per cent) if the New Economic Model growth targets can be achieved. These results suggest two policy implications. First, fundamental economic reforms will reduce skilled emigration flows, but will not reverse the continuous outflow of talent. Second, skilled immigration appears to be an economically more powerful lever than retention or re-attraction of the Malaysian emigrant diaspora.

Keywords: Brain drain, emigration, economic growth, Malaysia
JEL clasification: F22, J24, O15

1. Introduction

Politicians and academics alike now debate the 'brain drain' in Malaysia with more fervour and rigour than ever before. As a result, a wealth of new facts and findings has been established. For instance, as of 2010, it is estimated that some 1.1 million Malaysians live abroad (World Bank 2011). Of the 820,000 Malaysians aged 25 or above, 258,000 or 31 per cent have tertiary education, and thus qualify as 'brains'. The brain drain is heavily concentrated in four destination countries, which are home to 83 per cent of Malaysia's skilled diaspora. Singapore hosts 50 per cent of all highly-skilled Malaysians abroad, followed by Australia (17 per cent), the United States of America (10 per cent) and the United Kingdom (6 per cent). This phenomenon also has an ethnic dimension, as the propensity to migrate is higher among Chinese Malaysian and Indian Malaysian minorities (World Bank 2011).

In light of these figures, two important questions remain unanswered: (1) What are the economic costs of the skilled emigration for Gross Domestic Product (GDP) per capita today? (2) To what extent will skilled emigration flows reduce if Malaysia's GDP growth increases? This study strives to provide answers to these questions by modelling, for the first time, the costs and benefits of the Malaysian brain drain since 1980. To this end, a simple human capital augmented labour production function is specified and calibrated with endogenous skill and knowledge spill-over effects. This study then models economic growth per capita in Malaysia as observed from 1980 to 2010, using recent World Bank

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(2010) estimates for skilled emigration from Malaysia as well as different counterfactual net migration scenarios.

It is found that the actual costs of the exodus of skilled Malaysians is remarkably low. Without any brain drain, meaning that no skilled Malaysians were to leave the country between 1980 and 2010, it is estimated that today's incomes would be higher only by 1.6 per cent. This is equal to approximately four months of per capita growth at the last decade's pace, certainly not negligible but much lower than expected. Alternative estimates measuring only the cost of 'extra' skilled migration above a minimum level of non-skilled migration yield correspondingly lower figures of 0.7 per cent of GDP per capita in 2010. It must be said, however, that the reduction of the brain drain debate into one headline GDP figure does not do justice to the complex social phenomenon involved or the econometric method used. Rather, these relatively low estimates point to structural weaknesses in the Malaysian economy, namely low total factor productivity growth, low returns on higher education, and the lack of high value added employment (World Bank 2011). These estimates are also a reflection of educational advances made recently: The growing number of highly skilled Malaysians tends to mitigate the economic loss of migration by relaxing skilled labour supply constraints.[2]

This study simulates two generic policy responses to the brain drain. It is found that on average, skilled immigration has a more positive economic impact than the provision of incentives to lure skilled emigrants home. The brain drain is also endogenous to Malaysia's growth rate, with significant outcomes. Higher growth implies higher demand for labour, and thus a lower incentive to emigrate. Higher incomes also relax borrowing constraints to fund emigration costs. Extending the model by endogenising skilled emigration, it is found that higher annual GDP per capita growth of 5 per cent as compared to a lower annual growth path of 3.5 per cent would reduce skilled emigration outflows by 21,000 workers (or 29 per cent) between 2010 and 2020.

Ultimately, this paper has two core implications. First, the brain drain is a phenomenon created by a mix of different economic and social incentives. It is therefore crucial to focus on these root causes, with GDP growth solely being a broad proxy or correlate of these causes. Even higher growth will not reverse the trend of skilled Malaysians going abroad for work or education. Second, promoting skilled immigration seems more economically beneficial than addressing emigration. It is thus necessary to redirect the economic and political debate towards the sometimes neglected topic of skilled immigration.

This paper is structured as follows: Section two explains the construction and calibration of the economic growth model. Section Three shows results for the exogenous migration model. Section Four extends this to endogenised migration. Finally, Section five concludes the study.

