Marketing Educational Improvements via International Partnerships under Brain-Drain Constraints

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Abstract

We study the dynamics in an educational partnership between a university and a developing region. We examine how the university achieves its goals to improve and advertise its offerings while recruiting a cohort of students from the developing region and maintaining a sustainable relationship with the region and its students. We show that mutually beneficial partnerships can arise, particularly when both the university and the region exhibit strong preferences towards cohort students returning to work at home. We further show that such partnerships can induce developing regions to invest in domestic opportunities for returning students.

Keywords: Partnerships, education, brain drain, game theory, higher education marketing

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1 Introduction

Many types of organisations benefit from sourcing foreign human capital to increase the value of their own products or services. By importing this type of capital, organisations can advertise their quality both to their domestic market and to foreign markets. Universities are an excellent example of this strategy because recruiting top faculty and students from other countries can enhance university reputation, improve the quality of academic work, enrich the on-campus university experience, and justify higher tuition rates (Stephan, 2010). Other examples include cases of scientific or military collaborations in which an institution in one country seeks to access the knowledge and human capital from another country to increase its chances of success in research and development (Melkers and Kiopa, 2010). In some cases, institutions may directly approach citizens with offers of engagement and employment, whereas in other cases, they must go through the government or a parent institution to access those citizens. Under such circumstances, there must be mutual benefits for the foreign entities and the individuals. The partner-seeking institutions are in turn constrained by the needs of those actors.

Universities in developed countries have recognised that there are tremendous gains associated with recruiting international students (Wildavsky, 2010). Top-tier US universities, such as Harvard and MIT, have long had competitive admission processes with the goal of bringing in the brightest students from around the world, accepting a small number of the "crème de la crème."[1] For mid-tier universities without globally-established reputations, a more intensive effort may be required to recruit high-quality international students; this effort may include offering potential students generous incentives, such as scholarships.

A complication arises when recruiting from a developing region because universities must be conscious of the region's concerns about possibly losing one of its most valuable resources — its human capital. This process, often termed *brain drain*, refers to a situation in which talented individuals pursue tertiary education and employment opportunities in more devel-

[1]For its 2012 freshman class, MIT's admission rate for US students was approximately 10%, whereas the rate for international admission was 3%. Source: `http://mitadmissions.org/apply/process/stats`.

oped regions. They do so due to the limited availability of work and educational options in their home regions, be these rural areas or developing nations (Stark et al., 1998). In pursuing these opportunities abroad, individuals may gain knowledge and skills that are not well compensated in their home regions, if there are opportunities at all, resulting in the region's permanent loss of that talent (Coniglio and Prota, 2008). Thus, when partnering with a developing region to recruit students, a university may need to gain the approval of the local government — for instance, when the developing region provides or guarantees students' loans.[2] In such cases, the university must assure both students and their home regions that there are potential net benefits to all parties — to the university, to the developing regions, and to the students.

Drawing on the case of a US university and its recruitment of international students from small developing countries in the Caribbean, we use anonymous online surveys and interviews with staff from the university and the host country institutions to ascertain the objectives and preferences of the three parties. We construct a game-theoretic model that incorporates the students', the developing nation's, and the university's cost-benefit calculus for an educational partnership initiative. We then use the model to study the strategic implications for the involved parties to understand whether such a partnership is viable.

The applicability of our model extends beyond educational partnerships to other instances where organisations seek to enhance profitability by securing external resources, particularly human capital. Cases in which an institution requires human capital from a third party but may be restricted from doing so freely by the "owner" of that capital, such as a government presiding over its citizens' migration, fit naturally. In the case of universities, the model serves as a template for mutually beneficial partnerships that help improve profitability, increase diversity, market educational experience, enhance human capital in developing regions, and help mitigate the risk of brain drain through strategic incentives.

[2]For example, Coniglio and Prota (2008) study the case of the Basilicata region in Italy, where the regional government offered tuition subsidies to students who attended certain foreign universities.

1.1 Marketing Higher Education

Research on corporate marketing strategies, including image and branding, has been extended to the context of universities (Chapleo, 2010). Universities, like many private companies, must appeal to potential customers who cannot be certain of the full quality and value of the product until well after purchase. Successful university brands have been described as clear, consistent, demonstrative of a distinctive competitive advantage, and congruent with the needs of their stakeholders, such as students, parents, alumni, staff and community (Chapleo, 2010). Tremendous weight is placed on a university's reputation, as evidenced by the increasing competitiveness of rankings, such as those published by US News & World Report (Brennan et al., 2008; Bowman and Bastedo, 2009). Because students often pay for tuition prior to fully realising the quality of the university's educational offering, a university's reputation holds significant weight in students' matriculation decisions.

In a recent study, Belloni et al. (2012) examine how university programs can optimise the recruitment and allocation of scholarships to create an ideal cohort with desired characteristics, such as high test scores, diverse backgrounds, and potential for success at the institution. Recognising that universities face a complex marketing problem in targeting selective prices to diverse candidate students, Belloni et al. (2012) formulate a model to characterise individual enrollment potentials and attractive scholarship levels to create the optimal cohort for achieving a university's objectives. Although our model does not distinguish between individual students, we treat a cohort of international students as a unit to which the university offers differential pricing. The university's objective is to induce cohort students' matriculation in order to market its potentially improved educational quality to domestic and international markets.

1.2 Concerns regarding Brain Drain

From the perspective of a developing region, it is, on the one hand, beneficial to support the development of its human capital through foreign study. At the same time, doing so creates

a risk of losing that human capital to a more developed region. Small developing economies are constrained in their ability to compete with more developed regions: developed regions often offer more opportunity, higher wages, and higher standards of living (Portes, 2009). In Fiji, for example, teachers, architects, engineers, and health professionals comprise the majority of emigres because they can find better employment opportunities and earn more money abroad. The economic costs of the loss of human capital include forgone public investments in educating emigres, loss of income stemming from their productive activities, particularly those who may have started their own businesses, and loss of confidence among investors that there are adequate and appropriate human resources to meet their investment needs (Reddy et al., 2004).[3]

There is increasing debate about how individuals who have migrated contribute to local economic development in their home countries. Although it is generally believed that individuals contribute more to a local economy if they live and work there, some scholars argue that remittances can have multiplicative effects (Brown, 2006). Highly skilled professional migrants can also contribute to economic development through entrepreneurial and philanthropic activities in their home countries, as has been the recent case in countries such as China, India, and Israel (Portes, 2009). However, as Portes notes, the success of such ventures is highly dependent on the willingness of local governments to support these linkages through their own investments in local infrastructure and incentives. Our model has the flexibility to consider cases where students remaining abroad provides a net economic benefit or loss to the developing nation.

Developing regions must therefore be strategic in determining the extent of their support for sending their students abroad as well as the scope for creating incentives for these students to return. Coniglio and Prota (2008) present the case of the developing Basilicata region in Southern Italy and examine the strategies used by the regional government to induce students to obtain higher education abroad and return to work in the region. Sur-

[3]Although a developed region may also incur costs educating foreign students, our focus in this paper is on the costs of developing regions. For an analysis of the former, see, for instance, Chishti (1984).

veying a cohort of 1,000 students who had received funding for Master's degree programs, they sought to understand what individual characteristics inclined some students to migrate permanently and others to return home. They found that the most talented students (as evidenced by higher test scores) and those who completed their undergraduate experiences abroad were the most likely to migrate. They determined that local government policies that target employment opportunities, such as providing internships in local companies as well as enhancing local quality of life and cultural offerings, had a significant positive effect on students' decisions to return to work in the home region. In a related example, the Israeli government recently initiated a program to identify expats working abroad in high tech and scientific fields and create incentives for those professionals to return home.[4] In our model, a developing nation can invest in such opportunities, and doing so increases the probability that its students will return.

