



## WP 15-15

**Joanna Poyago-Theotoky**

Department of Economics and Finance, La Trobe University, Australia  
The Rimini Centre for Economic Analysis, Italy

**Alessandro Tampieri**

Faculty of Law, Economics and Finance, University of Luxembourg

# UNIVERSITY COMPETITION AND TRANSNATIONAL EDUCATION: THE CHOICE OF BRANCH CAMPUS

Copyright belongs to the author. Small sections of the text, not exceeding three paragraphs, can be used provided proper acknowledgement is given.

The *Rimini Centre for Economic Analysis* (RCEA) was established in March 2007. RCEA is a private, nonprofit organization dedicated to independent research in Applied and Theoretical Economics and related fields. RCEA organizes seminars and workshops, sponsors a general interest journal *The Review of Economic Analysis*, and organizes a biennial conference: *The Rimini Conference in Economics and Finance* (RCEF). The RCEA has a Canadian branch: *The Rimini Centre for Economic Analysis in Canada* (RCEA-Canada). Scientific work contributed by the RCEA Scholars is published in the RCEA Working Papers and Professional Report series.

The views expressed in this paper are those of the authors. No responsibility for them should be attributed to the Rimini Centre for Economic Analysis.

# University Competition and Transnational Education: The Choice of Branch Campus\*

Joanna Poyago-Theotoky<sup>†</sup>  
La Trobe University

Alessandro Tampieri<sup>‡</sup>  
University of Luxembourg

11<sup>th</sup> March 2015

## Abstract

We present a theoretical framework in which an elitist and a non-elitist university in a developed country compete by choosing their admission standards and deciding whether or not to open a branch campus in a developing country. Students from a developing country attend university if either a branch campus is opened or, they can afford to move to the developed country. We characterise the equilibria by focussing on the relationship between the investment costs of a branch campus and the graduate wage. There are three type of equilibria: (i) no branch campus is opened, (ii) only the elitist university opens a branch campus and (iii) both universities engage in transnational education, opening a branch campus. Very high investment costs discourage investment. A rise in the graduate wage increases the incentive for opening a branch campus, although this incentive is stronger for the elitist than the non-elitist university. Surprisingly, a government subsidy for opening a branch campus may be ineffective in ensuring investment by both universities.

**JEL Numbers:** I21, I23, L13, R32.

**Keywords:** University competition, branch campus, admission standards, transnational education, branch location.

---

\*We are grateful to Gianni De Fraja, Elena Del Rey, Simona Fabrizi, Francisco Martinez-Mora, Lynne Pepall, Pierre Picard, Sergey Popov, Dan Richards and seminar audiences at AMES 2014 (Taipei) and EARIE 2014 (Milan) for helpful comments. The usual disclaimer applies.

<sup>†</sup>Corresponding author. Department of Economics and Finance, La Trobe University, Melbourne, Victoria 3086, Australia; email: j.poyago-theotoky@latrobe.edu.au.

<sup>‡</sup>Faculty of Law, Economics and Finance, University of Luxembourg, Avenue de la Faïencerie 162a, L - 1511 Luxembourg; tamp79@gmail.com.

# 1 Introduction

A rapidly growing number of universities across the world are engaging in transnational education activities by establishing branch campuses in other countries. Transnational education is defined as arrangements in which courses or degree programmes offered by an institution in one country are delivered to students located in a different country [Ziguras (2003)].

The evidence shows that the international branch campus market has become more competitive. Higher education institutions from 22 countries have established branch campuses abroad compared with 17 countries in 2006. Most of these campuses (111 out of 162) were established by institutions in the Anglophone nations, the US continuing to overshadow all others with its 78 offshore bases accounting for 48% of the total. The US is followed by Australia with 14 campuses, 9% of the total number, the UK with 13 or 8% of the total, and France and India each with 11. Several other countries, including Mexico with seven small campuses, the Netherlands with five, Malaysia with four and Canada and Ireland with three each, operate multiple branches abroad. Since 2006, institutions from five new source countries have established at least one overseas campus: these are Lebanon, Malaysia, South Korea, Sri Lanka and Switzerland [Becker (2009)].

In the higher education economics literature, contributions on the effects of branch campuses are scarce, with few but notable exceptions. Lien (2006) analyses a university market in a developing country, with a domestic university and the branch campus of a foreign university. The domestic university provides education in both global knowledge (commonly accepted and being helpful for developing countries probably in the future) and local knowledge (being directly helpful for developing countries), whereas the branch campus specializes in global knowledge education only. Students have different learning ability in global knowledge (but not in local knowledge) and they choose which university to attend based upon the expected wages. If graduates from the branch campus have opportunities to work abroad and earn higher incomes, then an increase in the wage in the foreign country will lead to a reduction in local knowledge production. Lien (2008) extends Lien (2006) by considering different qualities of the branch campus. Finally, Lien and Wang (2010) examine student decisions in a developing country about whether to attend the local university or study abroad. All these papers focus on the effects of a branch campus on the question of brain drain on the developing country and treat the decision to open a branch campus as exogenous and not determined in equilibrium. Further, there is no university competition, in the sense that universities do not act strategically.

The growing importance of transnational education activities, such as the establishment of branch campuses, and its role in competition among universities appears not to have been investigated thoroughly in the literature. This is the main objective of the present paper. Moreover, it is also important to determine how university competition interacts with policy interventions aiming to attract transnational education activities, such as the establishment of branch cam-

puses. The paper is also related to the literature on spatial competition among universities [Del Rey (2001), De Fraja and Iossa (2002)]. In particular, the modelling framework borrows some elements from the analysis of university competition of De Fraja and Iossa (2002)<sup>1</sup>.

To the best of our knowledge, this is the first paper to analyse the decision of investing in a branch campus within a competitive environment. In a simple stylised model, two universities operating in a developed country compete by choosing their admission standards and deciding whether or not to open a branch campus in a developing country. One of the two universities is “elitist”, in the sense that it keeps its admission standard higher than its competitor. Thus, the location of universities along the admission standard spectrum is exogenous. A student who is admitted to university will graduate with certainty and will obtain a higher income in the job market. Students from a developing country can attend university either if a branch campus is opened or if they are “privileged”, i.e. if they can borrow money (from the family or the financial sector) to move to the developed country. So students decisions’ depend on travel costs and their borrowing constraints while university decisions depend on the fixed investment costs of opening the branch campus and their revenues.

We investigate the relationship between investment costs and graduate wages. Very high investment costs discourage the opening of a branch campus. An increase in the graduate wage increases the incentive for opening a branch campus, although the incentive is stronger for the elitist than the non-elitist university. This is due to the fact that students prefer to attend the elitist university, so that the demand for higher education is filled from the elitist university and the non-elitist university covers the remainder. Therefore three possible equilibria emerge: (i) no branch campus is established, (ii) one branch campus is opened by the elitist university only and (iii) each university opens a branch campus. Surprisingly, an increase in the proportion of privileged students increases the chance of an equilibrium of type (ii) to the detriment of equilibrium (i). The intuition is the following: an increase in privileged students reduces the demand for university from students who stay in the developing country. The non-elitist university suffers from the fall in the demand relatively more than the elitist university, given the higher benefit from the latter from opening a branch campus. We also consider the role of the government in the developing country in offering subsidies towards the opening of branch campuses with the aim of increasing university attendance locally. We find that government subsidies to attract branch campuses might in fact prevent their opening by both universities, although in general the elitist university will be attracted.

---

<sup>1</sup>In De Fraja and Iossa (2002), the two universities are located in different towns in a single country and compete by setting admission standards only. They show that universities choose the same admission standard only when the mobility cost (i.e. the cost for a student to attend university away from her town) is high; when the mobility cost is very low, there is no pure strategy equilibrium, whereas asymmetric equilibria exist for intermediate values of the mobility cost. Compared to De Fraja and Iossa (2002), in the present paper universities are located in the same country, and have the option of opening a branch campus overseas. Also, we assume that one university always sets its standard higher than the competitor. In other words, we focus on asymmetric cases, by excluding the case in which both universities set the same standard.