2. Economic Growth Model

Contrary to popular belief, emigration can have positive effects on GDP growth per worker (Mountford 1997; Beine *et al.* 2001). Understanding the dynamics of costs and benefits is

[2] Skilled emigration rates, or the share of skilled natives emigrating, have been decreasing since 2000 (from 22.5 per cent to 13.5 per cent). Improvements in overall tertiary educational attainment from 8.6 per cent to 13.9 per cent are a key driving factor (Barro and Lee 2010).

thus a critical input for the formulation of policy advice. Quantifying the costs and benefits of emigration is, of course, a challenge. The academic literature has so far largely abstained from conducting thorough evaluations of migration on GDP (or GDP growth) due to their inherent complexity.[3] Complexity arises due to the high number of channels of net emigration on GDP, the presence of secondary interaction effects between different primary effects, and the lack of well-established parameter estimates for the strength of these effects in a given country such as Malaysia. Nevertheless, a quantification of costs and benefits can be very useful, since it facilitates the understanding of trade-offs and compensation effects (i.e. emigration versus immigration) of policy options. It also allows policymakers to think not only in terms of minimisation of emigration *per se*, but maximisation of welfare, which may overall reduce political and administrative resistance to this sensitive topic.

For the model set-up and definitions, there are a number of economic and technical arguments for using GDP per worker as the main target of emigration policies. First, GDP per worker is a measure of the labour productivity of the economy and thus a measure of the economic efficiency of each worker. It thus relates directly to the level and growth of improvement of real wages, making it a key policy variable.[4] Second, one can avoid 'composition effects' since we only measure the impact of those leaving the country on those left behind. Imagine if we instead measured overall GDP or GDP per capita. Given that many emigrants are of working age, GDP and GDP per capita would decrease invariably due to the loss of GDP-generating units.[5] In practice, the modelling is based on GDP per worker, but the results will be translated back to GDP per capita, since these results are more easily interpreted.

This paper aims to estimate an economy-wide production function, a relationship that relates factor inputs (physical capital, human capital and total factor productivity as residual) to economic output (GDP per worker).[6] These input factors are proxies for fundamental long-term determinants of GDP growth. See Appendix A for details of data sources and calibration.

In line with the economic growth literature (Hall and Jones 1999), a constant-returns-to-scale Cobb-Douglas function is used to relate the input factors to output in a human capital augmented labour growth model. These models are useful in the context of the brain drain since they capture growth effects from skill accumulation (direct human capital effect) and knowledge spill-overs (indirect human capital effect). This model is then calibrated using Malaysia specific input data such as share of capital in overall income, returns to education and years of schooling (from the Penn World Table 7.0), Malaysian national

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[3] Popular fields of study for the effects of migration include labour markets, stocks of human capital, remittances, trade, and foreign-direct investment (FDI) flows. The dynamic effects of migration on economic growth have so far largely been neglected, mostly due to methodological challenges.

[4] This is due to the fact that the labour productivity (in a functioning market) reflects the value of the marginal product of labour. Note that GDP per worker also includes capital income (between 30 and 60 per cent of GDP), hence GDP per worker is not exactly equal to the productivity of labour.

[5] Thus the 'unit of measurement' must be GDP-generating, otherwise the result of the analysis will be trivial, with emigration always leading to lower GDP or GDP per capita.

[6] This procedure is called 'growth accounting'. See for example Hall and Jones (1999) or Caselli (2005) for an overview. The function used in this paper is inspired by Hall and Jones (1999) and uses effective labour units to quantify human capital.

accounts and other literature estimates from empirical cross-country studies (World Bank 2008, 2009; Heston *et al.* 2011).

When defining the brain drain, it is useful to define the main input variable of interest as 'net skilled emigration'. This implies that both the outflow of skilled emigrants and the (partially) compensating inflow of skilled immigrants are modelled. In addition, the analysis is limited to the impact of skilled emigrants or immigrants.

With regard to transmission channels and effects on economic growth, Figure 1 below shows the main setup of the objective function linking the three factor inputs to the output measure. Within this model, three factors will be modelled: physical capital, human capital, and total factor productivity (TFP). These factors are then varied with net skilled emigration through four effects: two effects on the stock of human capital, and two effects on the growth of TFP.