1.3 The Motivating Case

In 2010, a US university initiated a recruiting program in the Caribbean aimed at matriculating students from several islands to the university. Core components of this program, which distinguish it from other recruiting efforts, included the following: a focus on matriculating large cohorts (10 or more students per nation per year); encouraging students to pursue STEM fields (Science, Technology, Engineering, Mathematics); helping to build students' leadership skills through extracurricular activities; and maintaining students' engagement with their home countries through community service, research, and education initiatives. The university subsidised cohort students' undergraduate education by providing scholarships — in some cases covering 50-70% of the cost of attendance (tuition, room and board, fees, etc.).

University officials heralded the initiative as an opportunity to increase its international diversity and fulfill the university's mission of actively engaging and contributing to solutions that address the world's most challenging problems. Recruiting the Caribbean students

[4]See, for instance: `http://bit.ly/1ka6rcI`.

expanded an existing scholarship program aimed at matriculating domestic students from diverse backgrounds, particularly those under-represented in STEM fields.[5] The program emphasises matriculating "large cohorts versus 1-2 students" with the rationale that "if students know each other, they can support each other" and have larger impacts on the quality of campus life beyond their immediate numbers. The initiative has now expanded beyond the Carribean to the Middle East and Latin America. The university's provost supported the initiative because "it might achieve goals of greater diversity, enrollment of women, and increased downstream revenues" better than traditional recruiting efforts.

Concurrently, the university has undertaken major initiatives with the overall aim of improving the quality of its educational offerings. These initiatives include hiring new faculty, renovating classroom and recreational space, and offering new academic programs. Importantly, the university also aims for its international partnerships to facilitate reputational and marketing gains by attracting more full-paying students domestically and abroad.

The developing regions participating in this partnership expect to benefit from enhancing their human capital and expertise in technological subjects. For example, the Caribbean Community, a regional organisation that represents 15 member countries, has set a target tertiary education participation rate of 15% in member countries by 2015. However, participation rates in many of the smaller Caribbean islands have stagnated below 10% for decades. Higher education in the region is viewed as a vehicle for reducing poverty and for achieving economic prosperity and social cohesion (Smith, 2011). However, these regions may also incur opportunity costs because cohort students do not contribute to their local economies while they are studying abroad. Sending 'the best and brightest' students abroad also entails significant risks of brain drain, with some students not returning to their home countries after graduation. Individual students and their families are expected to benefit from receiving a tertiary education that is potentially not available in their home region, but may incur costs from being separated from their families and cultures.[6]

[5]The initial program targeted high achievers at US community colleges who exemplified a commitment to community service with the idea of "building a circulation of students back to their communities."

[6]In practice, these costs and benefits may also differ significantly by gender because young women can

RISE St. Lucia, a youth-development community-based organisation, was instrumental in facilitating a partnership in St. Lucia by working with the local community college and government to identify students who could benefit from the initiative. According to co-founders Stephen King and Jacqueline Bird, the targeted individuals who had graduated from the community college and were "high achievers, who had no means to move on to higher education. They lacked security to get loans. They were underemployed." The St. Lucian government — specifically, the Human Resources Training Division of the Ministry of Education — selected the students and agreed to secure their loans for the unsubsidised portion of tuition. RISE hoped that these students would "work in the US for 5-6 years, get experience, and come back home and open businesses when they return."

1.4 Results from Student Surveys

The authors conducted an anonymous online survey and received responses from 35 of the 48 (73%) Caribbean students at the university in Spring 2012. Approximately half of the respondents were males, with most between the ages of 20 and 24. The survey asked students to provide information about their activities prior to matriculating at the university, particularly information concerning whether they worked prior, their salary levels, and their best alternative had they not matriculated at the university. Next, the students were asked to evaluate their experiences at the university. Finally, the students were asked about their post-graduation plans, including what their immediate plans were, when they planned to return to their home countries, and what factors influenced their decisions.

Prior to matriculation, slightly more than half (54%) of the students worked full-time, with the majority of these receiving salaries of less than USD1,000 per month and a few making between USD1,001 and USD2,000. Of those who worked, the respondents commented that their positions and salaries were good by local standards, particularly for someone just starting a career, but several respondents felt that they were underpaid. One student commented: "It was a good job, but the pay was not satisfactory enough for the workload and

access skills and job options abroad that are too often closed to them in Caribbean societies.

extent of work." Another mentioned: "It was a great job. Transportation was covered by the company and after taxes I still had a great salary." A few at the higher end of the wage spectrum felt that they had been very fortunate to land these positions, such as a respondent who said it was a "great job, better than anything expected for someone my age." A total of 30% of the students had worked between one and three years, with 12% working more than three years and 11% working less than one year. Of the students who worked, all noted that financial constraints prevented them from pursuing further studies, with one-fifth reporting a lack of relevant academic opportunities as an additional factor. As one respondent recalls: "I worked night shifts most days of the week and was unable to take time off from work for school or anything else really. In addition, I knew asking my mom to help put me through school again was too much so I continued working, hoping to eventually save up for school." Figure 1 highlights the students' reasons for not previously pursuing university studies.

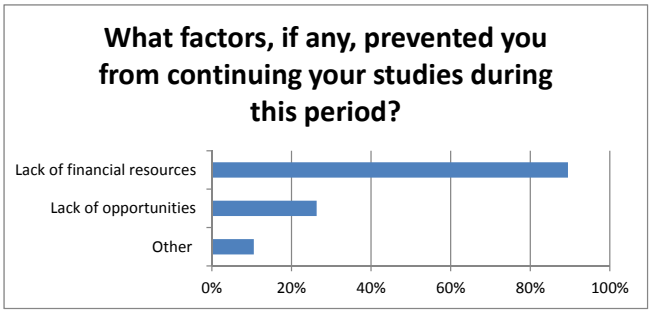


Figure 1: Survey responses to a question regarding financial constraints and local alternatives.

If these students had not come to the university, more than half (54%) of them said they would be working full-time in their home countries (see Figure 2). Another quarter said that they would combine work (full-time or part-time) and study, either through a local institution or an online degree program. One-fifth said they would pursue full-time studies either at home or abroad. More than 80% reported that the scholarship provided by the university was the prime reason for attending that institution. Approximately half of the students noted a good match between their academic interests and the programs offered, and half of them mentioned the opportunity to study in the US as an important pull factor.

For nearly all of students, the scholarships cover at least half of their costs. However, the

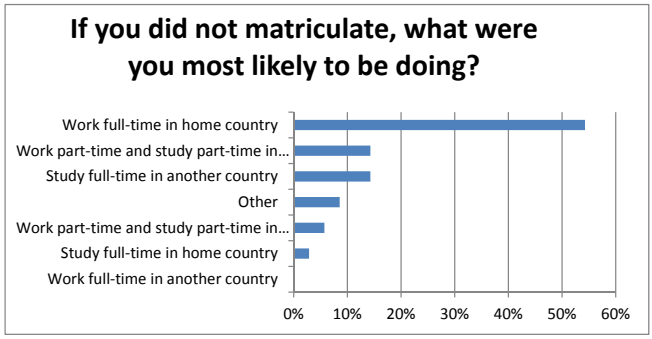


Figure 2: Survey responses to a question regarding opportunity cost.

majority of the students expect that their cumulative debt at graduation will be between USD50,001 and USD100,000, which, when converted to Eastern Caribbean dollars, nearly triples the nominal value owed. When asked about their plans after graduation, 51% said they would seek job opportunities in the US, with 40% interested in graduate studies (see Figure 3). Only one respondent planned to immediately look for a job in his home country.