The remainder of the paper is organised as follows. Section 2 presents the modelling framework and Section 3 provides the equilibrium analysis. Section 4 presents an example and Section 5 introduces government intervention in the form of an exogenous uniform subsidy. Section 6 provides some brief concluding remarks.

## 2 The model

Consider a large population of potential students that is evenly distributed in two countries, 1 and 2. In each country the number of students is normalised to one. Country 1 can be thought of as a “developed” country. In Country 1 two universities, denoted by  $A$  and  $B$ , are established. Country 2 can be thought as a “developing” country, and we assume that there are no local universities.<sup>2</sup> However, university  $A$  and  $B$  may decide to open a branch campus (from now on, BC) in Country 2.

### 2.1 Universities

Following De Fraja and Iossa (2002), each university  $i$ ,  $i = A, B$ , cares about its “prestige” consisting of the following parts:

- (i) the number of enrolling students  $n_i$ , where

$$n_i = \begin{cases} n_{i1} + n_{i2} & \text{if a BC is opened} \\ n_{i1} & \text{if no BC is opened} \end{cases}$$

- (ii) the quality of the student body  $\Theta$  (i.e. average ability), and
- (iii) the expenditure on research  $R_i$ .

Hence the objective function of a university is written as:

$$W(n_i, R_i, \Theta) - \Phi_i, \tag{1}$$

where  $W$  is the benefit associated to “prestige”, while

$$\Phi_i = \begin{cases} F & \text{if a BC is opened} \\ 0 & \text{if no BC is opened} \end{cases}$$

---

<sup>2</sup>This is a simplifying assumption in order to make the analysis more compact and tractable. The focus of the paper is on the choice of opening up a branch campus by the foreign universities. In the present work, local universities do not engage in transnational activities in a reciprocal manner.

are the fixed costs associated with opening a branch campus. The first partial derivatives of  $W$  in (1) are all positive, and  $W_{nn}(\cdot), W_{RR}(\cdot), W_{\Theta\Theta}(\cdot) < 0$ . Each university has a budget determined by the amount of tuition fees collected by the enrolled students,  $fn_i$ , where  $f > 0$  is the fees per student. Tuition fees  $f$  are set exogenously: universities are not free to choose what students are charged in fees.<sup>3</sup> Therefore, each university:

1. chooses the required standard necessary to admit a student in each campus. We denote this by  $x_{ij} \in [\underline{x}_{ij}, 1], i = A, B, j = 1, 2$ , where  $\underline{x}_{ij} > 0$  is the lowest possible admission standard. This implies that only students who reach at least standard  $x_{ij}$  are accepted at institution  $i$  with campus in Country  $j$ ;
2. decides whether or not to open a BC in Country 2 at a fixed cost  $F > 0$ .

Further, suppose that teaching  $n_i$  students carries a cost of

$$C(n_i) = \begin{cases} c(n_1) + c(n_2) & \text{if a BC is opened} \\ c(n_1) & \text{if no BC is opened} \end{cases},$$

with  $c'(n_j) > 0, c''(n_j) > 0, j \in \{1, 2\}$ . Thus the teaching cost is considered separately for each university site. This assumption aims to represent better a university technology in the real world: the costs are increasing and convex within each campus, due to the number of staff, classroom size, equipment, laboratories, and so on.

Finally, we assume that university  $A$  always sets a higher standard than university  $B$  in every country in which it operates.

**Assumption 1**  $x_{Aj} > x_{Bj}$ .

By doing this, we impose the existence of an “elitist” university (university  $A$ ) that always sets a higher admission standard than the competitor. The underlying justification is that, in the real world, some universities have higher prestige than others and, given the same admission standard and assuming no limits in university places, all students would choose to attend the elitist university.

## 2.2 Students

Students differ in ability, denoted by  $\theta \in [0, 1]$ . In each country, students’ distribution by ability is  $G(\theta)$ , with  $G(0) = 0, G(1) = 1$  and density  $g(\theta) = G_\theta(\theta)$ . The admission standard set by a university,  $x_{ij}$ , is in the same support as ability, so that  $x_{ij} \in [0, 1]$  and  $x_{ij} = \theta_{ij}$  where  $\theta_{ij}$  is the

---

<sup>3</sup>This simplifying assumption can be justified as a reasonable approximation of current practice in many European countries and beyond but also because it allows us to analyse the decisions on transnational investment in isolation from decisions about raising revenues. See Pepall and Richards (2014) for an analysis of fee setting in a different context.

lowest ability student that can be accepted by university  $i$  in Country  $j$ .<sup>4</sup> If a student attends university, she graduates with certainty at the end of the university period. Still with certainty, in the labour market she will receive a wage surplus for being a graduate (“graduate wage”)  $U(x_{ij})$ , depending on the university admission threshold  $x_{ij}$ . A student objective function is:

$$U(x_{ij}) + \theta - f - T,$$

where  $U_{x_{ij}}(x_{ij}) > 0$  and

$$T = \begin{cases} t & \text{if a student moves to attend university} \\ 0 & \text{if a student does not move} \end{cases},$$

$T$  representing mobility costs (flight tickets, rents, and the like). For the sake of simplicity, we assume  $U(\underline{x}_{ij}) > f$ . In other words, the lowest possible graduate wage is higher than tuition fees. This ensures that every student is willing to attend university irrespective of  $f$ . A possible interpretation is that a government agency designs tuition fees in order to give incentives to the largest number of students to attend university. This assumption simplifies the analysis as  $f$  does not play any role in determining the demand function of students, but only determines a university’s budget.

To simplify the analysis, all students from Country 1 attend university in Country 1, even if at least one BC is present in Country 2.<sup>5</sup> On the other hand, in Country 2 there is an exogenous number of students  $\beta \in (0, 1)$ , denoted as “privileged” who can borrow, either from their family or the banking system, the amount of money to cover the mobility costs  $t$ .  $\beta$  is independent of a student’s level of ability.

A student who does not attend university has a reservation utility of  $U(0) < U(x_{ij})$ , for all  $x_{ij} \in [\underline{x}_{ij}, 1]$ , so that a student from the developed country would surely attend university if admitted. A student from the developing country would surely attend university if admitted and either

- there is a BC, or
- there is no BC but she belongs to the group of privileged students and  $U(x_{ij}) - f \geq t$ .

Conversely for  $U(x_{ij}) - f < t$ , a student from Country 2 attends university only if a BC is present. Notice that, if  $U(x_{ij}) - f \geq t$  and only university  $B$  opened a branch campus, then a

---

<sup>4</sup>The results do not change by assuming that admission standards may change according to a student’s origin. In equilibrium, universities would set the same standards to students coming from different countries. Our results may be interpreted as follows. Usually, a university admits foreign students by asking further requirements than a local student. An example can be a standardized test, or a language test. However, the extra requirement compensates for the lack of information about the education system of the student’s country of origin.

<sup>5</sup>This is because we focus purely on the decision of a university’s transnational investment in a BC.

student from Country 2 who can be admitted to university  $A$  would move to Country 1 only if (i) she is privileged and (ii)  $U(x_{A1}) - t \geq U(x_{B2})$ . In other words, a student may be better off attending the BC of the non-elitist university if the cost of moving abroad is too high, since the increased benefit from attending the elitist university is more than offset by the moving costs. The next definition is convenient.

**Definition 1** Let  $t^*$  denote the cost of moving to Country 1 such that

$$U(x_{A1}) - t^* = U(x_{B2}).$$

### 3 Equilibria

#### 3.1 Students' admission

The following propositions follow directly from  $U'(x_{ij}) > 0$  and the discussion in the preceding section. The first proposition establishes university attendance of students from Country 1.

**Proposition 1** Consider students living in Country 1. University  $i \in \{A, B\}$  sets standard  $x_{i1}$ , and by assumption 1,  $x_{A1} > x_{B1}$ .

1. Let student with ability  $\theta_{A1}$  attend university  $A$ . Then all students with ability  $\theta > \theta_{A1}$  also attend university  $A$ .
2. Let student with ability  $\theta_{B1}$  attend university  $B$ . Then all students with ability  $\theta_{B1} < \theta < \theta_{A1}$  also attend university  $B$ .