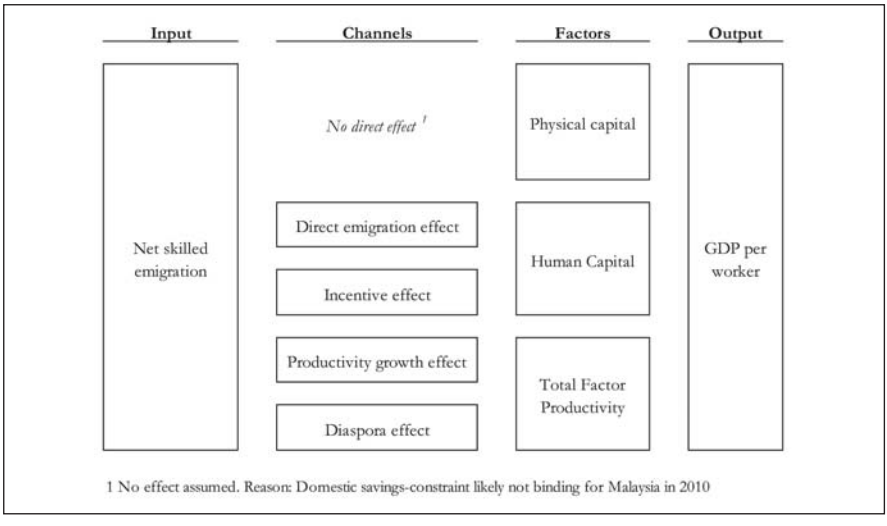

Figure 1. *Model setup – four main transmission channels on GDP per worker*

Physical capital is defined as the stock of productive capital in an economy in the form of machines and other tangible and non-tangible assets that are used in economic production processes. Measurement error is of concern, since this stock of capital can only be inferred via overall gross investment.[7] The accumulation of physical capital is a factor of production in many growth models (assuming the economy is not yet at the steady state), hence its

[7] Referring to Bernanke and Gurkaynak (2001: 26), the stock is calculated using the 'perpetual inventory method' and based on assumptions of the initial growth of investment and depreciation. These measurement problems are partially circumvented by choosing an early initial value (1960) but modelling starting in 1980. See Pritchett (2000) for a big caveat on the assumption that investment is necessarily productive, especially in countries with high public investment (such as Malaysia). This implies that Malaysia's contribution to capital is likely measured incorrectly. In the absence of better data, however, this is still the best that can be done.

inclusion is crucial.[8] Generally, the capital stock can be influenced by remittances or investments through the diaspora, but also via investments in the other direction. For the purpose of this analysis, however, physical capital will be modelled by assuming a constant investment rate (gross investment in percentage of GDP), implying that the physical capital stock is not impacted by emigration from the country.[9] This assumption is specifically justified for Malaysia, since Malaysia's investment does not seem to be constrained by domestic savings, as implied by the large current account surplus.[10]

Human capital is a measure for the accumulated skills of the workforce in a country. There is ample empirical evidence and theoretical considerations that the level of human capital increases the productivity of labour and hence has a direct GDP-increasing effect.[11] This study defines it as the stock of skills in the workforce, measured as the average years of schooling (quantity) weighted with a value for the extra income derived from each year of additional schooling (the return to education). This procedure is in line with the established Hall and Jones (1999) methodology, using inputs for schooling attainment data from Barro and Lee (2010). This paper extends the standard procedure by modelling the stock of human capital as the sum of the three stocks for graduates of each category of education (primary, secondary and tertiary). This allows one to account more accurately for the economic value of each school year per category and the variation in the stock of skilled workers.[12]

The impact of net skilled emigration can be gauged with reference to two effects. First, the emigration of skilled workers lowers the average human capital of the Malaysian workers, resulting in a loss of skills for production of economic output – the 'direct emigration effect'. Second, there is growing evidence for an 'incentive effect' (Beine *et al.* 2001). This refers to the prospect of emigration and earnings of higher wages abroad creating an incentive to pursue higher education and acquire skills to be better marketable in foreign labour markets. As not all of those people responding to this incentive actually emigrate (perhaps for non-economic reasons), there is a domestic accumulation of human capital that benefits the Malaysian economy, induced by emigration of prior age cohorts. While the 'direct emigration effect' lowers human capital, the second 'incentive effect' actually works in the opposite direction.

Total factor productivity (TFP) is modelled as a residual, being a factor that captures the entire unexplained proportion of variation in GDP and GDP growth. It captures the efficiency of use of the two other main input units, augmented labour (human capital) and

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[8] See Solow (1956) for an early account of the accumulation of capital.

[9] This implies that the results will, if at all, tend to overstate costs of migration since potential positive effects on the capital stock per worker are assumed to be nil.