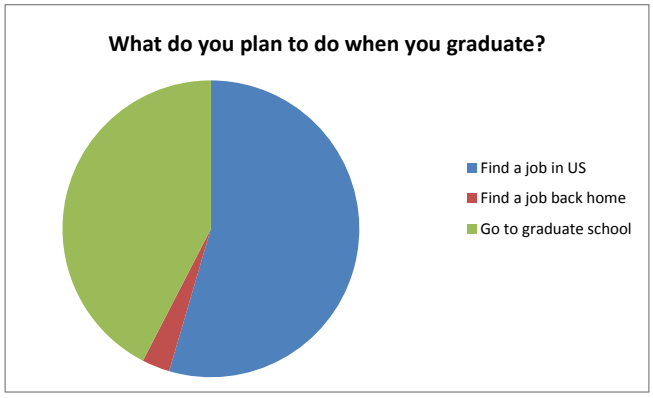


Figure 3: Survey responses to a question regarding post-graduation plans.

The drivers for their post-graduation choices appeared to be the desires to gain professional experience, increase earning potential, and repay student loans, in that order. When asked when they expected to return to their home countries to live and work, the largest number (46%) said that they expected to return within 5-10 years, with 38% within 5 years and 9% within one year. The rest (14%) indicated that it would be at least a decade before they considered returning. One-third of students indicated an interest in returning home to start their own business in areas related to their technical expertise.

2 Model

The model consists of three parties, the university, a representative student cohort from the developing nation, and the developing region. All parties are risk-neutral expected payoff maximisers with actions and objectives that are described below. Figure 4 depicts a summary diagram for the timing of the game.

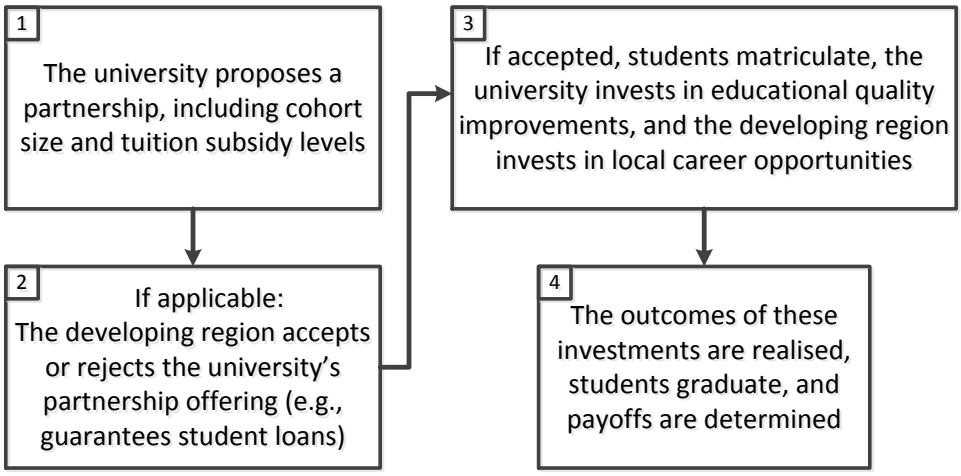


Figure 4: Summary timeline of the game.

2.1 The Students

A cohort student's outside option to attending the university is pursuing a local option, such as finding work or attending a local community college. Doing either of these results in an expected net payoff that is normalised to 0. A student's cost of attending the university is given by $t - s$, where t denotes the cost of tuition and s denotes the sum of any subsidies, such as scholarships, that are provided by the university.[7] A student's value from graduating from the university is denoted by v_θ, which can be either high or low, denoted by v_L and v_H, respectively, and these values are assumed to incorporate the expected returns from any downstream career decisions. We assume that if this value is low, the students are better off pursuing their outside option, and without loss of generality, set $v_L = 0$. Thus, if a student

[7]The parameter s may also be *negative*, in which case cohort students are charged a higher rate of tuition.

matriculates and a low outcome is obtained, the student's net utility is $-(t-s)$. If a high outcome is obtained, the student's net utility is $v_H - (t-s)$.[8] After graduation, students choose whether to seek employment locally or to return to their home regions; this choice is affected by their region's investment in local opportunities, detailed below.

2.2 The University

To facilitate its marketing efforts through cohort students, the university invests in the quality of its educational experience, including investments in faculty, facilities, and educational resources. A higher level of investment is more likely to result in quality improvements. The resulting quality can be low or high, denoted by $\theta \in \{L, H\}$, whereby a good outcome for the university is correlated with a good outcome for the students. To obtain a likelihood $q \in [0,1]$ of improving its educational quality, the university invests $I_U(q) = \frac{K}{2}q^2$ (the parameter $K > 0$ indicates an upper bound on the university's expected gain from quality improvement and is used to scale its investment cost function).

The university also chooses how many cohort students to admit, denoted by n. Bringing in diverse students from less developed regions may require a subsidy s (e.g., via grants or scholarships), and may offer benefits in terms of improving the educational experience offered (and thus the university's profit from domestic students). Universities often limit the number of students from such regions due to budgetary constraints, but they may choose to bring in larger cohorts depending on the circumstances (e.g., a larger cohort may foster a stronger sense of community and improve the students' experience). The university's outside option to admitting a cohort student is assumed to be a full-time student who pays the full tuition rate t.

We assume that the university currently has a pre-investment quality that is normalised

[8] Whereas the direct payoff associated with a low outcome, v_L, is normalized to 0, the overall payoff from a low outcome is given by $v_L - (t-s) = -(t-s)$, which will be strictly negative in equilibrium. Thus, the overall payoff to students from a low outcome is strictly lower than the payoff from the outside option (staying at home), which is 0. Moreover, the results continue to carry through with any $v_L < t$. For cases where $v_L \geq t$, attending the university is a dominant option for cohort students, regardless of subsidies, which detracts from the intricacies of the problem we study.

as 'low,' letting $R(n)$ denote the expected present-discounted returns realised should it successfully improve its quality. For simplicity, we treat the cohort size n as a continuous variable and assume that $R(n)$ is twice continuous and concave, satisfying the following conditions: (i) $R''(n) < 0$, that is, the university's benefit from increasing its cohort size exhibits diminishing marginal returns; (ii) $\lim_{n\to 0} R'(n) >> 0$, that is, conditional on a successful quality improvement, returns to cohort matriculation are high when there are currently no admitted cohort students; and (iii) there exists $\bar{n} > 0$ such that for $n \leq \bar{n}$, $R'(n) \geq 0$, and for all $n > \bar{n}$, $R'(n) < 0$; that is, the optimal cohort size is finite.

Provided that its investment in quality improvement is successful, the university also exhibits preferences towards cohort students returning to their home regions. Let $m \leq n$ denote the number of cohort students who return to the developing region after a successful outcome (as elaborated below), and let parameter B denote any additional payoff that the university derives from returning cohort students. The parameter B is positive if the university derives greater net benefits when a student returns home (e.g., due to returning students promoting the university among their peers, due to improving the university's relationship with the developing region, etc.) and negative when the university derives greater net benefits from a student staying in the US (e.g., due to promoting the university in its domestic market, due to higher alumni donations, etc.).

