Journal of Economics and Sustainable Development
ISSN 2222-1700 (Paper) ISSN 2222-2855 (Online)
Vol.4, No.13, 2013

Scientific Diaspora from an Emerging Economy: Inclination to Return and Connections to the Home Country

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Abstract
To better inform policies on talent flow in emerging countries, this article evaluates the determinants of return migration among Brazilian researchers and post-graduate students in Britain, as well as, their personal and professional ties to Brazil. Most participants were inclined to engage in return migration (67%). The perception of the job market and career values were associated to their willingness to return, particularly, to receive job advertisements from EU institutions (OR=0.32, p=0.03) and to identify high income as professional success (OR=0.35, p=0.05). Personal ties to Brazil were both more frequent and influential in return migration plans than professional ties. Only 19% of participants were actively involved in research partnerships between the two countries. A series of policy implications were discussed at the institutional, national and international level. Evidence-based policies to engage with the scientific diaspora and to foster international partnerships are both critical to maximize social benefits and to secure equitable development worldwide.
Keywords: scientific diaspora, international mobility of researchers, brain drain, migration, international research partnerships.

1. Introduction

`Brain drain' or human capital flight is a process in which individuals of high level qualification and knowledge emigrate from their country. Although the importance of `mental capital' had been previously examined by List (1841) in *The national system of political economy*, the term brain drain was coined by the Royal Society to describe the emigration of scientists and technologists to North America from post-war Europe (OECD 2010a). The term has helped to popularise the human capital flight debate. However, it only considers one side of the movement and does not capture the dynamic and long-term nature of the process (Tung and Lazarova 2006; Carr et al. 2005). Additionally, many have argued that the scientific diaspora has an important role in building and maintaining research connections between institutions in the host and home country (Meyer 2006; Canibano and Woolley 2012). In recent years, many terms have been suggested to replace brain drain, which include brain circulation, brain gain, talent flow, international mobility of researchers and others (Carr et al. 2005; Cao 1996; Meyer 1999; Mahroum 2006).

Independently of the term used to describe it, international mobility of researchers has progressively become part of academic life (Edler 2008). It not only represents an opportunity for post-graduates and researchers to gain experience in international centres of excellence and then return to their country with more knowledge, but also an opportunity to foster and strengthen research partnerships between host and home countries. Several authors find that higher mobility leads to a better career development of individual scientists and it contributes to the overall production and exchange of knowledge (Baruffaldi and Landoni 2012; Rigby and Edler 2005). Freeman (2010) argues that higher mobility creates global benefits with respect to the speed and breadth of knowledge production as well as transferability through scientific networks.

Brazil has been historically seen as a nation of immigrants (Ribeiro 1995). This is one of the features that distinguish Brazil from the other BRICs (Brazil, Russia, India and China). While under Portuguese rule, immigration was encouraged to secure the Portuguese territorial claim. During the colonial period, many African slaves were brought to Brazil to work in agriculture and mining. From the 19th century onwards, European immigration particularly from Italy and Germany also had a substantial impact on Brazil's demography. During the 20th century, the country experienced waves of immigration of Japanese, Polish and other groups, who were mainly driven out of their home countries by economic and military hardship. Nonetheless, in the 80s the patterns of migration changed and Brazil started to experience negative international net-migration flow due to a series of economic downturns. Many highly skilled individuals left the country in search for better opportunities (Ribeiro 1995).

Changes in the world economic outlook in the last 10 years have also changed the international patterns of migration especially highly skilled migration (The Royal Society 2011). Recently, emerging economies like Brazil have experienced more complex roles as home and host countries. As the country is more integrated to the

global economy, a growing number of highly educated individuals are immigrating to Brazil (BMFA 2011). Due to Brazil's sustained socioeconomic development and progressively better-educated and wealthier population, an increasing number of Brazilians have the opportunity to study and work abroad (OEDC 2010b). A more skilled and competitive work environment is likely to booster innovation. The large scholarship programme, Science Without Borders, recently launched by the Brazilian government is part of this active concern to improve research and development (SWB 2012). It is expected that by the end of 2015 more than 100,000 Brazilians including undergraduate and graduate students, as well as researchers will have spent at least one year at the best universities around the world. The programme will cost 1.65 billion dollars, a quarter of which will come from business and the rest from the Brazilian government (SWB 2012; Economist 2012).