[10] Higher-skilled emigrants would usually have a higher income and high rates of savings (implying an above average contribution to the capital stock). Taking into account the high foreign savings, it is highly doubtful that extra savings, even if they accrue, would remain in the country.

[11] Generally, schooling shows up in most empirical studies as a robust and significant contributor to GDP growth (Caselli 2005). It also partially explains the gaps in income levels between countries. Note, however, that the measurement of these skills is still a major challenge. Hanushek and Woessmann (2008), for example, focus on schooling quality and test scores rather than quantity (years of schooling). This study uses the traditional quantity of schooling approach.

[12] Using World Bank (2008; 2009) parameters, the result is an overall average stock of human capital with 1 as lower boundary (1=no schooling).

physical capital, and is not factor specific. In other words, TFP applies to both physical capital and labour.[13] This factor is a placeholder for all other immediate and fundamental causes for GDP growth, including structural transformations within the Malaysian economy, higher degrees of innovation, trade openness, quality of institutions, and knowledge spillovers (the positive externality of skilled workers on other workers) (Kremer 1993).[14] For example, the emigration of an entrepreneur without skilled education would be captured by this effect, in terms of the cost of employment not created in Malaysia. Regardless of its lack of specificity, it is important to model changes to this factor carefully, as motivated by endogenous growth models that put an emphasis on the importance of endogenous growth in technology or TFP (Aghion and Howitt 1998). Indeed, there is ample evidence that not only the stock of human capital, but also diaspora networks, FDI and trade openness contribute to annual growth and change (Vandenbussche *et al.* 2006: 111).

In order to examine the impact of net skilled emigration, two main effects must be modelled. The first is the 'productivity growth effect', the growth of productivity as dependent on different levels of human capital. The second is the 'diaspora effect', the positive impact of diaspora networks, trade and FDI on knowledge exchange and ultimately TFP growth. This establishes a framework for the analysis of changes in net skilled emigration and its effect on GDP per worker. This link, with its four main transmission channels (see Figure 2) crucially depends on other covariates or parameters to determine the functional form and strength of this link. Figure 2 presents an overview of these parameters and the assumptions made, and also shows the benefits of spelling out these levers. Once they are made explicit, one can begin to test their relevance on output (GDP per worker) in a scenario analysis, and then derive policy recommendations targeted at these levers.

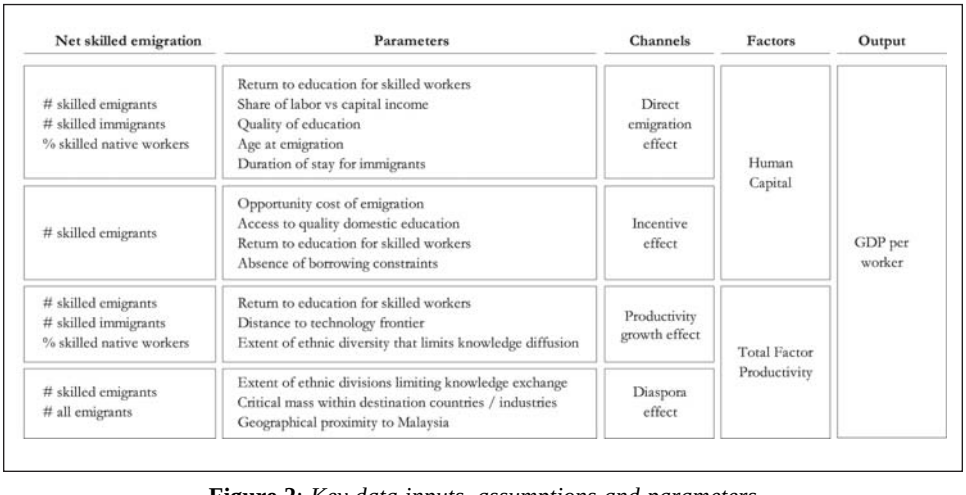

Figure 2: *Key data inputs, assumptions and parameters*

[13] Attempts at modelling TFP as factor-specific were made in this study, but did not contribute significantly to the reduction of unexplained residuals.

[14] Note that this list is far from mutually exclusive and exhaustive.

Figure 2 demonstrates that, apart from net skilled migration as key policy variable, there are a host of other parameters and variables that determine the size of the impact of one emigrant on GDP per worker. These other parameters are policy variables that can be affected by public policy. There are several input variables that, to a large extent, seem to drive the relationship between net skilled emigration and GDP per worker. These include the return to education, experience and work skills, the number of skilled workers in the economy, the number of emigrants or immigrants, and the extent of ethnic divisions in the Malaysian economy (as a background variable).