Summarising the above, the university's objective is to choose a specification for the parameter tuple (q, n, s) to maximise its expected net payoff, specified by the following:

$$q(R(n) + mB) - I_U(q) - ns. \tag{1}$$

We notice that in (1), because the university's outside option to a cohort student is a domestic student who pays tuition t, the difference in tuition rates is given by $-s$. Thus, given n cohort students, the overall difference in tuition rates is $-ns$. Moreover, it follows that a cohort student's *expected* utility from matriculating at the university is given by $qv_H - (t - s)$.

2.3 The Developing Region

The developing region's objective is to maximise the welfare of its citizens. Since both students and non-students' utilities factor into this welfare, we denote the region's welfare function by $CW(n, m, \theta) + nSW(n, s, \theta)$. Here, CW denotes non-student citizens' welfare as a function of the number of students who participate in the educational partnership, the number of students who return, and the realised quality of the university, as denoted by n, m, and θ, respectively; SW denotes the students' welfare as a function of the number of students who are supported, the support level provided by the university, and its realised quality, denoted by n, s, and θ, respectively. We assume that $CW(n, m) = mV_{r,\theta} + (n - m)V_{s,\theta}$, where $V_{r,\theta}$ and $V_{s,\theta}$ denote the non-student population value for students who do and do not return, respectively, depending on the realised quality of the university.[9]

The developing region chooses a level of investment for developing and deploying local infrastructure and employment opportunities for returning cohort graduates. For tractability purposes, we assume that if the university's quality is low, all cohort students return.[10] If the university's quality is high, to induce a graduating cohort student to return with probability $r \in [0, 1]$, the developing region must invest $I_D(r) = \frac{L}{2}r^2$, where the parameter $L > 0$ indicates an upper bound on the developing region's expected gains from the program.[11]

To summarise, provided that the educational partnership program is approved by the university and the developing region, the developing region chooses an investment level $I_D(r) = \frac{L}{2}r^2$, resulting in a fraction r of cohort students returning, to maximise its objective

[9]The difference in $V_{r,\theta}$ and $V_{s,\theta}$ amounts to the developing region's (net) preference for students returning to work domestically (e.g., whether increased remittances or increased domestic output are preferred overall). If this difference is negative, the developing region would not invest in facilitating local opportunities for returning students. Thus, we henceforth consider the more intricate case where this difference is positive.

[10]This assumption is not necessary for the results — the results are maintained provided there is a higher threshold of students returning when the university's quality is low.

[11]Our modeling assumptions entail that given $\theta = H$, a minimum level of investment is required for some students to return to their home region. In practice, some students may return even with no investment, and some regions may be fiscally constrained and thus unable to invest in this infrastructure. Our model can readily account for these situations by considering a baseline probability of a student returning that is independent of investment. Qualitatively, our insights would remain the same, except for the developing region possessing fewer incentives to expend resources on infrastructure investment.

specified by

$$n\big[q(rV_{r,H} + (1-r)V_{s,H} + v_H - V_{r,L}) + V_{r,L} - (t-s)\big] - \frac{L}{2}r^2. \tag{2}$$

Substituting for $m = rn$ in the university's objective given in (1), it follows that the university chooses a specification for the parameter tuple (q, n, s) to maximise

$$q(R(n) + rnB) - \frac{K}{2}q^2 - ns. \tag{3}$$

2.4 The Game

The game consists of several stages. First, the university proposes terms (s, n) to candidate students in the developing region. Then, should its approval be required, the developing region chooses whether to approve the exchange.[12] Once approved, provided the students' expected utilities are non-negative, n students matriculate. In the next stage, the university concurrently invests in improving its quality, and the developing region invests in improving its domestic employment opportunities. In the final stage, the university's new quality is realised, students graduate and either stay or return home to work, and payoffs are determined. The timeline of the game is summarised as follows:

1. The university announces its terms (s, n), which the students and the developing region (when its approval is required) accept or reject.
2. If the terms are accepted, the students matriculate, the university chooses its investment level I_U, and the developing region chooses its investment level I_D.
3. The outcomes of the university's and developing region's investments are realised, students graduate, and final payoffs are determined.

The solution concept that we employ is the Subgame-Perfect Nash Equilibrium (SPNE).

[12]Interviews with St. Lucia island representatives and the student surveys indicate that the majority would not have been able to attend the university without the support of their local government in providing additional scholarships and bank loan guarantees to help cover expenses. At the same time, our model extends to settings where the local government's approval is not required. In such cases, the university's proposed subsidy is primarily determined by the students' budget constraints. We return to this point in the next section.

3 Model Analysis

We begin by solving for the equilibrium of the investment subgame given an approved exchange program with a specification of s and n that has been provided by the university.

Lemma 1 *In the second stage of the game, the university's and developing region's best-response functions are given by* $q(r) = \frac{R(n)+rB}{K}$ *and* $r(q) = \frac{1}{L}nq(V_{r,H} - V_{s,H})$*, respectively. In equilibrium, the university invests* $I_U = \frac{K}{2}\left(\frac{LR(n)}{KL-n(V_{r,H}-V_{s,H})B}\right)^2$ *and the developing region invests* $I_D = \frac{L}{2}\left(\frac{n(V_{r,H}-V_{s,H})R(n)}{KL-n(V_{r,H}-V_{s,H})B}\right)^2$.

All proofs are available in the appendix.

From the best-response functions characterised in Lemma 1, it follows that the university's investment constitutes a *strategic complement* to the developing region's investment. That is, a greater investment by the university leads to additional investment by the developing region. Intuitively, a greater investment by the university entails that the high outcome is more likely to result, whereby cohort students are less likely to return. To mitigate this effect, the developing region is induced to increase its own investment. However, whether the same also holds for the university vis-à-vis the developing region's investment depends on the sign of parameter B — that is, whether the developing region's investment induces the university to increase its own investment depends on the latter's preference towards cohort students returning.

Recall that parameter B represents any additional payoff that the university derives from cohort students returning to their home regions. When B is positive, the developing region's investment also constitutes a strategic complement to the university's investment. However, if B is negative, the developing region's investment constitutes a *strategic substitute*. In other words, a larger investment by the developing region would lead the university to *reduce* its own investment.

The university's and developing region's investments give rise to the following equilibrium probability for quality improvement and a graduating student's likelihood of return, specified

respectively by

$$q^* = \frac{LR(n)}{KL - n(V_{r,H} - V_{s,H})B} \tag{4}$$

and

$$r^* = \frac{n(V_{r,H} - V_{s,H})R(n)}{KL - n(V_{r,H} - V_{s,H})B}. \tag{5}$$

We recall that the university's return from cohort students, $R(n)$, is increasing in the number of students over $[0, \bar{n}]$. From (4) and (5), it follows that over $[0, \bar{n}]$, both the university's and the developing region's investments rise in response to a larger number of cohort students, n. It also follows that both investments rise in response to an increase in the developing region's value from returning students, as specified by $V_{r,H} - V_{s,H}$. These observations are summarised in the following proposition.

Proposition 1 *The university's investment constitutes a strategic complement to the developing region's investment. The developing region's investment is a strategic complement (substitute) to the university's when $B > 0$ ($B < 0$). A larger cohort size n, provided $n < \bar{n}$, and/or a greater value to the developing region from returning students results in greater investments by both the university and the developing region.*

It follows from Proposition 1 that the role of the cohort size n extends beyond simply determining payoffs: it facilitates a mechanism for the university and the developing region to credibly commit to higher levels of investment.

