LUND UNIVERSITY

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The Effects of Skilled Emigration on Economic Growth

- An Empirical Analysis

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Abstract

This paper analyses the impact of skilled migration on economic growth in the origin country – a phenomenon often referred to as brain drain. Specifically, this paper aims to contribute to the scant empirical literature of the direct effect on GDP per capita growth following emigration of skilled. To study this dependence, a in depth literature review of the assumed channel that are interrelated with emigration of skilled individuals and its effect on growth. Following that an empirical model is constructed incorporating these channels. The model is estimated with 2SLS, and the results imply that human capital formation is affected negatively following high skilled migration. Other implications are that remittances and high skilled emigration rate interact in some extent and the relative size of the diaspora could potentially have positive effect on growth.

Keywords: Brain drain, migration, growth, human capital, remittances

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1. Introduction

In a more globalized world, cross-country migration has increased and the literature of the effects with it. According to the latest reported statistics in 2016 approximately 40 million migrants with higher education were living in OECD member countries. Moreover, the share of immigrants living in the world's most developed countries has tripled since 1960 and doubled since 1985. With this statistic in mind the effect on the origin countries has gained more attention in academic papers. More specifically if emigration has had any significant effect and how. One question raised is if the source countries are depleting the human capital level in favour of host countries. However, for developing countries to be able to integrate in the global economy some amount of labour mobility is expected. And as human capital has been noted in growth theory as a determinant of long-term growth, this pattern of large outflow of skilled individuals is a cause for concern that *brain drain* is increasing, and local growth is adversely affected (Lowell & Findlay, 2002). The purpose of this paper is to conduct an empirical analysis investigating the long-term effect of high skilled emigration on GDP per capita growth of the sending country[1].

According to OECD, the emigration rate of the highly educated is almost always higher than the rate of total emigration from sending countries to its member states. This is due to individuals with higher levels of education initially have the economic means to engage in cross-country migration and do not face any budget constraint that typically individuals with lower education do. Also, OECD countries have more generous migration policies for high skilled which have been gradually implemented since the 1960s (Docquier & Rapoport, 2011). Furthermore, developed countries experience labour shortages that has led to increased demand along with positive self-selection, better employment conditions, and better information in developed countries labour markets encourages skilled migrants to seek jobs abroad. Furthermore, as globalisation links the labour market tighter together, it creates flows of individuals to global cities around the world (Lowell & Findlay, 2002). Moreover, there is a heterogenous spread of the emigration rates of highly educated individuals across origin countries. However, the emigration rate of poorer countries is generally higher than the rates of richer countries. Countries such as Mozambique and Somalia are reported by the OECD to

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[1] The focus will be on the empirical aspect as there is a richer literature with focus on building theoretical models of the effects.

have emigration rates of around 30%, while Trinidad and Tobago and Guyana more than double that with above 66%. Differences in migration patterns between countries are the result of different factors linguistic, cultural, and geographical distance to the destination country. Furthermore, the former colonial link still plays a part in the emigration pattern together with the presence of a large community of migrants already living in the host country. Moreover, emigration that is observed follows from failed development policies of the origin countries. Which has led to higher emigration rates, especially for high skilled individuals (Kerr et al. 2017)

The data implies that highly skilled individuals tend to migrate from developing countries to developed ones. However, the challenge with studies of the effects of emigration is access to reliable and continuously updated data on migration by educational attainment which has limited researchers to draw conclusions only from theoretical analyses. The particular interest of the economic effects is due to the ambiguity from highly skilled emigration that appears in studies (OECD, 2017). More specifically, this paper will focus on the effect on the sending countries' economic growth from migration; a research area that has gained more attention during the past decades.

From the emigration of skilled individuals, there are feedback effects that relate to the development of the home country. The first one is human capital formation; if the emigration rate is high then this could incentivize individuals to pursue higher education to raise their chance of getting employed abroad. This is something that would add to, rather than deplete, the human capital stock as not all highly educated will migrate and the result would then be that the overall impact of emigration of skilled individuals is uncertain. Secondly, increased emigration leads to increased number of financial inflows to the home country believed to spur investments and consumption. The third channel is that a larger diaspora could potentially create opportunities for networks and knowledge spill overs benefiting the productivity of the origin country. Fourthly, institutional quality has long been a hot topic in the growth literature and the connection between skilled emigration and institutional development is somewhat uncertain. Lastly, the labour market is also affected following an increase in emigration which could affect the productivity and ultimately the economic growth.

I conduct the analysis using the panel data format of the collected data and run regressions to capture the effect of brain drain on economic growth. As there is risk of high endogeneity

among the variables of interest, an IV-regression is run jointly estimating two key equations for the effect of high skilled emigration on economic growth.

The remainder of the paper is structured as follows. In section two, the literature on how brain drain affects growth and economic development prospects is reviewed and discussed. Elaborating on the main channels that skilled emigration rate functions through. Following that, the methodology and the data collecting process is described. In the fourth section, the results from the regressions will be presented and what it could imply for countries experiencing high brain drain levels. The fifth and final section concludes.

2. Literature Review

2.1 General Literature Background

Both the theoretical and empirical literature regarding emigration of skilled individuals and the impact on the economic performance of the origin country provides support for both positive and negative effects. Studies on the effects of skilled migration dates back till the 1960s where studies were more conducted towards the theoretical effect. This is mainly related to the obstacle of lack of data which has made the quantification of the estimated effect difficult. Furthermore, the effect of studying the aggregate effect was not the focus of these studies, instead case studies were conducted trying to investigate how generally worse-off source countries were affected (Doquier & Rapoport, 2006).

These earlier studies established a conventional view that emphasized the detrimental effects of brain drain on growth in the sending countries. The models used in these papers incorporated that there is no uncertainty about the probability of emigration which results in that the flight of human capital directly affects the labour composition. A composition that renders in reduced stock of human capital per worker and lower productivity in the domestic labour market, thus, a welfare loss occurs for the sending country (Grubel & Scott, 1966; Johnson, 1967). A view that relates to traditional endogenous growth models, such as modelled by Lucas (1988), where the aggregate human capital level in a country affects long term growth. Later, (Miyagiwa, 1991) introduced the phenomenon of brain drain explicitly in an endogenous growth framework. This is done through the wage gap between developing and developed countries which induces migration and reduces growth through human capital formation, which is a common argument in the literature.

More recent studies highlight that the benefit from education goes beyond the individual gains to those who pursue higher education and that the benefits spill over to the economy. The brain drain issue has gained notable interest in the light of empirical studies like Barro (1991) and Hall & Jones (1999) which finds that the level of human capital has a significant effect on GDP per capita growth. In Mountford (1997), the author finds that a temporary increase in the possibility of emigration can permanently increase the productivity of an economy.

Kim & Lee (2016) incorporates a policy variable and FDI into a panel-setting and their interaction with the high skilled emigration rate, to study the effect on skilled emigration on growth rate. They set up both a static fixed effects model and a dynamic panel model with system generalized methods of moments estimators to compare the results. After estimating the models, the results imply a negative effect from the emigration rate and its interaction with FDI in the dynamic panel model. While at the same time, the coefficient is positive for high skilled emigration rate and the interaction with the policy variable in throughout the model specifications. The results imply that countries with poor policy conditions and low levels of FDI inflow benefit more from an increase in high skilled emigration rates

A major obstacle of the research of the first four decades was the absence of adequate data which led to that the theoretical findings could not be empirically tested. It was first when Docquier & Marfouk (2006) constructed the first extensive dataset on emigration stocks by educational attainment that empirical research became possible to a larger extent. The dataset composed of 195 source countries in 1990 and 2000 constitutes a fundament for multiple empirical studies. Furthermore, this dataset has been extended on occasions throughout the years. To begin with, Beine et al. (2008) improve upon the quality by controlling for the age of entry, thus ruling out individuals that only emigrate for a short period of time to study abroad. Secondly, Docquier et al. (2009) update the database by adding the gender of the emigrants. Thirdly, Artuç et al. (2015) add non-OECD destinations to the existing databases. Lastly, Defoort (2008) and more recently Brücker et al. (2013) constructed a by panel datasets on emigration stocks and rates by educational attainment to enable the investigation of long-run trends and patterns in migration.

In Docquier & Rapoport (2011) the authors review four decades of research on brain drain where the focus of the study is on more recent contributions to the literature. As the authors argue that this is due to high skilled migration has become the dominant pattern of international migration and a factor to consider when studying globalization. They use a stylized growth model and analyse the various channels through which brain drain affects the

origin countries. They conclude that the recent empirical studies shows that brain drain does not deplete the human capital stock of countries and instead can cause positive externalities.