3. Empirical Results: Exogenous Net Emigration

This specified and calibrated model has been used to construct a baseline growth and emigration scenario. This baseline is modelled precisely using actual economic and migration data from Malaysia. Alternative scenarios are then constructed as counterfactuals. Looking at the baseline for GDP growth from 1980–2010 (geometric mean using actual year-on-year growth rates), real GDP growth per capita was 5 per cent per annum, or 7.5 per cent per annum in overall GDP (Heston *et al.* 2011). The emigration scenario shows that an average outflow of 174,000 skilled Malaysians (aged 25 and above) is equal to an annual 3.8 per cent growth of the emigrant population, from 84,000 in 1980 to 258,000 in 2010 (World Bank 2011).[15]

The number of skilled workers in Malaysia, along with the number of skilled emigrants, has been growing from 1990–2010, but with different dynamics. While the education of the entire workforce has improved significantly since 2000 (from 8.3 per cent to 13.9 per cent with tertiary education), skilled emigration in terms of absolute and relative numbers was strongest until 2000. The lower net skilled emigration until 2010 and the higher stock of domestic skilled workers made the skilled emigration rate (share of all skilled native emigration) drop significantly, from 22.7 per cent to 13.5 per cent. These dynamics, as a baseline, also influence the following emigration scenarios (no emigration, skill-neutral and partial emigration).

The 'no emigration' scenario serves as an extreme reference point to indicate the total cost of skilled emigration since 1980. The costs of skilled emigration to average GDP per capita are between 1.6 per cent (2010) and 2.2 per cent (2000). The lower cost to incomes in 2010 relative to 2000 is due to three factors. First, there were relatively more skilled workers in 2010 than in 2000, indicating a lower scarcity of skilled labour and thus a lower impact on aggregate human capital. Second, skilled emigration was more prominent prior to 2000, with a decennial increase of 98,000 recorded from 1990 to 2000 but only 38,000 from 2000 to 2010. Third, the 'incentive' and 'diaspora' effects moderate costs to average incomes, particularly from 2000 to 2010, as they tend to work with a time lag. Therefore the overall costs of skilled emigration to average income since 1980 appear relatively modest. Incentive, (to a lesser extent) diaspora effects and higher education levels moderate the costs to a large degree. Furthermore, the results are mitigated by parameters indicating structural weaknesses in the Malaysian economy, namely the low share of labour in aggregate national income and

[15] The baseline uses a geometric average emigration stock between decennial estimates from the World Bank (2011).

low returns to education, both being reflections of the low demand for skilled labour. Without these issues, costs would be higher by between 0.2 per cent (2010) and 0.6 per cent (2000) of average income.

The 'skill-neutral emigration' scenario is modelled using the stock of skilled emigrants in 1980 as a starting point, and applying the growth rate of non-skilled emigration. This procedure avoids mixing growth with stock effects, and implies lower emigration by 83,000 skilled workers in 2010. A realistic benchmark requires an understanding of what proportion of emigration is driven by specific incentives for skilled workers versus the rest of the emigrants. As for the change to the baseline, assuming lower (but not zero skilled emigration) reduces the estimated costs. These are now 0.7 per cent of average GDP in 2010, and 1.2 per cent in 2000. The estimated costs and numbers of emigrants and skilled workers show that these aggregate model outputs behave nearly linearly, although the model is not necessarily specified as such (due to time lags and accumulated stock effects in the incentive effect).

The 'partial mitigation of emigration flows' scenarios assume a mitigation of the skilled emigration outflow by 20 per cent, through by different means. For instance, under the first scenario, it is assumed that a successful retention of possible skilled emigrants can be achieved through retention incentives (not modelled here), while under another scenario, we assumed an equivalent yearly inflow of skilled immigrants. The results are best interpreted jointly, since both sub-scenarios aim to reduce skilled net migration (both emigration and immigration) by 20 per cent. The results for both scenarios are different because the immigration scenario shows a (nearly trivial) relationship between the inflow of skilled immigrants and their impact on the skilled work force. For the mitigation of emigration, this relationship is not obvious. To an extent, avoiding emigration will deprive the economy of beneficial incentives and diaspora effects. This translates into a lower GDP growth effect (only around 2/3 of the immigration scenario impact) and also lower effective skilled workforce numbers (Table 1). Thus, in a simple 'horse race' of emigration and immigration policy levels, skilled immigration seems more beneficial for GDP growth from a purely economic point of view.[16]