Folding the game back to its initial stage, we substitute r^* and q^* into the university's problem. The university then chooses a cohort size n to maximise

$$\frac{LR(n)}{KL - n(V_{r,H} - V_{s,H})B}\Big[R(n) + \frac{n^2(V_{r,H} - V_{s,H})R(n)B}{KL - n(V_{r,H} - V_{s,H})B}\Big]$$

$$-\frac{K}{2}\Big(\frac{LR(n)}{KL - n(V_{r,H} - V_{s,H})B}\Big)^2 - ns$$

Letting $\psi = V_{r,H} - V_{s,H}$, the above can be rewritten as

$$\max_{n} \quad \frac{L(KL + 2(n-1)n\psi B)R^2(n)}{2(KL - n\psi B)^2} - ns \tag{6}$$

Increasing the size of the participating cohort, n, thus, has three effects. First, admitting a larger cohort strengthens the developing region's investment incentives, which works in favour of the university when $B > 0$ and against it when $B < 0$. Second, admitting a larger cohort can have a positive (if $n < \bar{n}$) or a negative (if $n > \bar{n}$) impact on $R(n)$ and thus on the university's payoff. Finally, admitting a larger cohort entails larger opportunity costs in terms of tuition waivers and scholarships, as represented by s.

The first-order condition of (6) evaluated at the optimally chosen cohort size, n^*, is given below, where the first two effects are indicated by (i) and (ii), and the third effect is on the right-hand side of the equation:

$$\underbrace{\frac{n^*\psi L(2KL - \psi B)R^2(n^*)B}{(KL - n^*\psi B)^3}}_{(i)} + \underbrace{\frac{L(KL + 2(n^* - 1)n\psi B)R(n^*)R'(n^*)}{(KL - n^*\psi B)^2}}_{(ii)} = s \tag{7}$$

Using the above first-order condition, we obtain the following result.

Proposition 2 *For a fixed tuition subsidy level s, when the university's and developing region's investments constitute mutual strategic complements (i.e., given $B > 0$), the university's optimal cohort size n^* is increasing in the developing region's benefit from returning students, $V_{r,H} - V_{s,H}$.*

Propositions 1 and 2 together show that when $B > 0$, that is, when the university receives net benefits from cohort students returning to their home regions post graduation, two things hold. First, the university's and the developing region's individual investments positively impact one another. That is, they are strategic complements. Second, ceteris paribus, a greater value to the developing region from returning students, $V_{r,H} - V_{s,H}$, results in a larger optimal cohort size n^*, for any fixed level of tuition subsidy s.

It further follows that an increase in the developing region's benefit from returning students has both direct and indirect effects on investment. In particular, from Proposition 1, an increase in $V_{r,H} - V_{s,H}$ has the direct effect of increasing the university's and developing region's investments. From Proposition 2, given $B > 0$, an increase in $V_{r,H} - V_{s,H}$ also results in a larger optimal cohort size n^*, which, given $n^* < \bar{n}$, also has the indirect effect of unambiguously increasing both parties' investments.

Thus, these results give rise to the following empirical prediction: when the university's interests and the developing region's interests are aligned, one would expect to observe larger cohort sizes and greater investments in educational partnerships.

In contrast to the above scenario, cases where interests are not aligned ($B < 0$) result in ambiguous comparative statics, where an increase in $V_{r,H} - V_{s,H}$ can result in both positive and negative effects on the optimal cohort size, n^*.

In folding the game back to its initial stage, we can determine the university's optimally chosen tuition subsidy, s^*. To do so, we re-examine the developing region's problem. In particular, should its approval be required, given (s^*, n^*), the developing region would approve the overall program provided its expected payoff function is non-negative. That is:

$$n^*\big[q^*(r^*\psi + v_H + V_{s,H} - V_{r,L}) + V_{r,L} - (t - s^*)\big] - \frac{L}{2}r^{*2} \geq 0$$

Substituting for q^* and r^*, letting $\varphi = v_H + V_{s,H} - V_{r,L}$, and simplifying, we obtain that s^* is implicitly defined by:[13]

$$s^* = t + LR(n^*)\Big(\underbrace{\frac{n^*\psi^2 R(n^*)}{2(KL - n^*\psi B)^2}}_{(i)} - \underbrace{\frac{\varphi}{KL - n^*\psi B}}_{(ii)}\Big) - V_{r,L} \tag{8}$$

[13]Equation (8) specifies a subsidy level s^* that satisfies the developing region's participation constraint. If students' budget constraints require that subsidies exceed a threshold larger than s^*, then the government's incentive-compatibility constraint will not be binding. Furthermore, we note that in the absence of students' budget constraints, our setup gives the university the first-mover advantage, and, consequently, the university would extract the full surplus from the partnership. However, a richer framework can incorporate a bargaining subgame between the university and the developing region, whereby (8) specifies a lower bound on the subsidy level that would result from this negotiation.

We note that the above characterization only implicitly defines s^*, because the equalities in (7) and (8) are simultaneously solved to characterise n^* and s^*. Term (i) represents the increased necessity of tuition subsidies given the costs of brain drain, i.e., of a loss due to students not returning to the developing region. Term (ii) in (8) represents the diminished need for tuition subsidies given the benefit to students from a successful university investment and/or given significant benefits to the developing region from students staying abroad. Finally, as $V_{r,L}$ increases — that is, given a greater benefit to the developing region from a low outcome — the need for tuition subsidies diminishes (an intuitive example for this latter case is a university that already has a well-established reputation and educational offerings, and that does not need to offer substantial subsidies to partner with the developing region).

For cases where investments by the university and by the developing region form strategic complements ($B > 0$), it follows that an increase in the cohort size n over the range $[0, \bar{n}]$ has both a negative and a positive effect on s^*. The former is explained by gains to students individually and to the developing region at large from expanded and increased chances for a higher-quality education, and the latter is explained by a greater likelihood of brain drain taking place.

As defined above, the subsidy s^* can be negative. Indeed, in practice, cases may arise where the university taps into a positive net gain to the developing region by either raising tuition across the board and providing some baseline support to domestic students or increasing tuition indirectly for cohort students (e.g., by setting higher fees for health-insurance premiums and mandatory on-campus dormitories). If there is an explicit requirement that cohort students are not charged more than the standard tuition rate, t, but may be charged less than this rate, we can implicitly define s^* with the following equality:

$$s^* = \max\{t + LR(n^*)\big(\underbrace{\frac{n^*\psi^2 R(n^*)}{2(KL - n^*\psi B)^2}}_{(i)} - \underbrace{\frac{\varphi}{KL - n^*\psi B}}_{(ii)}\big) - V_{r,L}, 0\}$$

Finally, should the developing region's approval *not* be required, the subsidy s^* is no longer constrained by the developing region's payoff function. Instead, minimum restrictions on the subsidy s^* would come directly from the students' budget constraints.

4 Comparative Statics and Simulations

Given our current framework, any surplus associated with the partnership between the university and the developing region can effectively be extracted by the university, provided that student subsidies can also be negative. This ability can be observed from equation (8), where a cohort student's tuition subsidy is set such that the developing region is indifferent between accepting and rejecting the partnership with the university. Our model readily extends to cases where the surplus from the partnership is distributed among the parties; this can be achieved by incorporating a bargaining subgame between the university and the developing region.[14] However, by omitting such a bargaining subgame, we can gain some qualitative insights into how the surplus from this partnership is affected by the underlying parameters by simply considering the university's expected profit from pursuing it. We begin to do so with the following proposition.

Proposition 3 *The university's expected profit increases as its preference towards cohort students returning to their home region, B, rises. If the university stands to gain (lose) from the return of cohort students, then its expected profit also increases (decreases) in the developing region's preference towards students returning, as specified by ψ.*

Proposition 3 strengthens the empirical implications of our previous findings: when the university's interests and the developing region's interests are more strongly aligned, one would expect to observe larger cohort sizes and greater investments in sustainable educational partnerships.