The feedback effects of emigration of high skilled individuals on the sending country is thought to operate through various channels. Some of these channels are labour market, remittance, human capital formation, and diaspora externalities such as less cultural and barriers and more tendency to trade with other countries where the diaspora size is large (Docquier & Rapoport, 2011). I go through and explain the logic by which each of these channels affect the origin country and review what previous literature concludes.

2.2 The Labour Market Channel

From a theoretical point of view, emigration could take pressure off the labour market if it is overcrowded. If the individuals that migrate were unemployed, or if the vacancies left behind from the workers that chose to emigrate are filled by those who stayed behind, it could help to decrease the unemployment level and could enhance domestic wage growth. However, the growth of domestic wage is conditioned, to some extent. If the probability of emigrating is high in a specific country, it gives greater bargaining power in the wage negotiation for the remaining population. This is further enhanced if the remaining individuals that have similar skills to those who migrate as the emigration can lead to labour shortage. On the other hand, the positive average wage effects are only evident in the short-term and once capital is controlled for emigration mainly affects the wage distribution, and not the wage growth (Benjamin Elsner, 2022).

As mentioned above, emigrants are positively selected in terms of skill level and the loss of a certain type of worker can contribute to a loss of productivity, as the ability to innovate and/or imitate decrease. The findings in empirical studies are ambiguous, Dustmann et al. (2015) found that emigration on a larger scale raised employment levels and wages in Poland, following the nations entry into the EU. On the other hand, Docquier et al. (2011) simulated labour market effects of net immigration and emigration in all OECD countries and found that the effect of emigration on wages was negative. Furthermore, studies have shown that when the emigrants are primarily highly skilled it leads to a negative externality which depresses the productivity in the origin country. Adding to this, Pryymachenko et al. (2013) estimated the effect of emigration on unemployment in Central and Eastern European member states in the European Union. They construct a panel data model with time and country fixed effects

and a specified a long-run relation in logarithmic levels of unemployment, real GDP per capita and emigration rate. The estimation found a strong negative relationship where a 10% increase in emigration rate leads to approximately 5% decrease in unemployment rate.

2.3 Remittance Channel (Financial Inflow Channel)

As the global number of remittances is estimated to be 548 billion USD in 2019 by the World Bank, it is not surprising that this is a channel that has gained much attention when considering the benefits to the origin country from emigration. Remittances, in size, is three times larger than the official development assistance volume and almost equal to the total flow of FDIs; in countries like Tonga and Haiti the number is even as large at 30-40% of GDP (Koczan et al. 2021). Furthermore, remittances are proved to be a more stable source of income compared to private capital which is often pro-cyclical. In fact, the flow of remittances is less volatile than the economic cycles and may increase in response to a downturn in the economy of the origin country. Therefore, remittances can be used as a coping mechanism against shocks that do not depend on interest rate differences. Moreover, the remittances received are often invested and when invested remittances contribute to output growth (Ratha et al. 2015). Furthermore, even if consumed, through multiplier effects the remittance offset the potential productivity loss from high skilled emigration (OECD, 2017; Ratha et al. 2015). Additionally, households in developing countries are liquidity constrained to some extent and remittances enable consumption smoothing for households (Koczan et al. 2021; Docquier & Rapoport 2011).

Figure 1: Remittances, FDI and ODA.
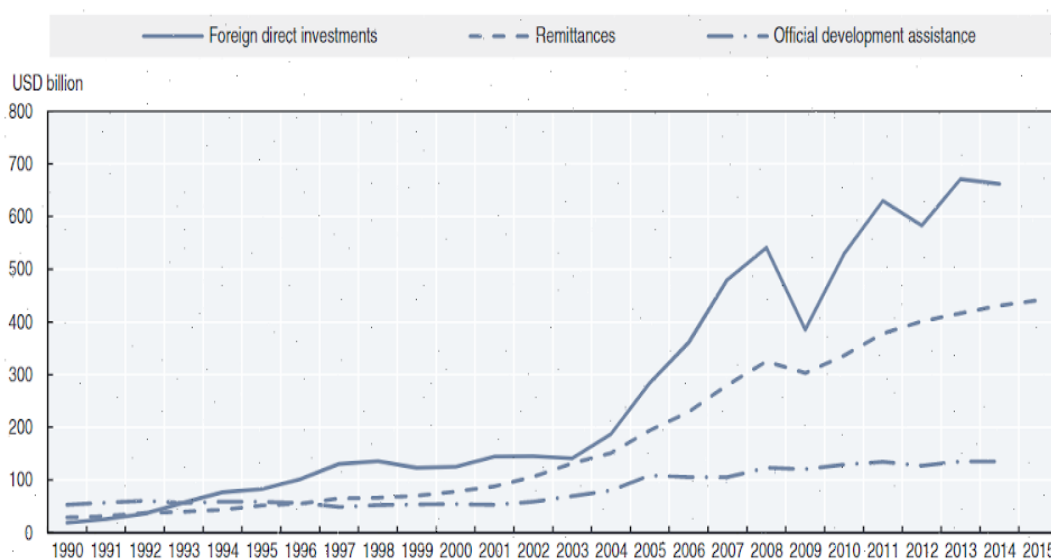
Early studies such as in Grubel & Scott (1966) argued that the remittances from highly skilled emigrants could compensate for the depletion of the human capital stock from brain drain. However, the argument relied on that for this to be the outcome it depends on whether the remittances are invested in education or not. This is a question that is becoming of more importance due to the increasingly selective immigration policies with respect to skill level, which leaves developing countries to be concerned of whether these policies could curb the rise in remittances and weaken the share of remittances that ultimately is invested towards education. Whether there is reason for concern depends upon if highly educated emigrants remit more or if they remit less (Docquier & Rapoport 2011). As skilled migrants generally have higher income they are expected to remit more. Furthermore, they are less likely to be illegal in the host country and access to bank accounts are a prerequisite for money transactions back to their home country (Faini 2007; Docquier & Rapoport 2011). On the other hand, emigrants with higher education are from wealthier families which have a higher propensity to migrate household altogether and the need to remit is missing (Docquier & Rapoport, 2011).

The empirical studies aimed at brain drain and remittances at a macro level across many countries are scant. Faini (2007) finds that the amount remitted decreases as the proportion of highly skilled individuals increases which implies that the negative impact from brain drain cannot be compensated with remittances. In turn, this is also confirmed by Niimi et al. (2010) after using an instrumental variable for the number of emigrants. However, if poverty is a constraint both to the choice of migration and the level of education that individuals attain,

this results in that those developing countries that are richer can send more migrants. Thus, these countries receive more remittances as these migrants have more years of schooling and higher levels of income. Making the correlation between remittances and skill level driven by these factors instead. Theory suggests ambiguous answers whether highly skilled remit more, however recent empirical results implies that remittances does not compensate for the brain drain affecting the origin country (Docquier & Rapoport, 2011).

Financial inflows from abroad can be a source of private external finance for households in developing countries. On the other hand, these inflows do not necessarily need to be financial as they might imply the transfer of other factors such as production of technology, skills, innovation capacity, and general knowledge. The transferring of skills and technology from high skilled emigrants back to their home countries is referred to *diaspora externality* by Docquier & Lodigiani (2010)[2]. Furthermore, they emphasize the importance of the diaspora channel for the development of the origin country as an effect of brain drain. Also, in their empirical study they show that FDI inflow is the result from an increase in the emigration rate of high skilled labour. This relationship was examined in an early study by Samuelson (1948) where he argues that the relationship between trade (FDI) and migration is a relationship of substitutability. The substitutability is due to trade contributes to the equalization of factor prices and therefore lowers incentives for factor mobility. This was later confirmed in a more recent study as well by Aroca & Maloney (2005) where they conclude that migration and FDI are negatively related as FDI, and trade variables are substitutes for labour inflows.

Abdih et al. (2012) shows that remittances improve the fiscal balance of the sending counties by increasing the aggregate private demand (mainly through consumption) and thus expanding the tax base. The improved balance gives place for welfare policies that benefit the poor. However, in Abdih et al. (2008) the authors argue that remittances create a moral hazard for the governance of the origin countries which hurts the long run development. As remittances function as a social security net against adverse economic shocks, general shocks and individual, the incentive for governments to implement policies that are beneficial for growth reduces. Adding to this, as it is a large substitute for labour income, remittances can reduce labour participation and especially for women which could potentially imply that remittances could create a poverty trap for developing countries as well as increase inequality. However, this depends on the structure and income level of the households that are on the receiving end of the remittances and theoretically, if the receivers are low-income households,

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[2] More on diaspora externalities in section 2.5.

it could be the other way around and inequality decrease. Through remittances, individuals in origin countries are enabled to set up businesses which results in employment opportunities for some and not for others, skewing the income distribution of the country (Koczan et al. 2021).