Worldwide the average brain drain rate increased from 5.0 to 5.4 percent between 1990 and 2000. A recent study by Michael Finn (2010) looking at foreign science and engineering PhD recipients from US universities found that the percentage of Brazilians who stayed in the US after receiving their PhD degrees was about 32% in the first year, and 31% in the fifth year. These numbers were very different from nationals from other emerging countries, for example, China (94% and 92%, respectively) and Latin American countries, for example, Chile (22% and 17%, respectively). However, the economic momentum coupled with the substantial increase of public-funded scholarships has raised concerns about brain drain in Brazil. These findings highlight both the importance and the difference of the brain drain phenomenon between countries. To analyze the determinants of scientific diaspora mobility and its connections with the home country will generate insights for policy making. Better informed policies regarding the scientific diaspora will be paramount to sending and receiving countries, if they are to maximize the social benefits of increase mobility of researchers (Lowell and Findlay 2003).

Most studies investigating the determinants of talent flow have focused on movements from Asia to North America and within Europe (Anas and Wickremasinghe 2010; Commander et al. 2008; Jonkers and Tijssen 2008; Ackers 2005; Gill 2005; Song 1997; Krishna and Khadria 1997). Fewer studies looked at brain drain in Latin American countries (Angel-Urdinola et al. 2008; Meyer et al. 1997; Barreiro and Velho 1997; Kreimer 1997; Didou-Aupetit and Gérard 2009). In light of the different intensities of the brain drain phenomenon among countries and the very dynamic socio-economic conditions of emerging countries in recent years, we believe that researchers from these countries currently abroad are subjected to particular conditions that merit more study. To our knowledge, no study has examined researchers and post graduate students inclination to engage in return migration between Brazil and European countries. Neither have we found published data on the professional links and research partnerships of the Brazilian scientific diaspora and its home country.

The present study´s main objective is to analyze the determinants of Brazilian researchers and post-graduate students' inclination to engage in return migration, using individual-level data from researchers and post-graduate students in Britain. The secondary objective is to examine the connections between Brazilian academics in the UK and their home country and whether these connections are associated with their willingness to return. The United Kingdom poses as an excellent case study to investigate this phenomenon for two reasons. Firstly, having some of the best-ranked European universities, Britain is a popular destination for international students (Hawthorne 2008). Secondly, the UK has common socioeconomic characteristics to other Western European countries what contributes to the generalizability of our findings. This information will help inform policies on international mobility of researchers at the institutional, national and international level.

2. Literature background

2.1 Theoretical background

In 1960s when the academic debate on brain drain gained popularity, human capital was primarily seem as the set of skills and knowledge enclosed in an individual, which was mostly valued in its aggregated form (Kidd 1965; Patinkin 1968). Although the most accepted view was that researchers were independent economic agents that leave interests and contacts in the home country to search for better conditions in host countries, there were some like Boulding who believed that the integration of human capital to the knowledge structures in society was more important than the aggregation of human capital itself (Boulding 1966). Additionally, Johnson proposed an alternative "internationalist model", which considered the potential benefits of the outflow of the highly skilled, both for the home country and the world economy (Johnson 1968).

Although many aspects of the 1960s brain drain debate were theoretically complex when considering the connectivity and complementarity of human capital in productive structures, the quantitative methods available to test those theoretical models were rather simple and so were the means of communication. This may explain why the subsequent empirical analysis on the international mobility of researchers followed conceptually and methodologically "standard" models, relying on neoclassical general equilibrium premises (Canibano and Woolley 2012). As observed by Lucas, most of general equilibrium models focus on comparing statistics once migration is complete (Lucas 2001). Little attention was given to personal and professional ties between scientists living abroad and their home country, or how these ties could influence their willingness to return.

In recent years, the literature witnessed the re-emergence of the connective dimension of 1960s brain drain debate. The revolution in digital and communications technology also had an important role in this conceptual shift, since it improved the capacity of scientists abroad to maintain personal and professional linkages with the home country (Mahroum 2006). By analysing diaspora knowledge networks based on national identification, Meyer and cols argued that connections between individuals and institutions allow benefits of human capital abroad to flow back to the home country (Meyer 2006). Additionally, those connections might increase the probability of researchers to find out about work opportunities in the home country and to receive support to return (Ackers 2005).

2.2 Determinants of return migration

The literature on the determinants of highly skilled migration depicts individuals as economic agents that leave their country in order to search for better economic and/or professional opportunities (Cao 1996; Gaillard and Gaillard 1997). According to Lewin's model, cross-border movements, including highly skilled migration, are subjected to pull and push factors (Lewin 1951). In essence the model departs from the assumption that in making decisions whether or not to move to a different country individuals experience contradictory forces. These forces are experienced in many dimensions, which are essentially related to: integration to the host country, connections to the home country, perception of the job market, and career values (Baruch et al. 2007). Although many exogenous factors play an important role in the decision, it is mainly the individual choice that will determine the final decision. According to the theory of reasoned action (Ajzen and Fishbein 1980; Fishbein and Ajzen 1975), the action of students (to stay in the host country or to return to their home country) will be positively correlated to their inclination to do so (behaviour intention).