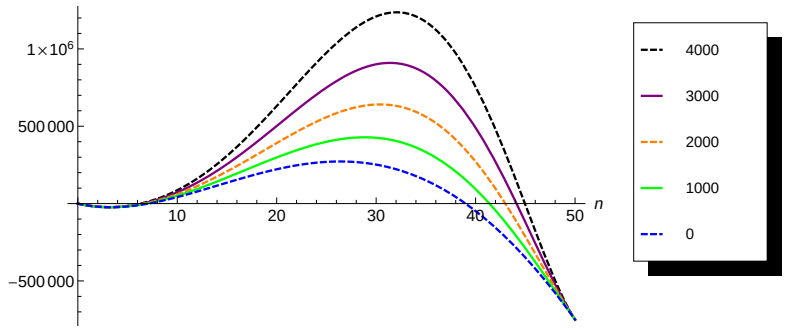
[14] One approach to doing so is to embed a Nash bargaining subgame with respective bargaining powers to the university and to the developing region prior to the stage in which the developing region accepts or rejects the partnership proposal.

Several sets of figures follow below — these figures depict graphical illustrations of comparative statics on the university's expected profit and the optimal cohort size n^* based on a variety of specifications for the underlying parameters. All of the figures depict the university's profit as a function of the cohort size. In the settings of Figures 5 and 6, the university's profit fully captures the surplus generated from the educational partnership. In the absence of any further restrictions (e.g., legal or policy restrictions on tuition rates to cohort students, minimum budget constraints, caps on the number of international students, etc.), the plots thus capture whether educational partnerships are viable (when the surplus is positive) or not (when it is negative). Figures 7 and 8 then place restrictions (an approval of the partnership is required from the developing region, and students face budget constraints, respectively) that limit the surplus from an educational partnership and thus the partnership's viability.

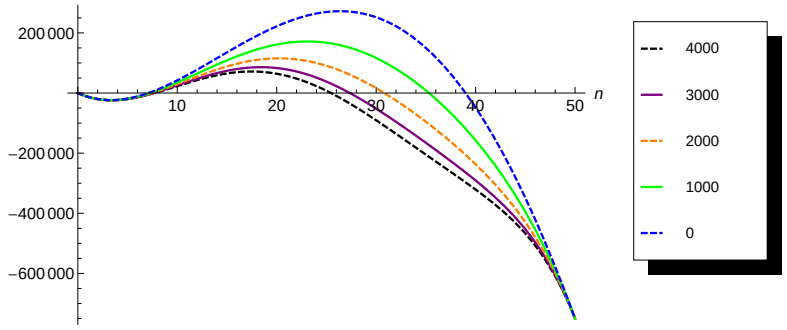
Summary: Figures 5 and 6 depict cases where the university extracts the full surplus from the partnership. Figure 7 presents the case where the university may not set negative subsidies to cohort students. That is, cohort students may not be charged higher tuitions than domestic students (i.e., price discrimination may only be in favour of cohort students). Figure 8 presents the case where the developing region's approval is *not* required and the university's proposed subsidies are instead determined by the cohort students' budget constraints.

In the figures, we employ the following specification for the university's (direct) return to cohort students, $R(n) = \alpha n(\beta - n)$ for $\alpha, \beta > 0$, which exhibits diminishing marginal returns and helps drive the parabolic shape of the figures. In each figure, curve segments that rise above the zero threshold indicate partnerships (among the university, the developing region, and cohort students) that are *sustainable* under the specified scenario. That is, partnerships under which all parties' participation constraints can be satisfied.

Detailed Descriptions: Figures 5(a) and (b) illustrate that given $B > 0$ ($B < 0$), the university's expected profit is increasing (decreasing) in the payoff that the developing region derives from returning students, ψ. The figures also illustrate that the profit-maximising



(a) The case where $B = 5000$

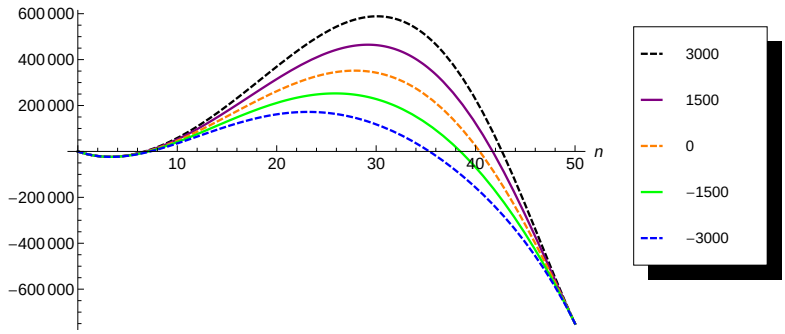


(b) The case where $B = -5000$

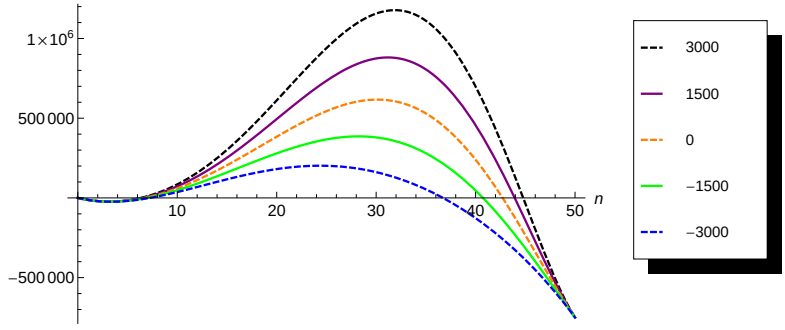
Figure 5: The university's expected profit as a function of n, given optimally set $s^*(n)$, $K = L = 100,000$, $\varphi = 10,000$, $t = 30,000$, $V_{r,L} = 15,000$, and $R(n) = \max\{300n(50-n), 0\}$, for $\psi \in \{0, 1000, 2000, 3000, 4000\}$.

cohort size n^* is higher when (i) the university's investments and the developing region's investments constitute mutual strategic complements (i.e., $B > 0$), and when (ii) given $B > 0$ ($B < 0$), the developing region exhibits a greater (lower) preference for returning students.

As the university's benefit from returning students, B, rises, Figures 6(a) and 6(b) show that the university's optimal cohort size also increases. This increase occurs because the points at which the university's profits are maximised shift to the right. This effect is amplified when the developing region's benefit from returning students, ψ, is higher. The intuition here is that a larger benefit to the university from returning students increases its incentive to invest. In turn, the developing region increases its investment as well, which reduces the required tuition subsidy for satisfying the developing region's constraint and leads to a higher optimal cohort size.