2.4 Human Capital Formation

The research literature on brain drain dates back to the 1960s where studies found that, through emigration of skilled individuals, the average human capital declined creating a brain drain that lowered long-run economic growth (Perkins 1965; Oteiza 1965). Moreover, these results were believed to be robust as they were reconfirmed in studies the following decades with different approaches used. However, this discourse was questioned by researchers in the late 1990s where the results implied that the increase in high skilled emigration rate rather created an incentive to invest in education and thus raising the human capital stock rather than deplete it. A so-called incentive effect — a *brain gain* rather than *brain drain* (Mountford 1997; Docquier & Rapoport, 1999). However, in an OECD report from 2001 found that the lack of R&D related human capital due to emigration may cause an economic slowdown in the source country. As the innovative performance and the research base are disrupted. As a result, the opportunities at home countries decreases and less individuals find it worthwhile to acquire higher level of education Kim & Lee (2016).

The central theoretical argument in the new brain drain literature is that the expectation about future migration opportunities affects education decisions. When the expected income is higher because of the opportunities to work at high-income countries abroad and achieve a higher standard of living, the incentive to invest more heavily in higher education rises and the average education level of the population also increase (Kim & Lee, 2016). More specifically, a brain gain can come about if individuals find it worthwhile to invest more in education in hope that they one day migrate. The gain comes about from the fact that not all individuals that invested in higher education migrate and thus increase the human capital level in the home country. In other words, an incentive effect to accumulate more human capital (Docquier & Rapoport, 2011). Another underlying theory is that when high-skilled emigrants return to their home country they bring skills and knowledge from abroad and serve as advanced human resources critical for innovation and growth of the source countries. (Stark et al., 1997; Beine et al., 2001)

One of several approaches to see how incentives to acquire higher education through high skilled emigration is to assume uncertainty about the probability to migrate. This is an approach that Mountford (1997) conducts using a model of overlapping generations with three periods and where productivity is a function of education. In the model set-up individuals first decide whether to invest in education or not, then to work in the country or emigrate, and following that they consume and live after retiring. The results imply that brain drain may cause a positive effect for the human capital accumulation in the country. However, the positive effect occurs if following prerequisites are fulfilled: the probability to emigrate is low, wages abroad are relatively high with respect to the home country, and if the educated worker proportion was previously low.[3]

Other studies that use different approaches confirms the above results. According to Stark et al. (1997) an emigrant worker's productivity is revealed at their destination only after some time passes. As the employer does not have full information, they pay the average wage of the group, whether it is the educated group or the uneducated, to the emigrant workers. This incentivises low-skilled individuals to acquire more education in the home country and migrate to receive a higher wage level as the high-skilled individuals. After the workers ability is revealed, low skilled but high educated workers return to their home country. In this case, a market failure increases the human capital level due to investments in education undertook prior to the emigration. Another study to confirm the results is presented in Domingues et al. (2003) where return migration leads to technological diffusion. The diffusion increases the efficiency and through the increase the diffusion compensates for the reduction of productivity of relatively low skilled in the labour force. More specifically, skilled emigrants that return contribute to a transmission of knowledge more than those unskilled.

Beinie et al. (2001) conducted an empirical study to investigate the effects of emigration on growth and human capital formation where gross migration rates were used as a proxy for the measure of brain drain and cross-section data of 37 developing countries was used. In their study a positive and significant impact of emigration on pre migration human capital formation for the sending country was found. More recently, Beine et al. (2008) conducted a study to test the robustness of their results with an updated dataset and finds a positive and significant relationship between human capital accumulation and anticipated prospects of

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[3] Similar method can be found in Stark et al. (1998), Vidal (1998), Beine et al. (2001) and Stark and Wang, (2002).

migration. They use cross-sectional data for 127 countries and estimate the net effect of brain drain for the sample. The data used in the paper was Docquier & Marfouk (2006) estimates of emigration rates for tertiary education level as a measure of brain drain instead. The result of the estimation implies that if countries have relatively low levels of human capital combined with low emigration rates, they experience a brain gain rather than a brain drain. However, there are more losers than winners in this regard. On the other hand, main globalisers like China, India, and Brazil experience economic gains from emigration. And once the numbers are compared the gains of the winners outweigh the losses, resulting in an aggregate gain for developing countries. Which would suggest that the traditional view of the brain drain does not have any evidence from empirical research at an aggregate level.

Even if some of the empirical results appear to be robust across different specifications as they are obtained in a cross-sectional setting where identification always is disputable. This endogeneity bias is argued by Docquier & Rapoport (2011) to depend on: reverse causality and omitted variables. For the former issue, it could depend on whether the increase of the quantity of human capital is accompanied by an increase in quality as well. Thus, making the positive relationship between highly skilled emigration and human capital formation a spurious result. However, Docquier & Rapoport (2011) argue that the risk of reverse causality is not substantial as the dependent variable of human capital investments has restricted effects on the stock of highly skilled migrants. Nonetheless, this is addressed by Beine et al. (2008) using population size and networks as instrumental variables. Groizard &Llull (2006) also test the hypothesis of brain drain using a model with instrumental variables, estimating both a human capital equation and a growth equation. They reject the hypothesis of a brain gain in both cases as the results confirm that countries with high emigration rates to rich economies have a lower level of human capital and ultimately worse economic performance.

Unlike the issue with reversed causality, omitted variable and unobserved heterogeneity issues cannot be addressed using a purely cross-sectional setting. To tackle these issues a panel setting was used by Beine et al. (2011) to estimate the relationship between human capital formation and migration prospects. When controlling for county fixed effects and the use of GMM dynamic estimation techniques for tackling the endogeneity of emigration rates the results show a positive and significant impact of migration prospects on human capital formation for low-income countries. Something that suggests that countries with higher income levels experience a decline of human capital following the emigration of skilled individuals. However, the authors point out that a potential source of bias lies in the

unobserved return migration. This is due to the rise in domestic human capital from the return of former skilled migrants is subsumed in the incentive effect and would then lead to an overestimation of its impact. And the absence of comprehensive data of return migration makes it impossible to control for.

In conclusion, the extended literature of the effects from emigration of high skilled individuals does not clarify the aggregate effect of the human capital flight for sending countries. Thus, the task is to detect the outcome through empirical studies. Nevertheless, the attempts to provide evidence for the effect of brain drain in a cross section of countries are scant. Beine et al. (2001) and Beine et al. (2008) are two of the first papers to try and quantify this effect, stressing the beneficial brain drain hypothesis – a brain gain. Using gross migration rate as a proxy for brain drain, they find a positive effect on human capital formation and ultimately on growth in the poorest countries. However, their results are likely to be sensitive as they use proxies on skilled migration, and to simultaneity and narrow sample biases (Groizard & Llull, 2006).

2.5 Diaspora and Other Externalities

Another feedback effect from emigration is through the creation of networks. This is something that Stark et al. (1997) argue occurs through the influences of the returned migrants and the diasporas living in developed countries. Furthermore, resources and technology for innovation are often transferred from those countries to the source countries with the help from the diaspora. This in turn creates a network of highly skilled individuals linked to their origin and makes the source countries accessible for inflow of financial aid/investments and trade contracts to increase between the different countries (Kim & Lee, 2016). Adding to this, as populous countries may have large diasporas while at the same time experience low emigration rates, thereby they can experience small loss of human capital while

Lodigiani (2008) studies how skilled migration contributes to growth of total factor productivity of the sending countries controlling for diaspora effects in technology diffusion. The author emphasises that the loss of human capital can hamper the growth process but that the economy can benefit from imitation and knowledge diffusion. Furthermore, findings of the study show that skilled migration is likely to increase growth in countries far from the technological frontier.

Rauch & Casella (2003) elaborates more on how diasporas enable investments and transfers from developed countries to developing countries. For instance, the international legislation is not the strongest and with diaspora it creates more trust in the business communities. Furthermore, the market information becomes more accessible and understandable between the origin country and the countries the diaspora lives in due to reduction of communication and cultural barriers. Moreover, this was supported in a paper conducted by Gao (2003) where the role of ethnic Chinese networks in attracting FDI was investigated. In the analysis the result showed a one percent increase, in the Chinese population share, in the investing country leads to around 3.7 percent increase of the cumulative FDI inflows to China. This phenomenon is sometimes referred to as social remittance.

FDI and trade linkages is connected to the formation of migrant networks (Kugler & Rapoport, 2005) which increases the gains from trade and knowledge diffusion. The gains from these factors ultimately spur growth in the economy of the origin countries[4]. The effect on trade by education level is used by Felbermayr & Jung (2009) where they make use of panel data methods to find a significant pro-trade effect of migration. A one percent increase in the bilateral stock of migrants raises bilateral trade by 0.11 percent.