This follows from the fact that a student with higher ability gains more from attendance at a university with a stricter admission test (Epple and Romano (1998), and De Fraja and Iossa (2002)). An immediate consequence of Proposition 1 and the characterization of a student's ability is the following.

**Corollary 1** Consider students living in Country 1. Let university  $i \in \{A, B\}$  set standard  $x_{i1}$ , and Assumption 1 hold. A student attends university  $A$  if  $\theta \in [x_{A1}, 1]$  and university  $B$  if  $\theta \in [x_{B1}, x_{A1})$ .

The next proposition establishes university attendance of students from Country 2. For these students, university attendance depends on (i) whether or not one or two branch campus are opened, and (ii), in the case where only university  $B$  opens a branch campus, whether  $t$  is greater or not than  $t^*$ . Indeed, a student with high ability may be admitted to university  $A$ , but the mobility costs are high so that the student may prefer to attend the branch campus of university  $B$ .

**Proposition 2** Consider students living in Country 2. Let university  $i \in \{A, B\}$  set standard  $x_{ij}$  for their site in Country  $j$  with  $x_{Aj} > x_{Bj}$  (assumption 1).



**1. No BC:**

- (a) Let a privileged student with ability  $\theta_{A1}$  attend university A. Then  $\beta$  students with ability  $\theta > \theta_{A1}$  also attend university A.
- (b) Let a privileged student with ability  $\theta_{B1}$  attend university B. Then  $\beta$  students with ability  $\theta_{B1} < \theta < \theta_{A1}$  also attend university B.

**2. University A operates BC:**

- (a) Let a student with ability  $\theta_{A2}$  attend university A. Then all students with ability  $\theta > \theta_{A2}$  also attend university A.
- (b) Let a privileged student with ability  $\theta_{B1}$  attend university B. Then  $\beta$  students with ability  $\theta_{B1} < \theta < \theta_{A1}$  also attend university B.

**3. Universities A and B operate BC:**

- (a) Let a student with ability  $\theta_{A2}$  attend university A. Then all students with ability  $\theta > \theta_{A2}$  also attend university A.
- (b) Let a student with ability  $\theta_{B2}$  attend university B. Then all students with ability  $\theta_{B2} < \theta < \theta_{A2}$  also attend university B.

**4. University B operates BC, and  $t \leq t^*$  (Case 1):**

- (a) Let a privileged student with ability  $\theta_{A1}$  attend university A. Then  $\beta$  students with ability  $\theta > \theta_{A1}$  also attend university A.
- (b) Let a student with ability  $\theta_{B2}$  attend university B. Then all students with ability  $\theta_{B2} < \theta < \theta_{A1}$  and  $1 - \beta$  students with ability  $\theta > \theta_{A1}$  also attend university B.

**5. University B operates BC, and  $t > t^*$  (Case 2):**

- (a) No students from Country 2 attend university A.
- (b) Let a student with ability  $\theta_{B2}$  attend university B. Then all students with ability  $\theta > \theta_{B2}$  also attend university B.

Notice that, in the case in which university B is the only university to open a BC and  $t \leq t^*$  (part 4 in proposition 2 above), students with ability at least  $\theta_{A1}$  attend university A only if they are privileged. If they are not, they will attend the BC of university B. Conversely, in the case in which university B operates a BC only and  $t > t^*$ , then none of the students of ability at least  $\theta_{A1}$  from Country 2 will attend university A, since the increase in utility from attending university A is more than offset by the mobility costs. The equivalent of Corollary 1 for students of Country 2 follows.

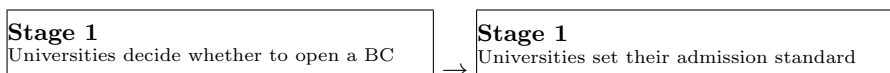


Figure 1: The timing of the game

**Corollary 2** Consider students living in Country 2. Let university  $i \in \{A, B\}$  set standard  $x_{ij}$  in their site in Country  $j$  with  $x_{Aj} > x_{Bj}$  (assumption 1).

- (i) **No BC:** a student attends university if she is privileged: in particular, university  $A$  if  $\theta \in [x_{A1}, 1]$  and university  $B$  if  $\theta \in [x_{B1}, x_{A1}]$ .
- (ii) **University  $A$  operates BC:** a student attends university  $A$  if  $\theta \in [x_{A2}, 1]$  and university  $B$  if privileged and  $\theta \in [x_{B1}, x_{A1}]$ .
- (iii) **Universities  $A$  and  $B$  operate BC:** a student attends university  $A$  if  $\theta \in [x_{A2}, 1]$  and university  $B$  if  $\theta \in [x_{B2}, x_{A2}]$ .
- (iv) **University  $B$  operates BC, and  $t \leq t^*$ :** a student attends university  $A$  if privileged and  $\theta \in [x_{A1}, 1]$  and university  $B$  either if non-privileged and  $\theta \in [x_{A1}, 1]$  or, if not privileged and  $\theta \in [x_{B2}, x_{A1}]$ .
- (v) **University  $B$  operates BC, and  $t > t^*$ :** a student never attends university  $A$ , and attends university  $B$  if  $\theta \in [x_{B2}, 1]$ .

Corollary 2 deserves a few comments. If a university operates a BC, a student from Country 2 being admitted to that university never moves to Country 1. The reason becomes clear in the example below (see Section 4). In equilibrium, a university sets identical admission standards both in Country 1 and 2 (for detailed calculations see the Appendix). Hence a student from Country 2 obtains the same graduate wage but would have to pay te mobility costs if she attended university in Country 1.

Propositions 1 and 2 allow us to simplify the interaction between universities and students. Indeed, we can set up a two-stage, two-agent game with universities  $A$  and  $B$  as the players. In the first stage, the strategy space is binary, and consists of the decision of whether to open (or not) a branch campus in country 2. In the second stage, the strategy space is given by the admission standard,  $x_{Aj} \in X$  and  $x_{Bj} \in X$ . The equilibrium concept is subgame perfect equilibrium by backward induction. Figure 1 depicts the timing of the game.

### 3.2 Admission standards

In the second stage, universities set their admission standard in order to maximise their payoff function, which is given by:

$$\pi_i = W(n_i(x_{Aj}, x_{Bj}), fn_i(x_{Aj}, x_{Bj}) - c(n_i(x_{Aj}, x_{Bj})), \Theta(x_{Aj}, x_{Bj})) - \Phi_i,$$

where  $n_i(x_{Aj}, x_{Bj})$  and  $\Theta_i(x_{Aj}, x_{Bj})$  are the number of students admitted and the average quality of students at university  $i$ ,  $i = A, B$ , respectively, given the admission standards  $(x_{Aj}, x_{Bj})$  for all  $j = 1, 2$ . Notice that  $R = fn_i(x_{Aj}, x_{Bj}) - c(n_i(x_{Aj}, x_{Bj}))$ , where  $R$  is the university budget. Also, it is clear that  $\partial\Theta_i/\partial x_{ij} > 0$ : an increase in a university's admission standard increases the average ability of that university's students. Of course the number of admitted students will also depend on a university's decision about opening a BC. In particular, according to Corollaries 1 and 2, the number of admitted student at university  $A$  is given by

$$n_A = \begin{cases} (1 + \beta)(1 - G(x_{A1})) & \text{no BC} \\ (1 - G(x_{A1})) + (1 - G(x_{A2})) & \text{A BC} \\ \sum_j^{1,2} (1 - G(x_{Aj})) & \text{A and B, BC} \\ (1 + \beta)(1 - G(x_{Aj})) & \text{B BC, A no BC and } t \leq t^* \\ (1 - G(x_{Aj})) & \text{B BC, A no BC and } t > t^* \end{cases},$$

whereas the number of admitted students at university  $B$  is given by:

$$n_B = \begin{cases} (1 + \beta)(G(x_{A1}) - G(x_{B1})) & \text{no BC} \\ (G(x_{A1}) - G(x_{B1})) + \beta(G(x_{A12}) - G(x_{B1})) & \text{A BC} \\ \sum_j^{1,2} (G(x_{Aj}) - G(x_{Bj})) & \text{A and B, BC} \\ (1 + \beta)(G(x_{A1}) - G(x_{B1})) + (1 - \beta)(1 - G(x_{B2})) & \text{B BC, A no BC and } t \leq t^* \\ (G(x_{A1}) - G(x_{B1})) + (1 - G(x_{B2})) & \text{B BC, A no BC and } t > t^* \end{cases}.$$

Thus a university's problem in the second stage is given by

$$\max_{x_{ij}} W(n_i(x_{ij}), fn_i - c(n_i(x_{ij})), \Theta_i(x_{ij})) - \Phi_i,$$

where  $j = 1$  if a university does not open a BC and  $j = 1, 2$ , if a BC is opened. Thus the admission in equilibrium is denoted by  $x_{ij}^* = \arg \max \pi_i(x_{ij})$ .