4. Empirical Results: Endogenous Net Emigration

In an endogenous model, skilled migration and GDP growth interact with each other in two ways. First, skilled emigration tends to lower Malaysia's GDP growth due to the loss of skilled workers that otherwise would contribute to the country's productivity. This effect was modelled in the previous section. Second, GDP growth itself influences skilled emigration, with higher future GDP growth (through New Economic Model reforms, for

[16] Caveat: this result obviously depends on the assumptions made. Alternative assumptions on immigration, such as age structure, duration of stay, extent of brain waste or even additional benefits from trade, knowledge exchange, as well as assumptions on the cost of avoiding emigration through costly monetary incentives are not modelled. These could change the results in either direction. Nevertheless, this exercise is limited to the most fundamental and strong factors and thus provides a useful benchmark for further refinements.

Table 1. Key results for the exogenous migration model

Base line: Malaysia (actual)	**1990**	**2000**	**2010**
GDP/capita	**8449**	**14222**	**18854**
growth p.a. (%)	3.5%	5.3%	2.9%
Skilled workers	**492**	**751**	**1646**
share of work force (%)	7.3%	8.3%	13.9%
Skilled emigrant workers	**122**	**220**	**258**
share of skilled native work force (%	19.9%	22.7%	13.5%
Scenario 1: No skilled emigration	**1990**	**2000**	**2010**
GDP/capita	**8529**	**14529**	**19154**
change to base case	80	307	300
change to base case (%)	0.9%	2.2%	1.6%
Skilled workers	**526**	**868**	**1770**
change to base case	34	117	124
change to base case (%)	0.5%	1.3%	1.0%
Skilled emigrant workers	**84**	**84**	**84**
change to base case	-38	-136	-174
change to base case (%)	-31.4%	-61.8%	-67.4%
Scenario 2: Low skilled emigration	**1990**	**2000**	**2010**
GDP/capita	**8480**	**14397**	**18991**
change to base case	31	175	137
change to base case (%)	0.4%	1.2%	0.7%
Skilled workers	**505**	**817**	**1703**
change to base case	13	66	57
change to base case (%)	0.2%	0.7%	0.5%
Skilled emigrant workers	**107**	**142**	**175**
change to base case	-15	-78	-83
change to base case (%)	-12.5%	-35.3%	-32.2%
Scenario 3a: Emigration lever	**1990**	**2000**	**2010**
GDP/capita	**8465**	**14283**	**18913**
change to base case	16	61	59
change to base case (%)	0.2%	0.4%	0.3%
Skilled workers	**499**	**774**	**1670**
change to base case	7	23	24
change to base case (%)	0.1%	0.3%	0.2%
Skilled emigrant workers	**115**	**193**	**223**
change to base case	-7	-27	-35
change to base case (%)	-6.3%	-12.4%	-13.5%
Scenario 3b: Immigration lever	**1990**	**2000**	**2010**
GDP/capita	**8469**	**14296**	**18940**
change to base case	20	74	86
change to base case (%)	0.2%	0.5%	0.5%
Skilled workers	**500**	**779**	**1681**
change to base case	8	28	35
change to base case (%)	0.1%	0.3%	0.3%
Skilled emigrant workers	**122**	**220**	**258**
change to base case	0	0	0
change to base case (%)	0.0%	0.0%	0.0%

Note: GDP/capita in 2005 constant MYR. Number of workers in thousands.
Native work force: sum of domestic skilled workers and skilled emigrants.

instance) promising more skilled employment and more incentives to stay or migrate back to Malaysia.[17] This second effect will be modelled in this section.

The extended model assumes an exogenous shock to the estimated production function residual (basically TFP), increasing the growth path of the Malaysian economy. This higher growth then serves as an explanatory variable for a migration equation. These migration equations typically take the form of gravity models, taking into account distances between country pairs, size and GDP, among other factors. Owing to data availability constraints, an own model for emigration is not specified from Malaysia. Instead, all other factors are assumed to remain largely constant. Only the marginal effects are modelled from changes in the key endogenously dependent variables, GDP per capita and educational attainment.