Agrawal et al. (2011) develops a model that introduces access to knowledge that affects innovation. This access to knowledge in turn depends on diaspora networks, an effect of diaspora networks is found to be strong on the number of patents cited which is presumed to have a high economic and social value. Docquier & Rapoport (2011) argue that diaspora networks created through emigration reduce the international transaction costs and facilitate the diffusion of ideas and knowledge. Furthermore, highly skilled diasporas tend to settle in developed countries that encourage technology diffusion and simulate trade as well as FDI. Moreover, emigration of highly skilled people also improves the domestic institutions. However, the authors also pointed out that it is unclear whether such diaspora externalities depend on the proportion or absolute number of highly skilled emigrants. There are many studies that confirm that trade benefits from migration (eg., Gould 1994; Combes et al. 2005). More specifically, these studies show that networks are key for overcoming informal barriers. However, these studies consider all emigration and not just high skilled.

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[4] Javorcik et al. (2011) find empirical support for this view.

2.6 Policy and Institutions

The relationship between institutional quality and emigration of high skilled is a well-reviewed topic in growth literature. Docquier et al. (2015) wrote a prominent paper which outlines that migration affects institutions because the institutional quality gives an "exit option" for individuals. The exit options are two dichotomous options with which individuals can respond to a decline in institutional quality: emigrate or to voice their opinion. However, there is another possible scenario of an exit, a *reversal phenomenon* where instead of individuals who have exited previously return home and try to make up for the loss that was created following their exit (Hirschman, 1970). Such a scenario is described in Docquier et al. (2015) where the outcome in Croatia was successful. Where the Croatians who had left the country returned home and supported their home country politically. Previous members of the Croatian diaspora took 12 seats at the national assembly during the first post-communist election in 1990 an event that later was called the *Croatian Diaspora Effect*.

The importance of well-functioning institutions for growth is implied by the literature. However, the relationship between emigration and institutions is not as well established. Li et al. (2017) claims that emigration has an indirect effect on institutions since educated people are assumed to contribute towards the change of institutions. Furthermore, highly educated individuals tend to resolve problems through the voting and negotiation rather than the use of violence (Kim & Lee, 2016). Another way that institutions and growth are linked together is through the human capital stock. According to Glaeser et al. (2004) human capital is a fundamental and basic source for growth prospects of a country. In their empirical analysis the results implies that positive institutional opportunities follow from a larger human capital stock.

On the other hand, as human capital is pinpointed to be a driving factor in establishing sound institutions and policies the effect of high skilled emigration could then render in opposite results. This is argued by Docquier et al. (2015) where the phenomenon is referred to as the selective process of migration that comes from the fact that people who emigrate to developed countries typically belong to the upper-middle class and/or are highly educated, which reduces the level of human capital in the political process in the home country. Moreover, their regression analysis finds a positive relationship between emigration and institutions implying that countries who have less restrictions on migration have better institutional quality and that human capital has a significant and positive effect on institutions as well. However, the results are ambiguous as the empirical analysis shows a positive but

insignificant effect of the skilled emigration. On the other hand, through the results of the numerical simulation and other empirical estimations, the authors conclude that since emigration creates an incentive effect to invest in human capital the outcome of institutional quality can possibly become positive. This however appears to be the case only for countries with moderate levels of institutional quality and have a high potential for policy improvement.

An argument that the emigration rates of high skilled individuals and the source countries policies are interrelated through the high skilled emigrants' experiences abroad. Those emigrants then act as pioneers for institutionalizing democratic and sound policies for growth. Thus, the economic development of the source country receives a benefit from the emigration (Docquier et al., 2015; J Kim, 2016).

Political networks and effects on institutions is one of the more recent diaspora externalities to be explored. As mentioned, remittances can offer a safety net and relax the pressure on governments to reform. On the other hand, as migrants get exposed to economic systems and political norms and values abroad that differs from the domestic ones, they start to engage in activities that enhance the institutional quality in their home country (Docquier & Rapoport, 2011). For an empirical assessment of these effects Li et al. (2017) use the World Bank governance indicators and the Docquier & Marfouk (2006) migration set. In a cross-sectional set-up they conclude that brain drain has a negative effect on economic institutions but a positive effect on political institutions at home. However, problem with endogeneity is related to the fact that bad institutions tend to cause more emigration, which is dealt with by instrumenting migration with geographic variables. A problematic factor that the authors recognise as geography affects institutions in more ways than only through migration. Furthermore, Docquier et al. (2011) consider a dynamic-panel regression instead to investigate the effects of foreign students and of migration/diaspora networks, respectively, on the quality of origin country institutions. The results imply that the level of human capital and the level of emigration have a strong positive effect on the quality of institutions using a large sample of developing countries. Their simulations show a positive but nonsignificant effect of skilled emigration on democracy at home. However, when the incentive effects of emigration on human capital is considered, the effect becomes significant and positive.

To make matters clearer, a table follows that summarizes the expected effect on growth from the various channels, which emigration operates through, described above.

Table 1: *Summary of channel effects*

Channel	*Expected effect*
Labour Market	Negative, as productivity goes down when skilled individuals emigrate. However, some positive effect can come about from low skilled emigration if labour market is overcrowded for a certain skill/profession.
Remittances	Positive, lifts budget constraints and spur both consumption and investments. Works as a social security net. However, potentially negative for inequality and could create a moral hazard for governments to implement certain policy.
Human Capital Formation	Unclear, deplete human capital stock while at the same time creates an incentive effect for individuals to accumulate more human capital. Depending on which of the effects that dominates, the outcome is uncertain.
Diaspora and other externalities	Positive, creates networks and enables more trade and investments. Knowledge transfer and social/cultural barriers are reduced.
Policy and Institutions	Positive, emigrants experience from abroad is transferred to back home and emigrants help institutionalize sound policies and institutions. Could potentially deplete the human capital in the political process, as high skilled individuals tend to be more politically active.

3. Empirical Analysis

Before moving on to the model specification and the results this section is dedicated to the description of the data that is used. The data availability for emigration rates – or data over brain drain – restricts the data sample to five-year intervals in the period of 1980-2010. Furthermore, the data collected for emigration rates consists of high skilled-, medium skilled- and low skilled emigration rates to the OECD from 136 countries. Moreover, data over other relevant variables for the paper are also collected in similar fashion from various databases.

3.1 Data Description

3.1.1 Migration Data

Data on skilled emigration rate is taken from Brücker et al. 2013. The data set cover information for 20 OECD destination countries by gender, country of origin and educational level, for the years 1980-2010 for 136 origin countries[5]. Furthermore, the data only includes the immigrant population aged 25 and over.

The emigration rate of skill type e is calculated according to the following formula

$$m_{e,t}^i = \frac{M_{OECD20,e,t}^i}{R_{e,t}^i + M_{OECD20,e,t}^i}$$

where $M_{OECD20,e,t}^i$ is the total number of emigrants of skill type e from country i living in all the 20 OECD destination countries added together at time t and $R_{e,t}^i$ is the resident population of source country i with the same level of education[6]. This variable indicates the direct loss of human capital through emigration – the *brain drain* variable.

The total diaspora size of a given origin country for a given e is thus given by

$$D_j^i = \sum_{j=1}^{t} M_{OECD20,e,k}^i$$

Total diaspora size is then divided by the total population in respective origin country. This is due to that a relatively large diaspora size for smaller less populous countries, e.g., Jamaica or Barbados can be reasoned to play a different role than for larger more populous countries, e.g., China or Brazil. However, including the diaspora share of the population can still capture and control for the effect that a relatively large diaspora can have even though emigration rate for the sample period is low.

The immigration to the OECD represents about half of total world migration and about 85 percent of high skilled migration. Thus, the estimates of brain drain for most countries will be

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[5] See appendix A for full list of destination countries
[6] As gender is not the aim to examine in this paper, both of the gender groups are accounted for together

reasonable. However, the South-South[7] migration is excluded which could potentially lead to underestimation in some of the estimations (Docquier & Rapoport, 2012)[8].

3.1.2   Human Capital Data

In this paper, I make use of the dataset from Barro & Lee (2013) which gives detailed information on the skill structure of the population. To construct the human capital variable for the regression, the share skilled of adults (age 25+) is calculated by including all individuals with post-secondary education. As the degree holding share of adult labour force in developing countries is not seldom below 1% the broad classification of Brücker et al. (2013) is applied, and whether individuals graduated or not from tertiary education they are included in the share of skilled labour.