### 3.3 Investment in BC

In the first stage, each university decides whether to open a BC according to the competitor's strategy. The following table shows the payoff matrix according to whether university  $A$  and  $B$

decide to invest in a BC, and  $k \in \{1, 2\}$ , where

$$k = \begin{cases} 1 & \text{for } t \leq t^* \\ 2 & \text{for } t > t^* \end{cases} .$$

|                     |           |                                |                                |
|---------------------|-----------|--------------------------------|--------------------------------|
|                     |           | University <i>B</i>            |                                |
|                     |           | <i>BC</i>                      | <i>N</i>                       |
| University <i>A</i> | <i>BC</i> | $\pi_{Ak}^{FF}; \pi_{Bk}^{FF}$ | $\pi_{Ak}^{FN}; \pi_{Bk}^{FN}$ |
|                     | <i>N</i>  | $\pi_{Ak}^{NF}; \pi_{Bk}^{NF}$ | $\pi_{Ak}^{NN}; \pi_{Bk}^{NN}$ |

**Stage 1 - Payoff Matrix**

Superscript *FF* indicates that both universities open a BC, superscript *FN* denotes that university *A* opens a BC and university *B* does not. Conversely, superscript *NF* says that university *A* does not open a BC but university *B* does. Finally, superscript *NN* indicates that none of the universities opens a BC. The subgame perfect equilibrium can be found according to values of the establishment (fixed) costs of opening a BC,  $F$ . This problem cannot be solved at this general level without imposing additional structure to the various functional relationships. In the remainder of the paper, we provide a detailed example in order to depict the characteristics of the equilibria.

## 4 An example

### 4.1 Students and universities

We begin by describing the students' behaviour. A student's utility function is:

$$U(x_{ij}) = wx_{ij} + \theta - f - T, \quad i = A, B, \quad j = 1, 2.$$

where  $w > 0$  is a parameter measuring the marginal impact of the admission standard on the graduate wage, and  $f$  denotes tuition fees, where  $f < wx_{ij}$  for every  $i$  and  $j$ . For  $T = 0$ , a student either (i) lives in Country 1 and attends university, or (ii) lives and attends university in Country 2, i.e. at least one BC is opened. Conversely, for  $T = t$ , a student from Country 2 attends university in Country 1,  $t$  representing mobility costs. The wage of a student who does not attend university is normalised to zero,  $U(0) = 0$ . In the example we set  $wx_{ij} + \theta - f > t$ .<sup>6</sup>

Consider next universities. Each university decides whether or not to open a BC in Country 2 at a cost  $F > 0$  and then it chooses the standard  $x_{ij}$ . Therefore for each university  $i = A, B$ , the objective function is:

---

<sup>6</sup>The results are qualitatively similar by considering  $U(x_{ij}) < t$  and can be provided upon request.

$$\pi_i = \sum_j^{1,2} (wx_{ij}n_{ij} + R_i) - \Phi_i, \quad (2)$$

where  $R_i = fn_{ij} - c(n_{ij})$ , with  $fn_{ij}$  the total budget given by the overall tuition fees and  $c(n_{ij}) = c \sum_j^{1,2} n_{ij}^2$  is total teaching costs. Hence (2) can be rewritten as

$$\pi_i = \sum_j^{1,2} n_{ij} (wx_{ij} + f - cn_{ij}) - \Phi_i, \quad i = A, B. \quad (3)$$

According to (3), a university's payoff is an increasing function of the number of graduates, its own admission standard, as well as the investment in research. Finally, we assume that the distribution of abilities in each population is uniform, so that  $G(\theta) = \theta$ . This allows us to explicitly calculate the number of admitted students in each university. Of course, this also depends on university  $A$  and  $B$  decisions about opening a BC. Lemma 1 shows the number of admitted students in equilibrium.

**Lemma 1** *Let Assumption 1 hold. Then the number of students being admitted to each university is:*

$$n_A = \begin{cases} (1 + \beta)(1 - x_{A1}) & \text{no BC} \\ (1 - x_{A1}) + (1 - x_{A2}) & \text{A BC} \\ (1 + \beta)(1 - x_{A1}) & \text{B BC, A no BC for } t \leq t^* \\ (1 - x_{A1}) & \text{B BC, A no BC for } t > t^* \\ (1 - x_{A1}) + (1 - x_{A2}) & \text{B, A, BC} \end{cases},$$

$$n_B = \begin{cases} (1 + \beta)(x_{A1} - x_{B1}) & \text{no BC} \\ (x_{A1} - x_{B1}) + \beta(x_{A12} - x_{B1}) & \text{A BC} \\ \sum_j^{1,2} (x_{Aj} - x_{Bj}) & \text{A and B, BC} \\ (1 + \beta)(x_{A1} - x_{B1}) + (1 - \beta)(1 - x_{B2}) & \text{B BC, A no BC and } t \leq t^* \\ (x_{A1} - x_{B1}) + (1 - x_{B2}) & \text{B BC, A no BC and } t > t^* \end{cases}.$$

## 4.2 Admission standards

In the second stage, each university sets the admission standard  $i$  in each country  $j$  according to the following problem:

$$\max_{x_{ij}} \sum_j^{1,2} n_{ij} (wx_{ij} + f - cn_{ij}) - \Phi_i.$$

In the Appendix we consider in full detail each possible case according to the decisions of opening a BC in the first stage and provide the solutions for admission standards and associated university payoffs. Based on these results, Lemma 2 below provides the critical value for mobility cost  $t^*$  that determines whether a student from country 2 will attend country 1 or not (see Definition 1).

**Lemma 2** *A student from Country 2 with ability at least  $\theta_A$  would either attend university A in Country 1 for all  $t \leq t^*$ , or attend the BC of university B for all  $t > t^*$ , where*

$$t^* \equiv \frac{wc\beta(w+f)}{2(w+c)[w+c(1+\beta)]}.$$

**Proof.** See Appendix ■

Of course university A (B) prefers  $w x_A - t \leq (>) w x_B$ , as shown by:

$$\pi_{A1}^{NF} - \pi_{A2}^{NF} = \frac{\beta w (w+f)}{4(w+c)[w+c(1+\beta)]} > 0,$$

and

$$\pi_{B1}^{NF} - \pi_{B2}^{NF} = -\frac{\beta w^2 (w+f) [w^2 (4-\beta) + 2wc(5+\beta) + c^2 (6+4\beta)]}{16(w+c)^2 (w+2c)} < 0.$$

### 4.3 Investment in BC

In this section we investigate the simultaneous choice of investing in a BC. For brevity, we consider Case 1 (relevant payoffs are given in the Appendix).<sup>7</sup>

Begin by examining the strategy of university A according to university B decisions. If university B plays BC, university A would do the same for  $\pi_{A1}^{FF} > \pi_{A1}^{NF}$ , whereas if university B plays N, university A would play BC the same for  $\pi_{A1}^{FN} > \pi_{A1}^{NN}$ . Both these inequalities hold for all:

$$F < F_A \equiv \frac{(w+f)^2 [w(1-\beta) + c(1+\beta)]}{4(w+c)[w+c(1+\beta)]},$$

so that A has a dominant strategy. For  $F < F_A$  it plays BC and for  $F > F_A$  it plays N.

Invoking dominance, we now turn to the behaviour of university B. For  $F < F_A$  university

---

<sup>7</sup>The computations of Case 2 are cumbersome, but bring about qualitatively similar results. Upon request, these results can be provided.