(a) The case where $\psi = V_{r,H} - V_{s,H} = 2500$

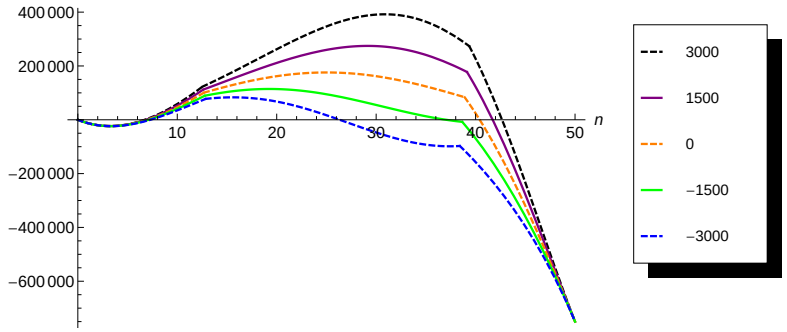


(b) The case where $\psi = V_{r,H} - V_{s,H} = 5000$

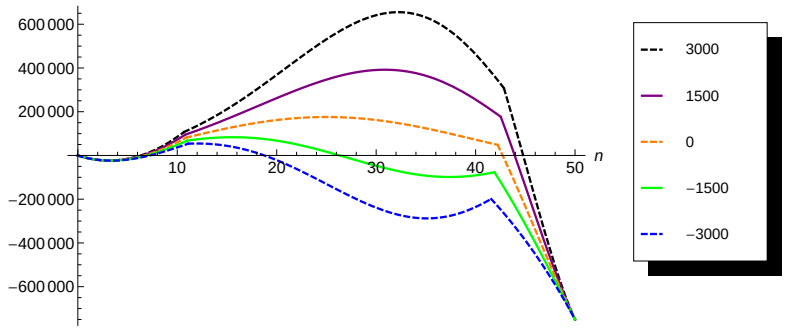
Figure 6: University's expected profit as a function of n, given optimally set $s^*(n)$, $K = L = 100,000$, $\varphi = 10,000$, $t = 30,000$, $V_{r,L} = 15,000$, and $R(n) = \max\{300n(50-n), 0\}$, for $B \in \{-3000, -1500, 0, 1500, 3000\}$.

Figures 7(a) and 7(b) repeat these comparative statics when the university is constrained by non-negative tuition subsidies. That is, when the university cannot negatively price discriminate against the developing region's cohort students. The kink in the university's profit at approximately $n = 10$ is the point at which tuition subsidies hit 0. These two figures illustrate that while there may exist beneficial opportunities for a larger cohort to matriculate, such opportunities may fail to materialise due to tuition bounds, particularly in cases where the university strongly prefers students not to return to their home regions after graduation (that is, when B is negative).

In Figures 8(a)-(d), matriculating cohort students face budget constraints, whereby a threshold tuition subsidy is required. In 8(a)-(b), 20% of tuition is subsidised by the university, and in 8(c)-(d), 50% is subsidised. These figures illustrate beneficial partnerships that may fail to materialise — specifically, the cases of $B \in \{0, -1500, -3000\}$, which, due to



(a) The case where $\psi = V_{r,H} - V_{s,H} = 2500$



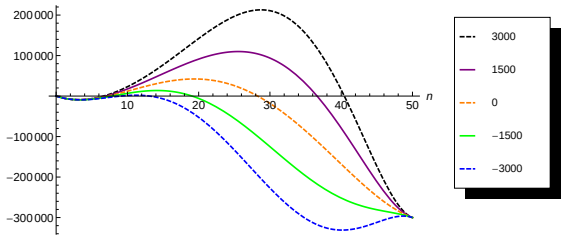
(b) The case where $\psi = V_{r,H} - V_{s,H} = 5000$

Figure 7: University's expected profit as a function of n, given $s^*(n) \geq 0$, $K = L = 100,000$, $\varphi = 10,000$, $t = 30,000$, $V_{r,L} = 15,000$, and $R(n) = \max\{300n(50-n), 0\}$, for $B \in \{-3000, -1500, 0, 1500, 3000\}$.

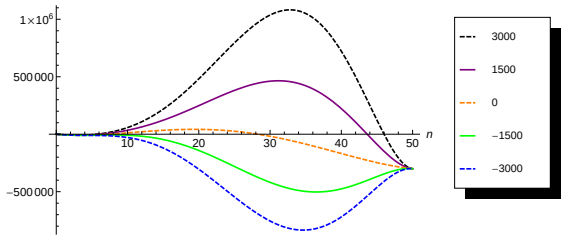
students' budget constraints, result in (mostly) negative expected profits for the university, regardless of the matriculating class size.

In the absence of budget constraints, as Figures 6(a) and 6(b) show, sustainable partnerships do exist in these cases. With the exception of cases where the university's benefit from returning students, B, and/or the developing region's benefit from returning students, ψ, are high, Figures 8(a)-(d) show that heavy tuition subsidies can eliminate otherwise viable partnerships. Thus, should the developing region assist cohort students in financing their education, partnerships can arise that would be beneficial to all involved parties.

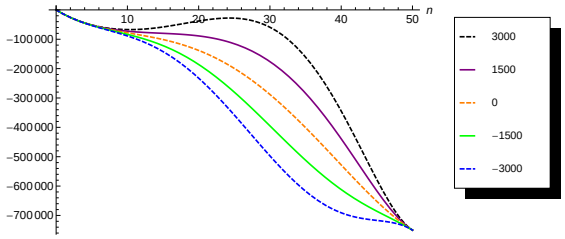
In the case presented, various approaches were taken by different governments in the developing region to assist students to cover their tuition balances. In one case, an island government provided scholarships to students. Another government guaranteed the bank loans taken out by students. In yet another case, no assistance was provided, and students



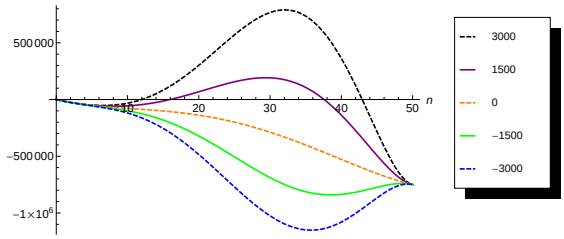
(a) The case where $\psi = V_{r,H} - V_{s,H} = 2500$ with 1/5 tuition subsidy



(b) The case where $\psi = V_{r,H} - V_{s,H} = 10,000$ with 1/5 tuition subsidy



(c) The case where $\psi = V_{r,H} - V_{s,H} = 2500$ with 1/2 tuition subsidy



(d) The case where $\psi = V_{r,H} - V_{s,H} = 10,000$ with 1/2 tuition subsidy

Figure 8: University's expected profit as a function of n, given a fifth of tuition is subsidized (subfigures a and b) and half of tuition is subsidized (subfigures c and d), $K = L = 100,000$, $\varphi = 10,000$, $t = 30,000$, $V_{r,L} = 15,000$, and $R(n) = \max\{300n(50-n), 0\}$, for $B \in \{-3000, -1500, 0, 1500, 3000\}$.

had to secure their own funding. Figures 8(a)-(d) present cases where the developing region's approval is not required. Instead, the university's subsidy is determined based on cohort students' budget constraints.

5 Conclusions

Our paper examined the strategic interactions among a university seeking to improve its profitability through an international partnership, a developing region seeking to improve its stock of human capital, and a cohort of students seeking to improve their earning potential through study at a foreign university. We used the specific case of a US university and its recruitment of Caribbean students to help guide the development of a game-theoretic model, incorporating the students', the developing region's, and the university's cost-benefit calculus in an educational partnership.

In our model, a university offered a partnership to a developing region to educate a cohort

of students. The university's objective was to increase its profitability by advertising its (potentially) improved offerings to target markets. The university decided how many cohort students to matriculate, the level of scholarships to offer, and the extent of the investment to improve its educational quality. The developing region was interested in improving the development of its human capital through the partnership and in repatriating that human capital to enhance economic development. The developing region decided whether to support the partnership (e.g., by securing students' loans), and chose a level of investment for creating domestic opportunities for returning students. The students from the developing region were interested in improving their earning potential and marketability through the educational experience.