3.1.3   Institutional and Political Data

Civil and political rights have been shown to affect growth and at the same time be a factor connected to whether individuals migrate or not. Therefore, it is important to control for these factors in any investigation of the effect of emigration on aggregate economic outcomes. The data used in this paper is taken from *Freedom House,* a non-partisan and non-governmental organization that conducts research on democracy, human rights, and political freedom throughout 195 countries in the world, including for the 136 countries in the sample used for the regressions. Furthermore, the organization publishes its flagship publication *Freedom in the world* annually. In this they report a comparative assessment of civil liberties and political rights by creating an index respectively. These indices are based on survey results that takes the following into account: non-discriminatory rule of law, freedom from unjustified terror or imprisonment, protection of personal property rights, meaningful process by which chief authority and legislature are elected, fairness in election laws and campaigning opportunity, reflection of voter preference in distribution of power, absence of military or foreign control, etc. for the political rights index, and freedom of open public discussion, assembly and

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[7] Emigration from developing country to another developing country.
[8] Docquier & Rapoport (2012) extend their data set with immigration data for some developing countries where it is available. However, this data set is not updated and hence will not be used in this paper.

demonstration, freedom of political censorship in media and literature , freedom of trade unions and businesses, among other criteria[9].

Rating of the index is composed of 12 political rights questions and 15 civil liberties question. For the political rights questions, 0-12 points are assigned for electoral process, 0-1 points for political participation and pluralism, 0-12 points for the functioning of the government, and two discretionary question each from 0 to 4 and -4 to 0 points. This cumulates to an index for each assessed on a 1 to 7 scale, with 7 being the least free and 1 being the freest (Freedom House, 2015).

However, the measure of institutional quality is a literature topic of its own and for the sake of completeness this needs to be addressed shortly. There are many creative ways used in the literature to determine the quality of institutions[10]. The use of the indexes from Freedom House is determined by the fact that data is available for a long period of time back and by the argumentation above that both political rights and civil liberties has a close link to emigration. Lastly, when the correlation between the two indexes is examined, this goes up to above 94% and the choice of one of the two should not affect the results to a greater extent. Thus, the control variable included in the regressions is the political rights index.

3.1.4   Economic and Financial Data

The data on remittances is taken from the World Bank. However, as the data is given in nominal USD terms it is deflated to obtain constant 2017 USD values to ensure compatibility with the GDP data, which is taken from PWT 10.0. The remittances data is then divided by GDP to obtain remittances' share of GDP.

For the dependent variable, GDP growth rate, the data is collected from the World Development Indicators (WDI) that the World Bank reports. The annual percentage growth rate of GDP at market prices based on constant local currency. Where the aggregates are based on constant 2015 prices, expressed in U.S. dollars. The output is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.

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[9] The interested reader is referred to Freedom House (2015) for a more elaborate description of criteria.
[10] See Islam & Montenegro (2002), Groizard & Llull (2006) among other.

Lastly, to control for openness this paper follows Kim & Lee (2016) that uses data over country trade as a proxy. More specifically, the data of trade is the sum of imports and exports of goods and services and is measured as the percentage of GDP. Which also is collected from the WDI database.

The sample of countries used in this paper is then obtained by the intersection of the data sets mentioned above. In table 1 descriptive statistics on the most important variables are presented, together with the total number of observations.

Table 2: Descriptive Statistics

Variable	Number of observations	Mean	Std. Dev.	Min	Max
GDP per capita growth	610	0.022	0.029	-0.119	0.138
Natural log of GDP	610	8.325	1.486	5.258	11.579
Trade	610	0.701	0.505	0	4.071
Remittances/GDP	610	0.032	0.113	0	2.005
Savings	610	0.166	0.120	-0.243	0.549
Political rights	610	3.407	2.121	1	7
Emigration rate	610	0.165	0.191	0.001	0.995
Diaspora/Population	610	0.038	0.064	0.000	0.485
Share of highly educated	610	0.183	0.168	0.001	0.865

Note: The statistics in the table are based on the observation included in the estimates from Table 3.

When plotting high skilled emigration rate and GDP per capita no clear pattern is observed. However, something that becomes evident is that countries with the highest emigration rates are among the poorest in the world, while countries that are among the richest experience levels of emigration below 20%. The same observations are made when plotting remittances with GDP per capita. Furthermore, these observations are somewhat in line with theoretical assumptions.

Figure 2: Emigration rate – GDP per capita and remittances – GDP per capita in 2010
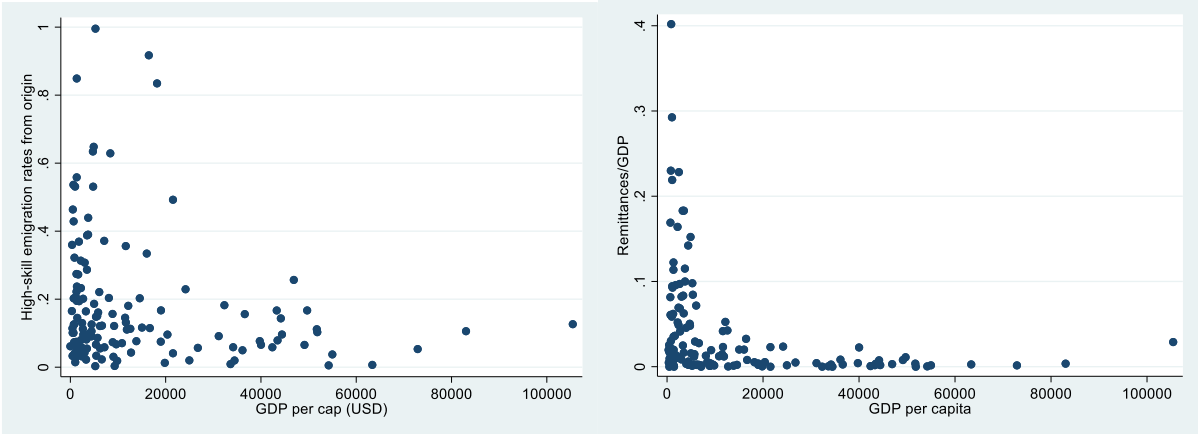
For the if assumptions that high skilled remit more, or less, remittances is plotted together with the high skilled emigration rate in figure 3 below. However, nothing about the relationship can be said between the two variables from the graph.

Figure 3: Emigration rate – GDP per capita.
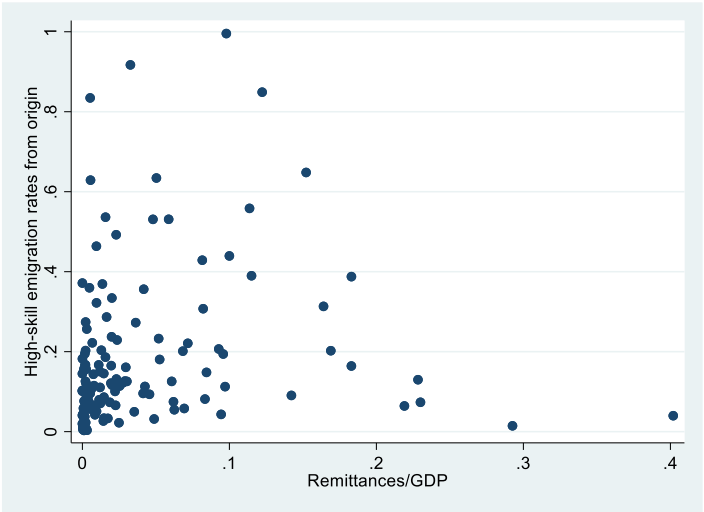
3.2   Empirical Model

For the empirical estimation of how brain drain effects growth could be viewed as an extension of the specification first formulated in Benie et al. (2001). The extension follows Kim & Lee (2016) and Groizard &Llull (2006) for choices of variables of interest and Lodigiani (2008) for the econometric approach. The set-up is a system of two equation that

will be estimated jointly. The joint estimation for the system is argued, as several previous studies have estimated the equation simultaneously (Groizad & Lull, 2006) and a human capital formation by itself to investigate the incentive effect (Beine, 2008). Thus, the approach implemented is joint estimation of the two variables.

The system is structured as follows

$$g_{i,t} = \beta_i + \beta_1 PGDP_{i,t-1} + \beta_2 h_{i,t-1} + \beta_3 d_{i,t-1} + \beta_4 m_{i,t-1} + \beta_5 rem_{i,t-1} + \beta_6 trade_{i,t-1} +$$
$$\beta_7 savings_{i,t-1} + \beta_8 PR_{i,t-1} + \beta_9 m_{i,t-1} * PR_{i,t-1} + \beta_{10} m_{i,t-1} * rem_{i,t-1} + \varepsilon_{i,t} \qquad (1)$$

$$h_{i,t} = \alpha_i + \alpha_1 PGDP_{i,t-1} + \alpha_2 m_{i,t-1} + \alpha_3 rem_{i,t-1} + \alpha_4 m_{i,t-1} * rem_{i,t-1} + \omega_{i,t} \qquad (2)$$

Where equation (1) is the equation for growth and (2) is the equation for human capital formation. $g_{i,t}$ is the GDP per capita growth rate of country i at time t the dependent variable of the regression. A standard control variable in the growth literature to include is initial GDP per capita. This is taken in natural logs and lagged one period (five years) given by $PGDP_{i,t-1}$. The average growth rate should, according to theory of convergence, be larger in poorer countries. Thus, controlling for initial GDP per capita captures this catching up effect and as developing countries are hypothesised to be the losers following brain drain this could be of interest when concluding the results.