A plays  $BC$  so that university  $B$  would also play  $BC$  when  $\pi_{B1}^{FF} > \pi_{B1}^{FN}$ , which occurs for all:

$$F < \widehat{F}_B \equiv \frac{(w+f)^2(w+2c)^2[w(1-\beta)+c(1+\beta)]}{16(w+c)^3[w+c(1+\beta)]},$$

and would play  $N$  if  $F > \widehat{F}_B$ . For  $F > F_A$  university  $A$  plays  $N$  so that university  $B$  would play  $BC$  for  $\pi_{B1}^{NF} > \pi_{B1}^{NN}$ , which occurs for:

$$F < \overline{F}_B \equiv \frac{w^3(4-\beta)(1-\beta)+cw^2(12-\beta^2(11-\beta))(w+f)^2}{16(w+c)[w+c(1+\beta)]^3} +$$

$$\frac{4wc^2(3-2\beta)^2(1+\beta)^2+4c^3(1+\beta)^3(w+f)^2}{16(w+c)[w+c(1+\beta)]^3}$$

and would play  $N$  for  $F > \overline{F}_B$ .

Notice that the chain of inequalities for the threshold levels is  $F_A > \overline{F}_B > \widehat{F}_B$ . Therefore, in conjunction with the preceding discussion, we establish the following proposition.<sup>8</sup>

**Proposition 3** *Let  $wx_{ij} > t$  for all  $i \in \{A, B\}$ ,  $j \in \{1, 2\}$  and  $t \leq t^*$ . For all:*

- [1]  $F > F_A$ , neither university opens a  $BC$ , the equilibrium is  $[N;N]$  (type 1);
- [2]  $F_A > F > \widehat{F}_B$ , university  $A$  opens a  $BC$  and university  $B$  does not, the equilibrium is  $[BC;N]$  (type 2);
- [3]  $F < \widehat{F}_B$ , both universities open a  $BC$ , the equilibrium is  $[BC;BC]$  (type 3).

Figure 2 illustrates the equilibria given by the combination between the investment cost  $F$  and  $w$  for given  $\beta$  and  $c$ . Also, notice that

$$F_A|_{w=0} = \widehat{F}_B|_{w=0} = \frac{f^2}{4c}.$$

university  $A$  gains more from the students' qualification  $x$  than university  $B$ . Hence, the number of students  $n$  has relatively more importance in determining the  $B$  profits. Students prefer to attend university  $A$ , so that the demand for higher education is filled from that institution, whereas university  $B$  serves only the remainder of the demand for higher education. Therefore university  $A$  has more incentives in investing in  $BC$ , given the same cost  $F$ .

Consider next how a variation of the amount of privileged students may affect the equilibrium. Differentiating  $w^*$  with respect to  $\beta$  yields:

$$\frac{\partial}{\partial \beta} (F_A - \widehat{F}_B) = \frac{w^2(w+f)^2(3w+4c)}{16(w+c)^2[w+c(1+\beta)]} > 0.$$

<sup>8</sup>It is easy to verify that the threshold  $\overline{F}_B$  is irrelevant for the Nash equilibrium.

**Corollary 3** *An increase in the number of privileged students increases the probability that university A opens a BC while university B does not (equilibrium [2]).*

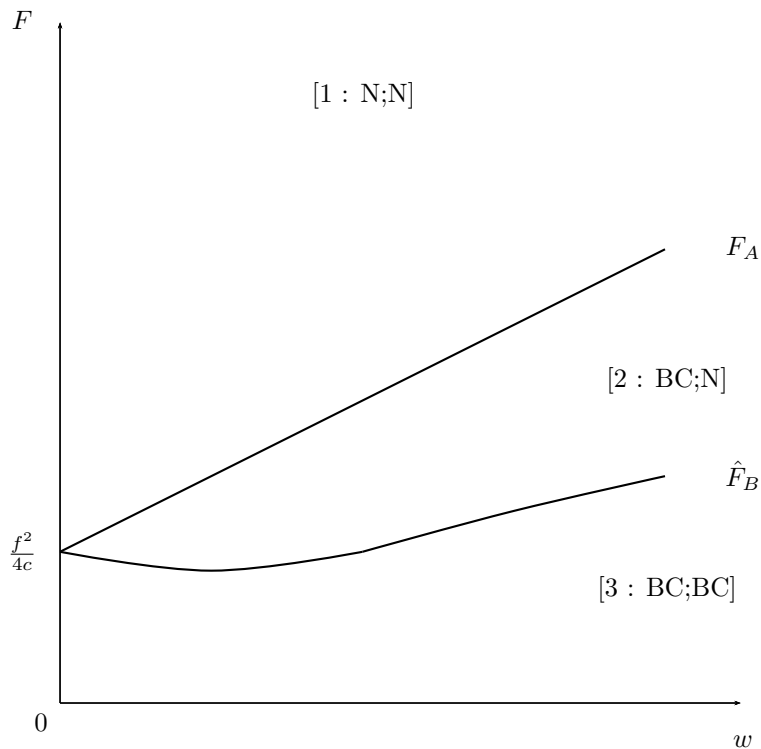


Figure 2: Illustration of Proposition 3

The result described in Corollary 3 can be explained as follows. A raise in the number of privileged students reduces the demand for university from students in the developing country. The non-elitist university is more affected by the fall in the demand relatively more than the elitist university, given the higher benefit from the latter from opening a branch campus.

## 5 Government intervention

An observed practice for a receiving, mostly developing, country is to provide subsidies to lure foreign universities into opening up a branch campus. For example, the NYU campus in Abu Dhabi is wholly bankrolled by the local government, while the new campus in China, a joint



venture with East China Normal University, is receiving subsidies from the district of Pudong and the city of Shanghai, which are providing the land and the campus, as well as funds for financial aid for Chinese students [Redden (2013)]. The model of the preceding section can be extended to throw some light into the effects of these practices.

We consider a simple case where the government of the developing country is willing to promote the establishment of branch campuses by providing a uniform subsidy. The subsidy is modelled in such a way that it does not really interact with universities and students' decisions, but it is simply given exogenously: for each enrolled student in the BC, the level of the subsidy  $m$  is set by equating the marginal benefit of subsidising universities (the salary of a graduate student  $w$ ) with the marginal cost (the subsidy for one student,  $m = M_i/n_{i2}$ ), so that  $m = w$ . Each university receives the same level of subsidy for every student.

For the sake of tractability, in what follows we make two simplifying assumptions. First, tuition fees are set at the same level as the unitary cost of education, that is,  $f = c$ . Second, we consider the government problem from a partial equilibrium perspective, in the sense that we do not design a tax for providing the government the necessary resources for the university subsidies. As a justification for this, we posit that the tax covering the cost of subsidising universities is evenly paid by the population of the developing country, and it is irrelevant in a student's decision about whether or not to attend university. This assumption ensures that Lemma 1 still holds, by allowing us to avoid cumbersome and out-of-context analytical issues. Finally as previously in the example we focus on Case 1, in which  $t \leq t^*$ .

In the second stage, each university sets the admission standard  $x_{ij}$  according to the following problem:

$$\max_{x_{ij}} \sum_j^{1,2} n_{ij} (wx_{ij} + f - cn_{ij}) + M_i - \Phi_i,$$

where  $M_i = mn_{i2}$  if a university opens a BC, and  $M_i = 0$  otherwise.