With regard to the baseline, the notion of higher than expected GDP growth implies that this NEM-inspired growth trajectory needs to be measured against an unobservable counterfactual from 2010–2020. To this end, different data sources are used to construct the expected GDP growth path without full implementation of NEM reforms. Therefore, in line with past growth, GDP growth from 2010–2020 is set at 3.5 per cent per capita (real), analogue to 4.9 per cent GDP growth overall (assuming annual population growth of 1.4 per cent as projected by the United Nations for Malaysia). This GDP growth assumption is in line with the 1999–2009 GDP growth average of 4.8 per cent per annum, and even slightly more positive in terms of per capita income due to lower population growth (1.88 per cent).

Considering the emigration scenario, as of 2010, 820,000 Malaysians (age 25 and above) have emigrated and live outside of their native country. Of these, 258,000 (or 31.4 per cent) Malaysians are highly skilled (World Bank 2011). Extrapolating these numbers linearly to 2020 with an assumed constant growth of 30 per cent and constant skill distribution, we can expect 331,000 skilled Malaysians to live abroad in 2020, an increase of 73,000 skilled workers.[18] In addition, we assume an increase in the share of skilled workers from 13.9 per cent to 18.8 per cent (linear extrapolation) and stable returns to education (Barro and Lee 2010).[19]

Against this baseline, we model an alternative higher-growth scenario under proposed New Economic Model reforms. The NEM as proposed by National Economic Advisory Council advisors provides a vision for Malaysia as a high income country in 2020 (NEAC 2010: 4). This target GDP level is associated with a higher than current trajectory GDP growth. Interestingly, the document is ambiguous with respect to a clear GDP per capita growth goal, with ranges given from USD 15,000–20,000 GDP per capita (NEAC 2010: 4). An objective of 5 per cent real GDP per capita growth between 2010 and 2020 (equal to a GDP growth of 6.5 per cent per annum) seems ambitious yet attainable. It thus serves as basis for

[17] The first Malaysian New Economic Model (hereafter NEM) was launched in 2010 under the Prime Minister's Office. This has been followed by a NEM part 2. Previously, the Malaysian government introduced the New Economic Policy in 1971, followed by the National Development Policy in 1991 and the National Vision Policy in 2001 (Cheong *et al*., 2009).

[18] This simple projection should not be viewed as an attempt to model future emigration, but rather as a basic reference case assuming no structural breaks in the key factors determining Malaysian emigration until 2010.

[19] For all other parameters, Malaysia-specific values (i.e. the share of capital, employment ratio) are used as of 2010, and thus assumed to be stable.

Table 2. Summary of key results for the endogenous migration model

Base line: Malaysia (actual+projected)	2010	2020
GDP/capita	**18854**	**26340**
growth p.a. (%)	2.9%	3.4%
Skilled workers	**1646**	**2621**
share of work force (%)	13.9%	18.8%
Skilled emigrant workers	**258**	**331**
share of skilled native work force (%)	13.5%	11.2%
Scenario 4: Higher growth (as of NEM)	**2010**	**2010**
GDP/capita	**18854**	**30670**
growth p.a. (%)	2.9%	5.0%
change to base case	0	4330
Skilled workers	**1646**	**2921**
change to base case	0	300
share of work force (%)	13.9%	20.8%
Skilled emigrant workers	**258**	**310**
change to base case	0	-21
change to base case (%)	13.5%	9.7%

Note: GDP/capita in 2005 constant MYR. Number of workers in thousands. Native work force: sum of domestic skilled workers and skilled emigrants.

the higher GDP growth path under proposed NEM reforms. The scenario also assumes higher educational attainment (+2 percentage points, tertiary education) and a return of gross investment rates in the economy to a pre-crisis average level of 25 per cent.[20]

Apart from obvious GDP differences (as assumed), there is also a key difference in migration flows. Instead of a projected increase of 73,000 skilled emigrants, the model predicts an outflow of only 52,000, thus 21,000 or (29 per cent) lower than anticipated skilled emigration. This equals to a reduction in the skilled emigration rate from 11.2 per cent to 9.7 per cent, a reduction driven both by a larger pool of skilled workers and the reduction in skilled emigration flows due to higher domestic incomes (Table 2). These results need to be carefully interpreted. First, the model is consciously limited to one iteration from a GDP-shock to migration.[21] Second, the model is limited to skilled emigration and does not make

[20] The first assumption influences the migration rate through a higher number of skilled workers as potential migrants. The second assumption does not have a direct impact on migration, but rather serves to keep the assumed scenario internally consistent. Pre-crisis refers to average investment levels of 1985-1995, prior to the 1997 Asian financial crisis.