To control for human capital $h_{i,t-1}$ is included in the equation which gives the lagged share of adults that has some tertiary education in the labour force, $d_{i,t-1}$ gives the lagged log of total skilled diaspora size abroad. Starting with the human capital variable, as Beine et al. (2001) suggests, that controlling for human capital level controls for the human capital accumulation incentive that follows from migration prospects – an ex-ante brain gain effect. However, the gain effect is countered by a drain effect that some individuals with human capital level do leave[11]. For the diaspora size, in section 2 of the paper many externalise arise from having a large diaspora living abroad. This variable is used to control for these effects as some of the externalities are hard to quantify, such as social remittances, the relative size of the diaspora living abroad suffices as a measure for these effects. Lastly, both variables are expected to have a positive effect on growth but should diverge as the level of development differ.

The variable that follows is the core variable which represents brain drain or the lagged share of highly skilled that emigrants given by $m_{i,t-1}$ and $rem_{i,t-1}$ stands for the inflow of lagged remittances as a share of output. The latter variable is to control for the remittance channel

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[11] Also, human capital is an important variable in endogenous growth model (Lucas, 1988 for example).

that potentially could enhance growth, by lifting budget constraints and generate more investments in education. In the literature it is not clear whether highly skilled emigrants remit more or less than other emigrants. Furthermore, negative effect of brain drain could be compensated with large enough remittances that spur growth in the sending country. The coefficient for the remittance variable could then determine if remittances could off-set the brain drain effect and. Thus, the variable for emigration rates then captures other effects, not operating through channels not described, on growth.

Quite straight forward $trade_{i,t-1}$ and $savings_{i,t-1}$ are control variables where trade is the sum exports and imports measured as a share GDP and savings is also measured as a share of GDP. Trade is, as mentioned, used as a proxy for openness of a country in its activities with other nations. Furthermore, as the literature suggests trade could either function as a complement or substitute for migration and thus, when migration increases trade should decrease (increase) if it is a substitute (complement). $PR_{i,t-1}$ represents the political rights index and whether level of political fairness is beneficial for growth or not, there is no consensus in the literature. However, it is believed that high skilled emigration and institutional quality is linked together and controlling for political rights then would help capture the effect of the brain drain. Then there are two interaction variables with emigration rate and political rights, and remittances and emigration rate to capture the interrelation between the two variables and emigration rate.

Finally, β_i (and α_i for the human capital equation) captures unobserved country-specific factors that may influence growth rate via country dummies[12]. Furthermore, including dummies in the regression also helps to remove serial correlation. Moreover, conducting a country fixed effect model is to get consistent and efficient estimates of the coefficients. As the determinants of growth varies between countries and are hard to control for. Also, some of these determinants are reasoned to be inevitably correlated with, and affect, some of the explanatory variables included. For example, some countries have certain cultural norms, geographical conditions, and ways of conducting business that varies over countries but not over time. Potentially, running a panel regression using country fixed effects could the potentially cause that some of the effects, that we would like to observe in the variable of

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[12] Hausman test is applied which confirms the fixed effects model, the null hypothesis is rejected confirming the fixed effects model.

interest, are removed[13]. Adding to this, all regressions are run with time fixed effects for each period to control for time-dependent shocks and changes.

3.3 Econometric issues

Before any estimation is conducted some econometric issues needs to be addressed. To start with, this model assesses joint determination of two effects of brain drain on growth rate. As a result of this, the system must be estimated simultaneously to identify these two effects. This implies that emigration rate and remittances will be correlated with $\omega_{i,t}$ and that human capital will be correlated with $\varepsilon_{i,t}$ and estimation with OLS would lead to biased an inconsistent results[14]. Furthermore, reverse causality could be a risk as the decision of emigration is dependent on the economic situation in the sending countries this also raises the concern. This concern also applies to the political rights index, as more political rights may cause growth, which then may enhance the political rights even further. For the second specification, reverse causality between the human capital level and emigration rate could be problematic as, ceteris paribus, when the proportion of educators increases the quality of the education goes up. A high standard of education enables the transfer of skills onto labour markets abroad and thus the frictions decrease for international employment of potential emigrants. Moreover, the quota systems, which is comparable to the immigration policies of developed countries, could constitute another source of simultaneity. Resulting in that destination countries only will grants immigration to a certain number of skilled workers and a higher share of educated among natives would in turn lower the chances of emigration for individuals (Beine et al. 2011). Concluding that, the results from a first stage OLS regression cannot be trusted.

Other variables for the specification were considered but ultimately left out[15]. In some of the cases this was due to the lack of sufficient data for certain variables in developing countries, something that would make the interpretation and implication of the results limited. Furthermore, if all variables related to growth were to be included the model would tend to suffer from over specification bias. However, this could result in that the β_4 parameter captures some other effect rather than the effect of high skilled emigration. Nevertheless, the variables included are the main channels connected to emigration rates and thus makes

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[13] This justifies that some of the specifications are regressed specifications with random effects.
[14] By construction remittances share of GDP causes endogeneity of the variable.
[15] Such as R&D expenditures, return migration, and labour market tightness among others.

interesting in this study to control for. Still, omitted variable bias could still be an issue as some of the channels that more accessible and elaborate data are captured in the explanatory variables included instead. But as the data is unavailable and the effect could be argued to appear in our brain drain variable, the variable of interest, and that the channels included in our model is the channels of interest omitted variable issue should not be of any concern. Moreover, in macroeconomic questions of this magnitude the challenge is to build a "close to the world" model that does not omit any variables is close to impossible (Sims, 1982).

Given that the model does not suffer from any omitted variables or reverse causality issues, it captures the effect that brain drain has on growth, controlling for some of the shown channels that it operates through. To control for some of the channels could capture some of the effect that would otherwise be assigned to the emigration rate when estimating the model, while if not controlling for these channels it would be hard to say what aspect of high skilled emigration is beneficial. Furthermore, as some of the effects are hypothesised to pull in different directions, only controlling for the emigration rate the results would suggest an aggregate effect and policy implications would be hard to formulate.

To deal with the endogeneity, instruments are implemented for the variables mentioned above. To find instruments that both eliminates endogeneity and still provides a sufficient number of observations both Lodigiani (2008) and Vandenbussche et al. (2006) proceeded with using the lagged variable of the independent variables as instrument when investigating the effect of emigration on growth[16]. Thus, the instruments implemented in this model are the endogenous variables lagged twice (the emigration rate, natural logarithm of GDP, savings, skill share of the labour force, remittances share of output, political rights index, and values for both interaction variables). The justification that the lagged values of the endogenous variables can be used as instruments can be found in Arellano & Bover (1995) and Reed (2015). However, in Reed (2015) the author highlights an effective estimation strategy using the lagged variable is if the lagged values do not themselves belong in the respective estimating equation, and if they are sufficiently correlated with the simultaneously determined explanatory variable. If the correlation between the endogenous variable and the lagged value is low or the variables are uncorrelated, the estimation using 2SLS will still be biased. As both perquisites are fulfilled the instruments can be implemented with unbiased and consistent results. However, the use of the lagged dependent variable in this case could be somewhat

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[16] Other instruments that have been used in previous literature could potentially skew the sample towards more developed countries with more accessible data. See, Kim & Lee (2016) and Groizard &Llull (2004, 2006) for different approaches and choice of instruments

problematic since the variables have a high degree of persistence. On the other hand, as many of other valid instruments are hard to get consistent and complete data for regarding some of the poorest countries in the sample used, the lagged variable will do for this analysis.

Something that is left unaddressed in the literature is when in time the effect of migration on growth becomes evident. Different approaches have been used, Beine et al. (2001) and Groizard & Lull (2006) considered the contemporaneous effect, while Lodigiani (2008) lags the explanatory variables one period. Kim & Lee (2016) uses a forward-looking approach, starting with the growth one period ahead, then continues to estimate five years and ten years ahead, respectively. A logical reason for the contemporaneous effect has some explanatory challenges is due to the time it takes for emigrants to settle in the destination country. Furthermore, some of the variables controlled for, like remittances, are assumed to increase growth through investments. As the yield from investments also tend to affect growth in future periods rather in the same. Hence, lags should be included in the model, and following existing literature one period is lagged in the model to capture the average effect on growth from the previous five-year period. On the other hand, case could be made to include more lags as when the effect starts to show is uncertain. Additionally, more lags could also capture whether the positive, or negative, effects on growth from emigration is reversed in the long(er)-run than in the regression.