Following the previous structure of the exposition, in the Appendix we consider separately each possible case according to the decisions of opening a BC in the first stage. Using these results, we now evaluate the investment decisions in BC in the first stage. Begin by examining the strategy of university  $A$  according to university  $B$  decisions. If university  $B$  plays  $BC$ , university  $A$  would do the same for  $\pi_{A1}^{FF} > \pi_{A1}^{NF}$ , whereas if university  $B$  plays  $N$ , university  $A$

would play  $BC$  the same for  $\pi_{A1}^{FN} > \pi_{A1}^{NN}$ . Both inequalities hold for all:

$$F < F_A^{Gov} \equiv \frac{w^3(4-\beta) + 2w^2c(4+\beta) + wc^2(5+3\beta) + c^3(1+\beta)}{4(w+c)[w+c(1+\beta)]}.$$

We now turn to the behaviour of university  $B$ . If university  $A$  plays  $BC$ , university  $B$  would do the same for  $\pi_{B1}^{FF} > \pi_{B1}^{FN}$ , which occurs for all:

$$F < \widehat{F}_B^{Gov} \equiv \frac{4c^4(1+\beta) + 4wc^3(5+3\beta) + 24w^2c^2 + w^3c(8-5\beta) - \beta w^4}{16(w+c)^2[w+c(1+\beta)]}.$$

If university  $A$  plays  $N$ , university  $B$  would play  $BC$  the same for  $\pi_{B1}^{NF} > \pi_{B1}^{NN}$ , which takes place for:

$$F < \overline{F}_B^{Gov} \equiv \frac{w^5(16-\beta+\beta)^2 + w^4c(64+46\beta-\beta^2+\beta^3) + w^3c^2(100+143\beta+43\beta^2-2\beta^3)}{16(w+c)[w+c(1+\beta)]^3} + \frac{w^2c^3(76+156\beta+93\beta^2+13\beta^3) + 4wc^4(7+4\beta)(1+\beta)^2 + 4c^5(1+\beta)^3}{16(w+c)[w+c(1+\beta)]^3}.$$

The chain of inequalities of the threshold levels is still  $F_A^{Gov} > \overline{F}_B^{Gov} > \widehat{F}_B^{Gov}$ , so that the results with government intervention are qualitatively similar to the case with no government summarised in Proposition 3.

We are now in a position to compare the results in the two situations through the differences in the threshold levels. In order to do that, we need to set  $f = c$ , also for the no-subsidization case. The differences between  $F_A^{Gov}$  and  $F_A$ , and between  $\widehat{F}_B^{Gov}$  and  $\widehat{F}_B$  yield:

$$F_A^{Gov} - F_A = \frac{w(3w+2c)}{4(w+c)} > 0,$$

and

$$\widehat{F}_B^{Gov} - \widehat{F}_B = -\frac{w(w^2-3wc-8c^2)}{16(w+c)^2} \geq 0 \text{ for } w \leq \widehat{w} \equiv \frac{c(3+\sqrt{41})}{2}.$$

The results can be summarised as follows and are illustrated in Figure 4.

**Proposition 4** *Let  $wx_{ij} > t$  for all  $i \in \{A, B\}, j \in \{1, 2\}$  and  $t \leq t^*$ . Then:*

1. For  $F_A^{Gov} > F > F_A$ , the subsidy has the effect of attracting the elite university (A); the equilibrium shifts from type 1,  $[N; N]$ , to type 2,  $[BC; N]$ .
2. For  $\hat{F}_B^{Gov} > F > \hat{F}_B$  and  $w \leq \hat{w}$ , the subsidy has the effect of attracting both universities; the equilibrium shifts from type 2,  $[BC; N]$  to type 3,  $[BC; BC]$ .
3. For  $\hat{F}_B^{Gov} < F < \hat{F}_B$  and  $w > \hat{w}$ , the subsidy has the effect of dissuading the non-elitist university (B) from opening a BC. There is a switch from a type 3 equilibrium,  $[BC; BC]$ , to a type 2 equilibrium,  $[BC; N]$ .
4. For all other values of  $F$  and  $w$  the effect of the subsidy is neutral, in the sense that there are no differences with the non-subsidization case.

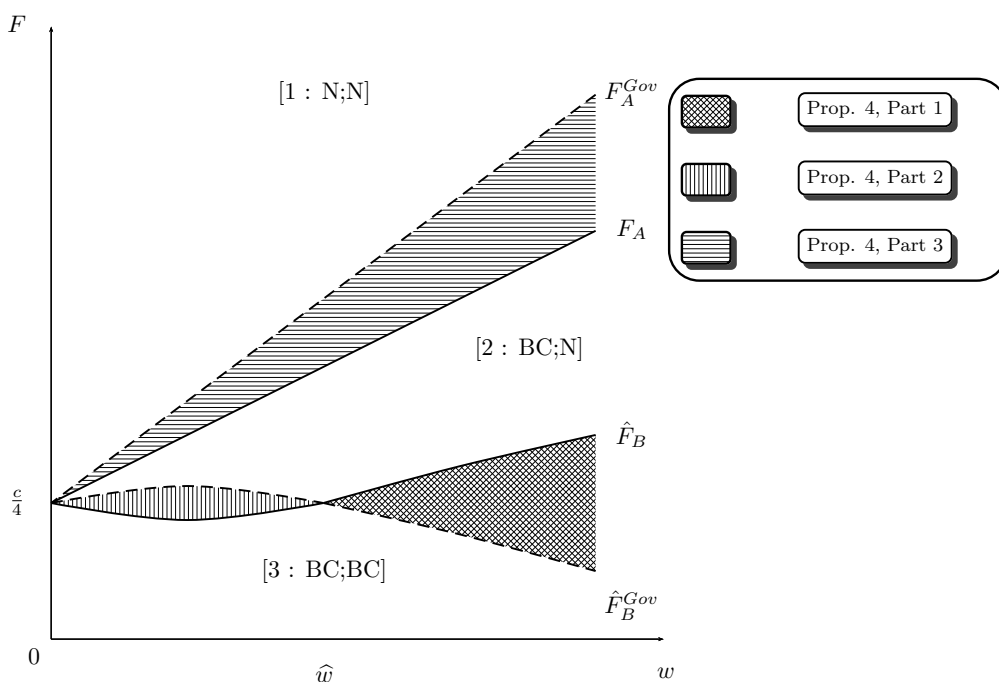


Figure 3: Illustration of Proposition 4

Figure 3 illustrates Proposition 4 in  $(w, F)$  space. Notice that

$$F_A^{Gov}|_{w=0} = F_A|_{w=0} = \hat{F}_B^{Gov}|_{w=0} = \hat{F}_B|_{w=0} = \frac{c}{4}.$$

Recall that the uniform subsidy is set at the level  $m = w$ .  $F_A^{Gov} - F_A > 0$  implies that a higher sunk cost is necessary in order to switch from equilibrium  $[N; N]$  to equilibrium  $[BC; N]$ ; this occurs irrespective of the level of the subsidy (part 1). Here the introduction of the subsidy

makes investing in a BC more attractive to the elitist university  $A$  who stands to gain more. In contrast, for not too high sunk costs, the level of the subsidy is significant.  $\hat{F}_B^{Gov} > \hat{F}_B$  for  $w < \hat{w}$  so that a lower subsidy is required to bring about a shift from equilibrium  $[BC; N]$  to  $[BC; BC]$  and both universities engage in BC as a result (part 2). When  $\hat{F}_B^{Gov} < \hat{F}_B$  for  $w > \hat{w}$ , so a larger subsidy has the counter-intuitive effect of dissuading investment in BC, in particular it makes the non-elitist university  $B$  not invest in a BC. The equilibrium switches from  $[BC; BC]$  to  $[BC; N]$  (part 3). Since the elitist university  $A$  gains more than the non-elitist university  $B$ , the advantage of the fixed uniform subsidy (marginal benefit is the same among universities) favours  $A$  more than  $B$ . As a consequence, the incentive of university  $B$  to invest in BC is diminished. In turn, the lower incentive to university  $B$  affects the incentive of university  $A$  so that it has a higher incentive in operating BC for a higher subsidy level ( $m > \hat{w}$ ). In summary, the effects of the subsidy are subtle and hinge on the extent of the sunk costs, the size of the graduate wage and the competition between the two universities.

## 6 Concluding remarks

We have analysed competition among universities and its effect in opening a branch campus. Competition among universities from a developed country takes place by both setting admission standards and deciding whether or not to open a branch campus in a developing country. Students living in the developing country can attend university only if a branch campus is opened or if they can afford to move to the developed country. An increase in the graduate wages increases the incentives for opening a branch campus, although the incentive is stronger for the elitist than the non-elitist university. Three possible equilibria emerge: (i) no branch campus, when the investment costs are too high, (ii) a branch campus is opened by the elitist university only and (iii) two branch campuses. An increase in the proportion of privileged students increases the chance of an equilibrium of type (ii) to the detriment of equilibrium (i). A uniform subsidy for opening a branch campus typically will achieve its purpose; however, there are instances where it may be ineffective in ensuring that both universities do so.