We found that the university's investment always constitutes a strategic complement to the developing region's investment, where the latter's may be a strategic complement or a substitute to the university's, depending on the university's preference towards returning cohort students. In equilibrium, if the university shares (does not share) the developing region's interest in returning students, then its profit is increasing (decreasing) in the developing region's preference towards returning students. Furthermore, we showed that the university's profit and its chosen cohort size increase as the university's preference towards returning students rises. As the first cohort of students under this partnership graduated in 2013, it is interesting to note that none have yet returned to their home region, and all are either employed or enrolled in graduate programs in the US.

We showed that there are significant feedback effects between the university's investments and the developing region's investments. A greater investment by the university tilts the scale in favour of cohort students staying to work in the foreign market. Conversely, if the developing region increases its investment to create domestic opportunities, more students are likely to return. However, if the university is interested in cohort students returning to work in their domestic markets, then this feedback loop is enhanced, and the university will further increase its investment, enroll a larger student cohort, and see its profits increase. In effect, the university facilitates the developing region's incentive to invest in domestic opportunities

and vice versa (in terms of educational offerings), to the benefit of all parties. Thus, a partnership is more likely to be sustainable when both the university and the developing region exhibit strong preferences towards cohort students returning to work at home.

Our model extends beyond the specific partnership to other instances where organisations seek to enhance profitability by bringing in human capital from other regions. For universities, the model serves as a template for mutually beneficial partnerships that help improve profitability and achieve other objectives, while enhancing human capital in developing regions and mitigating the regions' risks of brain drain through strategic incentives.

Such partnerships – as well as the one we study – have several additional features that we have omitted from this study. Importantly, our analysis did not incorporate heterogeneous human capital. Students, for instance, may differ along various dimensions. Some of these dimensions consist of verifiable attributes (e.g., gender, age), whereas others, such as quality and ability, may be private information. Verifiable attributes raise interesting questions of tuition price discrimination, whereas private non-verifiable attributes introduce asymmetric information, and quite possibly, issues of adverse selection. Future analysis can also incorporate risk-averse students, multiple competing universities, multiple competing regions, multiple time horizons for returning to home regions, and varying degrees of university rankings and reputations. The process of facilitating the three-way partnerships we study is complex; it is impossible to capture all of the facets in a single model, and no attempt was made to do so here. Rather, our analysis focused on providing a tractable baseline framework of strategic educational partnerships. A multitude of important extensions of our framework remain to be explored in future work.

References

Belloni, A., M. Lovette, W. Boulding, and R. Staelin (2012): "Optimal Admission and Scholarship Decisions:Choosing Customized Marketing Offers to Attract a Desirable Mix of Customers," *Marketing Science*, 31, 621-636.

Bowman, N. and M. Bastedo (2009): "Getting on the Front Page: Organizational Reputation, Status Signals, and the Impact of U.S. News and World Report on Student Decisions," *Research in Higher Education*, 50, 415–436.

Brennan, J., R. Brodnick, and D. Pinkley (2008): "De-Mystifying the U.S. News Rankings: How to Understand What Matters, What Doesn't and What You can Actually Do About It," *Journal of Marketing for Higher Education*, 17, 169–188.

Brown, R. (2006): "Can Remittances Spur Development? A Critical Survey," *International Studies Review*, 8, 55–75.

Chapleo, C. (2010): "What defines a 'successful' university brand?" *The International Journal of Public Sector Management*, 23, 169–183.

Chishti, S. (1984): "Economic costs and benefits of educating foreign students in the United States," *Research in Higher Education*, 21, 397–414.

Coniglio, N. and F. Prota (2008): "Human capital accumulation and migration in a peripheral EU region: the case of Basilicata," *Papers in Regional Science*, 87, 77–95.

Melkers, J. and A. Kiopa (2010): "The Social Capital of Global Ties in Science: The Added Value of International Collaboration," *Review of Policy Research*, 27, 389–414.

Portes, A. (2009): "Migration and development: reconciling opposite views," *Ethnic and Racial Studies*, 32, 5–22.

Reddy, M., M. Mohanty, and V. Naidu (2004): "Economic Cost of Human Capital Loss from Fiji: Implications for Sustainable Development," *International Migration Review*, 38, 1447–1461.

Smith, W. W. (2011): "The Paradigm Shift in Higher Education: A Call for Action." *Caribbean Development Bank*. `http://goo.gl/yzBwF5`.

Stark, O., C. Helmenstein, and A. Prskawetz (1998): "Human capital depletion, human capital formation, and migration: a blessing or a curse?" *Economic Letters*, 60, 363–367.

Stephan, P. (2010): "The I's Have It: Immigration and Innovation, the Perspective from Academe," in *Innovation Policy and the Economy*, ed. by J. Lerner and S. Stern, MIT Press.

Wildavsky, B. (2010): "University Globalization Is Here to Stay," *Chronicle of Higher Education*, http://chronicle.com/article/University-Globalization-Is/124148/.

Appendix

Lemma 1:

Proof. The developing nation sets r to maximise:

$$n\big[q(rV_{r,H} + (1-r)V_{s,H} + v_H - V_{r,L}) + V_{r,L} - (t-s)\big] - \frac{L}{2}r^2$$

The university sets q to maximise:

$$q(R(n) + rB) - \frac{K}{2}q^2 - ns$$

The first-order condition of the developing region's problem with respect to r yields the developing region's best-response function, given by

$$r(q) = \frac{1}{L}nq(V_{r,H} - V_{s,H}) \tag{9}$$

The first-order condition of the university's problem with respect to q gives

$$q(r) = \frac{R(n) + rB}{K} \tag{10}$$

Substituting using (10) in (9), we have

$$r = \frac{n}{KL}(V_{r,H} - V_{s,H})(R(n) + rB)$$

Rearranging, we obtain

$$r^* = \frac{n(V_{r,H} - V_{s,H})R(n)}{KL - n(V_{r,H} - V_{s,H})B} \tag{11}$$

Solving similarly for q^*, we have

$$q^* = \frac{LR(n)}{KL - n(V_{r,H} - V_{s,H})B} \tag{12}$$

Substituting in $I_U(q) = \frac{K}{2}q^2$ and $I_D(r) = \frac{L}{2}r^2$ gives the result. ■

Proposition 2:

Proof. First, we observe that the solution is interior. This is because the objective function is continuous in n, defined over a compact set, and does not obtain its maximum at $n = 0$ or at $n > \bar{n}$. Thus, the second-order condition is satisfied at the interior maximum. Applying the Implicit Function Theorem to the first-order condition in (7), let

$$T(n, \psi) = \frac{n^*\psi L(2KL - \psi B)R^2(n^*)B}{(KL - n^*\psi B)^3} + \frac{L(KL + 2(n^* - 1)n\psi B)R(n^*)R'(n^*)}{(KL - n^*\psi B)^2} - s = 0$$

Then $\frac{\partial n}{\partial \psi} = -\frac{\partial T(n,\psi)/\partial \psi}{\partial T(n,\psi)/\partial n}$, where the denominator's sign is negative due to the second-order condition being satisfied. For $B > 0$, it is straightforward to see that the sign of the

derivative of the second term with respect to ψ is positive; focusing then on the first term, simple algebra shows that the sign of $\frac{\partial T(n,\psi)}{\partial \psi}$ is identical to the sign of

$$\frac{2KL(KL + (2n-1)B) - n\psi^2 B^2}{(KL - n\psi B)^4}$$

which, given $KL > n\psi B$ and $B > 0$, is unambiguously positive. ■

Proposition 3:

Proof. The result follows immediately from an application of the Envelope Theorem on the university's expected profit expression in (6). ■