Table 2: Correlations of Variables

Variables	(1) L.PGDP	(2) L2.PGDP	(3) L.EMI	(4) L2.EMI	(5) L.rem	(6) L2.rem	(7) L.h	(8) L2.h	(9) L.PR	(10) L2.PR
(1) L.PGDP	1.000									
(2) L2.PGDP	0.992	1.000								
(3) L.EMI	-0.082	-0.090	1.000							
(4) L2.EMI	-0.071	-0.067	0.971	1.000						
(5) L.rem	-0.153	-0.166	0.030	0.038	1.000					
(6) L2.rem	-0.137	-0.140	0.016	0.017	0.933	1.000				
(7) L.h	0.582	0.585	-0.287	-0.289	-0.092	-0.107	1.000			
(8) L2.h	0.577	0.575	-0.286	-0.290	-0.095	-0.104	0.980	1.000		
(9) L.PR	-0.525	-0.518	-0.021	-0.033	0.056	0.049	-0.400	-0.407	1.000	
(10) L2.PR	-0.515	-0.537	-0.001	-0.017	0.049	0.057	-0.424	-0.420	0.899	1.000

Note: L. represents the lagged variable and L2. represents the variable lagged twice.

To control for heteroscedasticity robust standard errors is applied and the estimation method used is Instrumental Variables on within-group variation (or 2SLS), as the country-specific effects are eliminated through dummies.

4. Results and Analysis

4.1 Growth Equation Results

The estimation of the growth equation is conducted through several specifications. To start with, control variables are included that are not directly linked to any of the channels described previously together with the main variable of interest, emigration rate of skilled individuals. Following that, the human capital variable is included as human capital is assumed to have both a direct effect on GDP growth and works as a channel for the brain drain. Then both the diaspora as a share of the population and remittances as a share of GDP is included. Lastly, the political rights variable is included. All different specifications are run with both country random effects and then country fixed effects.

First thing to notice is that the natural log of GDP per capita is significant at the one percent level in all eight columns and negative. Thus, the result imply that the backward advantage of

less developed economies is confirmed and a converging effect between countries could be the case. Furthermore, our control variables savings and trade, are non-significant throughout the different specifications. This is also the case for the emigration rate, the coefficient is positive in all eight different columns, but show no significant effect on GDP growth. Therefore, from these results no conclusion can be drawn regarding if there is a brain drain or brain gain effect in origin countries.

When the share of highly educated in the labour force is included the results imply that human capital has a positive significant effect on GDP per capita growth. However, the significance only appears when country specific characteristics are included, which further implies that educational systems and structure are heterogenous between countries and constant over time. This is also the case for the diaspora share living abroad, where the coefficient is positive and significant when country dummies are included. However, neither remittance as a share of GDP or the policy variable show significance at any level in any specification.

Table 3: Growth equation results

VARIABLES	Dependent variable: GDP per capita growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP per capita	-0.047***	-0.0053***	-0.0052***	-0.0485***	-0.00530***	-0.0485***	-0.00578***	-0.0487***
	(0.00115)	(0.0136)	(0.00122)	(0.0130)	(0.00143)	(0.0126)	(0.00147)	(0.0127)
Emigration rate	0.00645	0.0528	0.00848	0.0157	0.00743	0.0358	0.00868	0.0335
	(0.00954)	(0.0394)	(0.00975)	(0.0468)	(0.0167)	(0.0488)	(0.0169)	(0.0484)
Savings	0.0182	0.0243	0.0188	0.0351	0.0188	0.0478	0.0171	0.0487
	(0.0220)	(0.0538)	(0.0218)	(0.0579)	(0.0216)	(0.0562)	(0.0218)	(0.0562)
Share of highly educated			0.00849	0.0807**	0.00837	0.0849**	0.00681	0.0874**
			(0.00915)	(0.0372)	(0.00949)	(0.0385)	(0.00984)	(0.0375)
Remittances/GDP					-0.000644	0.00143	-0.000146	0.000812
					(0.00489)	(0.0135)	(0.00513)	(0.0149)
Diaspora/Population					0.00408	0.131**	-0.00737	0.128**
					(0.0447)	(0.0598)	(0.0487)	(0.0634)
Political Rights							-0.00100	0.000455
							(0.00150)	(0.00328)
Trade	0.00274	-0.00916	0.00264	-0.00812	0.00263	-0.0107	0.00298	-0.0106
	(0.00354)	(0.00988)	(0.00349)	(0.00989)	(0.00354)	(0.0106)	(0.00371)	(0.0105)
Constant	0.0453***	0.435***	0.0480***	0.415***	0.0486***	0.416***	0.0566***	0.416***
	(0.0104)	(0.110)	(0.0106)	(0.106)	(0.0129)	(0.103)	(0.0148)	(0.102)
Observations	610	610	610	610	610	610	610	610
Country FE	NO	YES	NO	YES	NO	YES	NO	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES

Note: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$ respectively.

In the following table results are presented for the complete model as specified in equation (1) where the interaction variables are included. And the same approach is applied, the regression is estimated with first country random effects and then country fixed effects. The same results are observed for the logarithm of GDP per capita, share of educated, savings, trade, and the policy variable. However, remittances are now significant, when not controlling for country fixed effects, and implies that an increased inflow of financial support from abroad increases growth in the sending country. While at the same time the significance of diaspora share disappears in both cases.

Only the remittances interacted with emigration rate turns out to be significant in the regression of the interaction variables. As the coefficient of the parameter is negative, this implies that when high skilled emigration increases the remittances reduces. Moreover, this is something that implies the that high skilled emigrants do not remit more but less. Finally, the emigration rate becomes significant in one of the specifications and implies a brain gain rather than drain. However, when country fixed effects are included then the variable once again becomes insignificant.

Table 4: Some more growth equation results.

	Dependent variable: GDP per capita growth	
VARIABLES	(1)	(2)
GDP per capita	-0.00572***	-0.0426***
	(0.00142)	(0.0140)
Emigration rate	0.0495**	0.152
	(0.0240)	(0.100)
Savings	0.0229	0.0127
	(0.0218)	(0.0764)
Share of highly educated	0.00799	0.0785**
	(0.00974)	(0.0386)
Remittances/GDP	0.0670**	0.128
	(0.0327)	(0.185)
Diaspora/Population	-0.00486	0.0346
	(0.0438)	(0.293)
Political Rights	-1.91e-05	0.00261
	(0.00184)	(0.00400)
Remittances * Emigration rate	-0.501**	-0.819
	(0.244)	(1.223)
Political rights * Emigration rate	-0.00778	-0.0262
	(0.00632)	(0.0209)
Trade	0.00121	-0.0137
	(0.00367)	(0.0113)
Constant	0.0504***	0.357***
	(0.0146)	(0.116)
Observations	610	610
Country FE	NO	YES
TIME FE	YES	YES

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 respectively

4.2 Incentive Effect Equation Results

As the model presented in section 3.1 suggests, this is a system of structural form with two equations. Therefore, the system must be estimated simultaneously, and equation (2) is regressed in same fashion as the growth equation and the results are presented in Table 4 below.

The results do not imply any incentive effect on human capital formation and instead imply a loss of human capital because of migration. However, once remittances are included some benefits occur as the variable is significantly positive in column 4 to 6. The interaction variable between remittances and highly skilled emigrants is negative and significant when country fixed effects are excluded. And loses its explanatory power once country characteristics are controlled for. Furthermore, as the natural logarithm of GDP per capita is positively significant throughout the specification, countries that are initially richer tend to have a larger stock of human capital formation.

Table 5: Incentive effect equation results

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Dependent variable: Human capital formation					
GDP per capita	0.0738***	0.0888**	0.0746***	0.0959**	0.0759***	0.0969**
	(0.0107)	(0.0440)	(0.0108)	(0.0437)	(0.0106)	(0.0430)
Emigration rate	-0.324***	-0.419***	-0.328***	-0.359***	-0.286***	-0.364**
	(0.0680)	(0.160)	(0.0693)	(0.107)	(0.0716)	(0.164)
Remittances/GDP			0.0420*	0.0638**	0.208**	0.303**
			(0.0228)	(0.0267)	(0.0876)	(0.133)
Remittances * Emigration rate					-1.056**	-1.429*
					(0.534)	(0.796)
Constant	-0.388***	-0.496	-0.395***	-0.567	-0.413***	-0.574
	(0.0852)	(0.365)	(0.0859)	(0.359)	(0.0847)	(0.356)
Observations	610	610	610	610	610	610
Country FE	NO	YES	NO	YES	NO	YES
Time FE	YES	YES	YES	YES	YES	YES

Note: Robust standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$ respectively.