The paper could be further enriched by considering different tuition fees between universities in the developing and developed country. Tuition fees are usually lower in the branch rather than the main campus. However, this extension would have complicated the analysis by not adding so much. Indeed, the difference in tuition fees can be captured by the mobility costs, so in effect is already captured by the analysis.

An interesting extension could implement a preference for attending university at the main campus. This preference might be related to social prestige. A student from a rich family coming from a developing country might prefer to attend the main campus of a prestigious university even though a branch campus of that university is present, even if this is more costly. Indeed,

the higher costs of attending the main campus can be offset by benefits in social status or life experience. The development in this direction is left for future research.

## References

- Becker, R., 2009. International Branch Campuses: Markets and Strategies. Report of the Observatory on Borderless Higher Education.
- De Fraja, G., Iossa, E., 2002. Competition among Universities and the Emergence of the Elite Institution. *Bulletin of Economic Research* 54, 275–293.
- Del Rey, E., 2001. Teaching versus Research: a Model of State University Competition. *Journal of Urban Economics* 49, 356–373.
- Epple, D., Romano, R., 1998. Competition Between Private and Public Schools, Vouchers and Peer-Group Effects. *American Economic Review* 88, 33–62.
- Lien, D., 2006. Borderless Education and Domestic Program. *Education Economics* 14, 297–308.
- Lien, D., 2008. Economic analysis of transnational education. *Education Economics* 16, 149–166.
- Lien, D., Wang, Y., 2010. The Effects of a Branch Campus. *Education Economics*, 1–16.
- Pepall, L., Richards, D., 2014. Competition, Selectivity and Innovation in the Higher Educational Market, working paper, Department of Economics, Tufts University.
- Redden, E., 2013. Global Ambitions. <http://www.insidehighered.com/news/2013/03/11/nyu-establishes-campuses-and-sites-around-globe#sthash.wtvfhpc9.dpbs>.
- Ziguras, C., 2003. The impact of the GATS on transnational tertiary education: Comparing experiences of New Zealand, Australia, Singapore and Malaysia. *Australian Education Researcher* 30, 89.

## A Appendix

### A.1 Calculations - admission standards and payoffs

**No BC:** in the case where neither university  $A$  nor  $B$  open a BC, the first order conditions with respect to  $x_A$ ,  $x_B$  are:

$$\frac{\partial \pi_A}{\partial x_{A1}} = (1 + \beta) [w(1 - 2x_{A1}) + 2(1 + \beta)c(1 - x_{A1})] = 0,$$

$$\frac{\partial \pi_B}{\partial x_{B1}} = (1 + \beta) [w(x_{A1} - 2x_{B1}) + 2(1 + \beta)c(x_{A1} - x_{B1})] = 0.$$

Solving yields the admission thresholds in equilibrium:

$$x_{A1}^{NN} = \frac{w + 2c(1 + \beta) - f}{2[w + c(1 + \beta)]}, \quad x_{B1}^{NN} = \frac{w(w - 3f) + 4c^2(1 + \beta)^2 + 4c(w - f)(1 + \beta)}{4[w + c(1 + \beta)]^2},$$

and the universities payoffs are:

$$\pi_A^{NN} = \frac{(w + f)^2(1 + \beta)}{4[w + c(1 + \beta)]},$$

$$\pi_B^{NN} = \frac{(w + f)^2[w + 2c(1 + \beta)]^2(1 + \beta)}{16[w + c(1 + \beta)]^3}.$$

Notice that

$$x_{A1}^{NN} - x_{B1}^{NN} = \frac{(w + f)[w - f + 2c(1 + \beta)]}{4[w + c(1 + \beta)]^2} > 0.$$

**University A BC:** if university  $A$  opens a BC but not university  $B$ , the first order conditions with respect to  $x_A$ ,  $x_B$  yield:

$$\frac{\partial \pi_A}{\partial x_{A1}} = (w + 2c)(1 - x_{A1}) - wx_{A1} - f = 0,$$

$$\frac{\partial \pi_A}{\partial x_{A2}} = (w + 2c)(1 - x_{A2}) - wx_{A2} - f = 0,$$

$$\frac{\partial \pi_B}{\partial x_{B1}} = (1 + \beta)[(w + 2c(1 + \beta))(x_{A1} - x_{B1}) - wx_{B1} - f] = 0.$$

The admission threshold in equilibrium is then:

$$x_{A1}^{FN} = x_{A2}^{FN} = \frac{w + 2c - f}{2(w + c)},$$

$$x_{B1}^{FN} = \frac{w(w - 3f) + 4c^2(1 + \beta) + 2c(w - f)(2 + \beta)}{4[w + c(1 + \beta)]^2}.$$

Thus the universities profits are:

$$\begin{aligned}\pi_A^{FN} &= \frac{(w+f)^2}{2(w+c)} - F, \\ \pi_B^{FN} &= \frac{(w+f)^2 (w+2c)^2 (1+\beta)}{16(w+c)^2 [w+c(1+\beta)]}.\end{aligned}$$

Notice that

$$x_{A1}^{FN} - x_{B1}^{FN} = \frac{(w+f)(w+2c)}{4(w+c)[w+c(1+\beta)]} > 0.$$

**University A and B BC:** if both universities open a BC, the first order conditions with respect to  $x_A$ ,  $x_B$  are:

$$\begin{aligned}\frac{\partial \pi_A}{\partial x_{A1}} &= (w+2c)(1-x_{A1}) - wx_{A1} - f = 0, \\ \frac{\partial \pi_A}{\partial x_{A2}} &= (w+2c)(1-x_{A2}) - wx_{A2} - f = 0, \\ \frac{\partial \pi_B}{\partial x_{B1}} &= (w+2c)(x_{A1} - x_{B1}) - wx_{B1} - f = 0, \\ \frac{\partial \pi_B}{\partial x_{B2}} &= (w+2c)(x_{A2} - x_{B2}) - wx_{B2} - f = 0.\end{aligned}$$

The admission threshold in equilibrium is:

$$\begin{aligned}x_{A1}^{FF} = x_{A2}^{FF} &= \frac{w+2c-f}{2(w+2c)}, \\ x_{B1}^{FF} = x_{B2}^{FF} &= \frac{(w+2c)^2 - f(3w+4c)}{4(w+c)^2},\end{aligned}$$

where the superscript indicates that both universities invest in  $BC$ . Therefore the universities payoffs are:

$$\begin{aligned}\pi_A^{FF} &= \frac{(w+f)^2}{2(w+c)} - F, \\ \pi_B^{FF} &= \frac{(w+2c)^2 (w+f)^2}{8(w+2c)^3} - F.\end{aligned}$$

Notice that

$$x_{A1}^{FF} - x_{B1}^{FF} = \frac{(w+f)(w+2c)}{4(w+c)^2} > 0.$$

**University B BC:** as previously stated, in the case in which university  $B$  is the only one who sets a BC, then there are two possibilities according to whether  $t \lesseqgtr t^*$ . Consider first



$w x_A - t \geq w x_B$  (i.e.,  $t \leq t^*$ ). In this case (Case 1), according to Lemma 1 demands for university  $A$  and  $B$  are:

$$\begin{aligned} n_A &= (1 + \beta)(1 - x_{A1}), \\ n_B &= (x_{A1} - x_{B1}) + (1 - x_{A1})(1 - \beta) + (x_{A1} - x_{B2}). \end{aligned}$$

The first order conditions with respect to  $x_{A1}$ ,  $x_{B1}$  and  $x_{B2}$  are:

$$\frac{\partial \pi_A}{\partial x_{A1}} = (1 + \beta)[(w + 2c(1 + \beta))(1 - x_{A1}) - w x_{A1} - f] = 0,$$

$$\frac{\partial \pi_B}{\partial x_{B1}} = (w + 2c)(x_{A1} - x_{B1}) - w x_{B1} - f = 0,$$

$$\frac{\partial \pi_B}{\partial x_{B2}} = (w - 2c)[1 - \beta(1 - x_{A1}) - x_{B2}] - w x_{B2} - f = 0.$$