[21] A second iteration (feeding lower emigration into the GDP model) has been performed and yielded next-to-nil changes in GDP per capita or emigration.

any prediction on skilled immigration (likely to be higher) and non-skilled emigration (likely to be higher as well as borrowing constraints to making emigration decision are relaxed). Third, the analysis is deliberately policy-invariant: additional changes to emigration and immigration incentives can and will severely change the actual outcome. Fourth, the intended economic policy changes will also have socio-political consequences, likely lowering the push factors driving skilled migration. Nevertheless, it remains plausible that even these additional aspects will not reverse the outflow of skilled talent within the next decade.

5. Conclusion

We model the costs and benefits of the Malaysian brain drain (emigration of skilled workers) for the 1980-2010 period. Using a parameterised endogenous growth model with exogenous migration decisions, these costs are estimated to be between 0.7 to 1.6 per cent of average incomes (GDP per capita) in 2010. These lower-than-expected costs are due to lower absolute and relative skilled emigration flows since 2000, improvements in educational attainment rates raising the supply of skilled workers and, as a reflection of structural weaknesses of Malaysia's economy, the low demand for and wage premium to skilled labour.

Extending the model to endogenous immigration, higher future growth rates from 2010–2020, expected at a pace of 6.5 per cent per annum GDP (equivalent to 5 per cent p.a. growth per capita) as outlined in the New Economic Model, will not reverse ongoing emigration trends. This finding shows that the migration decision of Malaysians is a revealed preference for a lifespan abroad, shaped not only by economic, but also political and social factors. Addressing only the economic root causes will thus only provide a partial solution to this complex problem. Within the existing set of economic policy responses to the brain drain, the economic viability of both skilled immigration and a mitigation of skilled emigration are compared. Skilled immigration is found to be a more effective lever than current attempts to retain or re-attract the Malaysian emigrant diaspora, mainly due to persistent incentive effects on human capital accumulation. To an extent, this goes against the current policy options being developed by Malaysia's Talent Corporation.

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Appendix A: Data Sources and Calibration

The model developed in this study uses input data and parameter estimates from a range of different sources. Base data such as real GDP, GDP per worker, GDP per capital on an annual basis, and the investment share of real GDP per capita are derived from the Penn World Tables (PWT) Version 7.0 (Heston *et al.* 2011). Years of schooling and percentage of workers with primary, secondary and tertiary education are from Barro and Lee (2010).

Parameter estimates and assumptions for physical capital are modelled as capital per GDP, following Klenow and Rodriguez (1997). Capital stock scales with GDP growth are based on PWT 7.0 input. This implies that the savings quota of skilled emigrants equals that of the overall population. It also implies that remittances are consumed in equal proportion as domestically generated GDP. The capital share of income (0.3 alpha) coincides with the global average. The alternative (0.6) is the World Bank estimate for Malaysia derived from Malaysian National Accounts and the Malaysian Department of Statistics (MEPU 2010). The depreciation rate of capital is held at 0.06 per year (delta) based on a typical growth accounting assumption, while the initial capital stock for 1960 is derived from the perpetual inventory method (Bernanke and Gurkaynak 2001).

Parameter estimates and assumptions for returns on human capital are modelled per educational attainment group. Primary education is 13.4 per cent per year according to Hall and Jones (1999), and 4.2 per cent according to the World Bank (2009). Secondary education is 10.1 per cent per year (Hall and Jones 1999) and 7.1 per cent (World Bank 2009), while tertiary education is 8.6 per cent according to Hall and Jones (1999) and 5.2 per cent according to the World Bank (2009). Returns to education are exogenous, and hence do not increase through emigration. Such returns are assumed to be stable across the period 1980–2010, and assuming there is no 'brain waste', returns to human capital can be fully realised socially. The incentive effect (growth of relative human capital stock due to emigration propensity) is assumed to be log-linear (0.0481), as estimated by Beine *et al.* (2007). Parameter estimates are based on the IV regression for global data set, linear in GDP per capita, with an assumed absence of liquidity constraints.

Finally, parameter estimates and assumptions related to total factor productivity (TFP). For TFP scales with human capital, parameter estimates are derived from Vandenbussche *et al.* (2006) and Lodigiani (2008). The diaspora effect is modelled based on parameter estimates from Lodigiani (2008), with an alternative lower bound representing a more likely value for Malaysia due to the country's high ethnic diversity and the lower levels of knowledge diffusion across ethnic boundaries.