4.3 Analysis

After estimating the different specifications, the results tend to confirm the results from the hypotheses formulated in both Grubel & Scott (1966) and Johnson (1967) regarding high skilled emigration. As the incentive equation implies, an increase in high skilled emigration rate does deplete the stock of human capital. However, the welfare loss predicted from the loss of human capital is not observed in GDP per capita growth, instead there is an increase following higher emigration rate[17]. Although, the increase is only evident when country dummies are excluded and as the conditions for emigration to be constant over different countries is a hard case to make, these results should be interpreted with caution. Furthermore, Grubel & Scott (1966) did imply that remittances could potentially compensate from the loss of human capital, which is somewhat implied by the results obtained. Remittances do affect human capital formation in a positive way and, as for the emigration rate, the significance disappears when country fixed effects are included. Like emigration, it is unlikely that the condition for remittances are constant over different countries, due to factors unobserved in our model but as the countries in the sample varies from high income to low income the need for financial inflow differs. Nevertheless, the findings in this paper also confirm the results in Perkins (1965) and Oteiza (1965) where the showed that the average human capital level

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[17] Also conflicts with Perkins (1965) and Oteiza (1965) that this lowers long-run economic development.

declined. And in line with Groizard & Llull (2006) where the hypotheses are rejected in the human capital formation.

The negative effect on human capital following high skilled migration is conflicted by theoretical results from numerous papers that suggests a brain gain from the brain drain, as the incentive effect is positive (Mountford 1997; Stark et al. 1997; Vidal 1998). We can conclude that human capital has some a positive effect on growth as suggested by Lucas (1988) but that the accumulation of human capital does not increase following high skilled emigration.

For empirical comparisons, Beine et al. (2001) found that human capital formation benefits from emigration. However, these results are sensitive for specification and as only 37 countries are included, and the estimates could suffer from small sample bias. Furthermore, gross migration rate is used as a proxy for the measure of brain drain and thus the coefficient is expected to capture the effect of general migration and not the specific effect from brain drain. Both factors stated could be instrumental in the differences between the results regarding human capital formation. These results are tested again with update data to check the robustness of the results by the authors in Beine et al. (2008) with updated data on emigration rate[18]. Their variable is now closer related the one used in this paper, but the results still differ. The source of different results could be that the regression is still estimated using cross-sectional data which does not account for country specific characteristics. As mentioned, creating a true world model is challenging when it comes to macro-economic analysis, and not controlling for characteristics specific to a given country, estimates should be interpreted with caution[19].

To account for country specific characteristics Beine et al. (2011) investigate if there is an incentive effect following emigration. The results imply an incentive effect for low-income countries that benefits human capital formation. As these results differ it could be the case that a rise in human capital following return migration is captured in the incentive which could bare some answer to the difference in the results.

Considering the interaction variable between high skilled emigrants and remittances, the compensating theory might break down. Faini (2007) showed that high skilled emigrants do remit less, and which the results from the incentive equation suggests as well. However, Faini (2007) conducted a study towards the pattern of remittances and not growth or human capital

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[18] The authors check the robustness one more time in Beine et al. (2010) where the data and the set-up is the same but with alternative measures for brain drain, definitions of human capital, and functional form.

[19] Full disclaimer for the authors is that cross-sectional data was the only form of data available.

formation. Furthermore, in the model total migration was also included which has positive effect on the amount remitted and could partially explain the initial benefit observed in the growth equation as the model formulated in this paper does not control for total migration. Thus, the remittance effect could be overestimated at first. This is consistent with the findings of Kim & Lee (2016) that also states that, increasing levels of emigration diminishes the positive effect of FDI on growth. Furthermore, they found FDI to be positively significant in their model including fixed effects panel regression. However, they do not account for the endogeneity of remittances, something that could potentially make the results biased. This is however addressed in the dynamic panel model, where the findings are somewhat conflicted of the effects.

The argument that is presented by OECD (2017) and Ratha et al. (2015) that as remittances often are invested it spurs growth and through multiplier effect the increased consumption could offset the productivity loss from skilled emigration is not something observed by our results. However, the remittances could capture an aggregate of the effects that remittances have on growth ss both previous empirical and theoretical findings are ambiguous on whether a positive or a negative effect are to be expected. For example, the positive effect from increase investments and consumption could be countered by the moral hazard that Abdih et al. (2012b) argues the remittances create for the governance leading to a zero net effect as implied by the obtained results in the growth equation. In conclusion, the results obtained is in line with recent empirical studies that implies that the brain drain effect is not compensated by remittances.

Any confirmation of the benefits from having a large diaspora living abroad cannot be obtained by the results. Neither the knowledge or network effect argued by Docquier & Rapoport (2012) is not evident in our model. However, as trade and FDI expected to increase with a larger diaspora, controlling for both trade as a proxy for openness and for remittances the effects of each could capture the significant effects of having a large diaspora abroad. Suggesting that financial remittances is of more importance than social remittances.

Considering the ambiguous results from the rich literature of growth and institutional quality, the insignificance for our policy variable on growth is not surprising. However, as Li et al. (2017) conclude that brain drain has negative effect on institutional quality in the origin country and that emigrants could inspire more sound policy implementation at home. Resulting, in that the non-significance from both the policy variable and the interaction with emigration could be an aggregate of these effects. As for the positive effect following the

Croatian Diaspora Effect controlling for return migration once again would be of interest to capture the positive effects on growth from institutions following emigration of highly skilled.

The results from this paper (and growth papers in general) should however be interpreted with caution, due to the fact the model's form is simple. This could lead to that some of the results are overestimated as constructing a model that accounts for all factors affecting the growth rate that invites no objections is unobtainable.

5. Conclusion

Theory and results from empirical investigations suggests that the impact of brain drain not necessarily harms the economic development of the origin country. Therefore, this study aims at contributing to the scant empirical literature that investigates the direct effects of outflow of skilled individuals on the growth prospects of the sending country. Presenting some of the main channels that emigration rate operates through and present the expected effects on growth if high skilled emigration occurs. These channels are then operated into an empirical specification building on the previous work of Beine et al. 2001, Lodigiani (2008), Kim & Lee (2016), and Groizard & Llull (2006). In the empirical model specified all channels are controlled for to observe the results from each of them, to capture how skilled emigrants contributes to economic development back home. The sample used to assess the empirical implications is a panel data set of 136 countries between 1980-2010.

Incorporating all the channels in the same empirical framework is something that is missing from previous literature. Thereby this paper contributes to analysing the effects when controlling for each.

As the study took shape it became clear that an incentive equation should be estimated jointly with the growth equation. The results implied that remittances do not compensate for the outflow of talent, and rather that the human capital stock was depleted as a result. Neither emigration rate, institutional quality interrelationship with emigration, or remittances was found significant in any extent. However, human capital does determine the growth rate, but the emigration of skilled labour did not incentives the accumulation. Lastly, diaspora size does contribute to growth which is suggested in the literature is through business networks, knowledge spill overs, and the breakdown of social barriers.

The main shortcoming is the lack of data for certain channels, that potentially could control for more specific consequences following high skilled emigration. Also, a discussion of the time aspect is missing from the literature when the expected effects are to be shown. Furthermore, as the estimates of the growth specification is inconclusive to some extent any inference of policy suggestions are hard to conduct. Moreover, policy implications regarding emigration are hard to implement in practice, but studies of similar nature still could give some information for governing bodies in different countries.

For future studies, as the international mobility of labour has been increasing and is expected to increase in the following decades, brain drain is likely to gain attraction from various subject areas conducting research. However, the challenge is that in the frequency and quality of data acquisition must be improved, specifically for developing countries. Not until more comprehensive data is collected can research regarding brain drain assist in designing policies.

6. References

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Appendix A

Countries in the sample:

Albania, Algeria, Argentina, Armenia, Australia, Austria, Bahrain, Bangladesh, Barbados, Belgium, Belize, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cambodia, Cameroon, Canada, Central African Rep., Chile, China, Colombia, Congo Dem. Rep., Costa Rica, Cote d'Ivoire, Croatia, Cuba, Cyprus, Czech Republic, Denmark, Dominican Rep., Ecuador, Egypt, El Salvador, Estonia, Eswatini, Fiji, Finland, France, Gabon, Gambia, Germany, Ghana, Greece, Guatemala, Guyana, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan Kazakhstan, Kenya, South Korea, Kuwait, Kyrgyz Rep., Lao PDR, Latvia, Lesotho, Liberia, Lithuania, Luxembourg, Malawi, Malaysia, Maldives, Mali, Malta, Mauritania, Mauritius, Mexico, Moldova, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Rwanda, Saudi Arabia, Senegal, Serbia, Sierra Leone, Singapore, Solvak Rep., Slovenia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Tajikistan, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Turkiye, Turkmenistan, Tuvalu, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States, Uruguay, Venezuela, Vietnam, Zambia, Zimbabwe.