The admission thresholds in equilibrium are:

$$\begin{aligned} x_{A1}^{NF}(t \leq t^*) &= \frac{w + 2c(1 + \beta) - f}{2[w + c(1 + \beta)]}, \\ x_{B1}^{NF}(t \leq t^*) &= \frac{w(w - 3f) + 4c^2(1 + \beta) + 2c(w - f)(2 + \beta)}{4(w + c)[w + c(1 + \beta)]}, \\ x_{B2}^{NF}(t \leq t^*) &= \frac{4c^2(1 + \beta) - w[f(2 + \beta) - w(2 - \beta)] + 2c[3w - f(1 + 2\beta)]}{4(w + c)[w + c(1 + \beta)]} \end{aligned}$$

where the superscript indicates that university  $A$  did not invest in BC ( $N$ ) and university  $B$  did ( $F$ ). Therefore the universities payoffs are:

$$\begin{aligned} \pi_{A1}^{NF}(t \leq t^*) &= \frac{(w + f)^2(1 + \beta)}{4[w + c(1 + \beta)]}, \\ \pi_{B1}^{NF}(t \leq t^*) &= \frac{(w + f)^2[8c^2(1 + \beta)^2 + 4wc(3 - \beta)(1 + \beta) + w^2(5 - \beta(4 - \beta))]}{16(w + c)[w + c(1 + \beta)]} - F. \end{aligned}$$

We then consider the case (Case 2) in which  $w x_{A1} - t < w x_{B2}$  (i.e.,  $t > t^*$ ). In this case, the demands for university  $A$  and  $B$  are:

$$\begin{aligned} n_A &= (1 - x_{A1}), \\ n_B &= (x_{A1} - x_{B1}) + 1 - x_{B1}. \end{aligned}$$

The first order conditions are:

$$\frac{\partial \pi_A}{\partial x_{A1}} = (w + 2c)(1 - x_{A1}) - w x_{A1} - f = 0,$$

$$\frac{\partial \pi_B}{\partial x_{B1}} = (w + 2c)(x_{A1} - x_{B1}) - wx_{B1} - f = 0,$$

$$\frac{\partial \pi_B}{\partial x_{B2}} = (w + 2c)(1 - x_{B2}) - wx_{B2} - f = 0.$$

The admission thresholds in equilibrium are:

$$\begin{aligned} x_{A1}^{NF}(t > t^*) &= \frac{w + 2c - f}{2(w + c)}, \\ x_{B1}^{NF}(t > t^*) &= \frac{(w + 2c) - f(3w + 4c)}{8(w^2 + 3wc + 2c^2)}, \\ x_{B2}^{NF}(t > t^*) &= \frac{w + 2c - f}{2(w + c)}, \end{aligned}$$

and universities payoffs are:

$$\begin{aligned} \pi_{A2}^{NF}(t > t^*) &= \frac{(w + f)}{4(w + c)}, \\ \pi_{B2}^{NF}(t > t^*) &= \frac{(w + f)^2(5w^2 + 12wc + 8c^2)}{16(w + c)^3} - F \end{aligned}$$

## A.2 Proof of Lemma 2

**Proof.** A student in Country 2 with ability equal or greater than  $\theta_A$  is indifferent between moving to Country 1 to attend university  $A$  and attending the BC of university  $B$  if

$$wx_{A1}^{NF}(t \leq t^*) - t^* = wx_{B2}^{NF}(t > t^*),$$

which occurs for

$$t^* = \frac{wc\beta(w + f)}{2(w + c)[w + c(1 + \beta)]}.$$

Finally, it is necessary to verify that indeed below  $t^*$  the condition

$$wx_{A1}^{NF}(t \leq t^*) - t > wx_{B2}^{NF}(t \leq t^*) \tag{A.1}$$

holds and, accordingly, above  $t^*$  the condition

$$wx_{A1}^{NF}(t > t^*) - t < wx_{B2}^{NF}(t > t^*) \tag{A.2}$$

holds. Inequality (A.1) holds for all

$$t < \tilde{t} \equiv \frac{w\beta(w + f)(w + 4c)}{4(w + c)[w + c(1 + \beta)]},$$

whereas inequality (A.2) holds for all

$$t > \hat{t} \equiv 0.$$

Finally, notice that  $\hat{t} < t^* < \tilde{t}$ , thus the threshold  $t^*$  satisfies the conditions (A.1) and (A.2) along the entire parameter range. ■

### A.3 Calculations - government intervention

For brevity, we will omit the derivation of the first order conditions. The case **No BC** is identical since no subsidisation occurs. Given  $f = c$ , the universities payoffs are:

$$\begin{aligned}\pi_A^{NN} &= \frac{(w+c)^2(1+\beta)}{4[w+c(1+\beta)]}, \\ \pi_B^{NN} &= \frac{(w+c)^2[w+2c(1+\beta)]^2(1+\beta)}{16[w+c(1+\beta)]^3}.\end{aligned}$$

**University A BC:** if university  $A$  opens a BC but not university  $B$ , the admission threshold in equilibrium is:

$$\begin{aligned}x_{A1}^{FN} &= \frac{1}{2}, \\ x_{A2}^{FN} &= \frac{c}{2(w+c)}, \\ x_{B1}^{FN} &= \frac{w+2\beta c}{4[w+c(1+\beta)]}.\end{aligned}$$

Notice that  $x_{A1}^{FN} > x_{A2}^{FN}$ . In other words, the admission requirements for the university in the developed country are higher than in the developing country. Thus the universities payoffs are:

$$\begin{aligned}\pi_A^{FN} &= \frac{5w^2 + 6wc + 2c^2}{4(w+c)} - F, \\ \pi_B^{FN} &= \frac{(w+2c)(1+\beta)}{16[w+c(1+\beta)]}.\end{aligned}$$

**University A and B BC:** if both universities open a BC, the admission threshold in equilibrium is:

$$\begin{aligned}x_{A1}^{FF} &= \frac{1}{2}, \\ x_{A2}^{FF} &= \frac{c}{2(w+c)}, \\ x_{B1}^{FF} &= \frac{w}{4(w+c)}, \\ x_{B2}^{FF} &= -\frac{w(2w+3c)}{4(w+c)^2} < 0.\end{aligned}$$

Since an admission standard cannot be negative, we set  $x_{B2}^{FF} = 0$ , implying full market coverage

in Country  $B$ . Therefore the universities payoffs are:

$$\begin{aligned}\pi_A^{FF} &= \frac{5w^2 + 6wc + 2c^2}{4(w+c)} - F, \\ \pi_B^{FF} &= \frac{w^3 + 13w^2c + 24wc^2 + 8c^3}{16(w+c)^2} - F.\end{aligned}$$

**University  $B$  BC:** remember that we are considering the case where  $t \leq t^*$ . The admission threshold in equilibrium is:

$$\begin{aligned}x_{A1}^{NF} &= \frac{w+c(1+2\beta)}{2[w+c(1+\beta)]}, \\ x_{B1}^{NF} &= \frac{w+2\beta c}{4[w+c(1+\beta)]}, \\ x_{B2}^{NF} &= \frac{2c^2 + wc(2-3\beta) - \beta w^2}{4(w+c)[w+c(1+\beta)]}.\end{aligned}$$

Therefore the universities payoffs are:

$$\begin{aligned}\pi_{A1}^{NF} &= \frac{(w+c)^2(1+\beta)}{4[w+c(1+\beta)]}, \\ \pi_{B1}^{NF} &= \frac{w^4(17+\beta^2) + 2w^3c[27+\beta(20+\beta)]}{16(w+c)[w+c(1+\beta)]} + \\ &\quad \frac{w^2c^2[65+\beta(88+25\beta)] + 4wc^3(1+\beta)(9+7\beta) + 8c^4(1+\beta)^2}{16(w+c)[w+c(1+\beta)]} - F.\end{aligned}$$