Numerous factors are known to influence the inclination of highly skilled individuals to return home. Studies by Lee and Mauer (1999) and Baruch et al (2007) found that the integration of students/researchers to the host university and the host country environment seem to be the most significant predictor of the inclination to stay in the host country. Smooth adaptation is likely to generate positive attitudes towards the host country, an important factor in a migration decision. It has been observed that individuals from the Far East find it more difficult to adapt to Western societies (Baruch et al. 2007). In the case of Brazilians, despite potentially different patterns of social interaction observed in Brazil than those usually seen in the UK, the adaptation is likely to be easier than experienced by Easterners.

The role of support networks has also been shown to have profound impact on the level of integration to the host country environment (Van Dick et al. 2004). The degree of satisfaction from the support provided by the host research centre will likely determine the decision to stay. It is important to highlight that researchers receiving support from their host institutions and colleagues are likely to produce more and better, therefore generating a satisfying feeling of accomplishment. In the light of these findings and rationale, we hypothesize that the higher the integration of Brazilian post-graduate students and researchers to British institutions and environment, the lower will be their inclination to engage in return migration.

The individual's values and perceptions concerning labour markets are also likely to influence the decision to stay or return. Professional success is a complex concept that takes into account factors like financial rewards and structured career plan. It is possible that individuals who value those at a high level may perceive the UK as being in a better place to satisfy their demands. That is mainly because Britain is a high-income country and home to well establish international research centres. However, Brazil, as an emerging market, could potentially offer similar or better conditions in the future. Professional success also takes into account other aspects for which Brazil may offer better conditions, for example, greater autonomy at work and flexible working hours. As mentioned in the paper by Hazen and Albert, many individuals from developing countries who move abroad for post-graduate studies have an expectation to get high-level jobs in their return. For those at managerial positions, it is possible that they will have more autonomy and greater saying in defining their work schedule (Hazen and Albert 2006).

The perception of the job market regarding chances of finding a suitable position is likely to influence highly skilled individuals decision to engage in return migration. A suitable job would allow them to fully apply their potential and provide good chances of rising in the institutional hierarchy (Baruch 2007). Additionally, the quantity and quality of information on job opportunities received by researchers is likely to influence their perception of the job markets. Hence, we hypothesize that the career values and perceptions of job markets in Brazil and Britain will be associated with Brazilian post-graduate students and researchers intention to return to their home country. Whether the association will be positive or negative, it will depend on which job market is perceived as having more positions that allow the development of certain career values weighted higher by highly skilled individuals and which market offers greater probability of finding such positions.

The connections between the migrant and its home country are important factors influencing the decision to return (Baruch 2007; Baruffaldi and Landoni 2012). Family ties of migrants to their family members back in the home country exemplify well the importance of these connections. However, it is noteworthy that the nature of

family relationships tends to vary across settings. For example, in Asian cultures there is a greater sense of responsibility for the care of parents and grandparents. In China due to the one-child policy this responsibility cannot be shared among brothers and sisters. In Northern European countries, society is dominated by weaker family ties. It has been advocated that these differences in family ties are even reflected in the national pension systems (Galasso and Profeta 2010). Latin American cultures tend to have strong family ties (Carlo et al. 2007).
The scientific diaspora also seems to have an important role in facilitating the mobility of academics worldwide (Edler et al. 2008; The Royal Society 2011). Very often researchers and post-graduate students in developing countries have supervisors who studied or have partnerships abroad and they may directly or indirectly act as a facilitator so these researchers may also go abroad to acquire additional expertise. By maintaining professional and research links to their home institutions, these researchers may find it easier to secure a position to return to (Baruffaldi and Landoni 2012). Therefore, we hypothesize that maintaining personal and professional connections to individuals and institutions in Brazil while in Britain will be positively associated with an inclination to return to Brazil.
Instead of just being seen as lost human capital, scientists abroad are progressively being perceived as active nodes in personal and professional networks connecting individuals and institutions in home and host countries (Meyer 2006; Mahroum 2006). Despite the growing interest in the existing linkages between expatriate scientist and their home country, there is limited evidence regarding the frequency and nature of these links as well as the profile of individuals forming them, particularly in emerging countries like Brazil. Therefore, we attempted to examine professional and research linkages between Brazilian researchers and students in the UK and their home country.

3. Materials and methods

This study uses different methodologies according to the nature of the analysis. Firstly, in order to assess the determinants of the inclination to engage in return migration among Brazilian post-graduates students and researchers in the UK, we used a logistic regression model. The model is based on a model previously proposed by Baruch et al to study the inclination of foreign students in the UK and the US to engage in migration (Baruch et al 2007). It takes into account the previously discussed theories of Lewin (1951) as well as Ajzen and Fishbein (1980). Our model encompasses questions related to different dimensions (i.e. the explanatory variables): demography, integration to the host country, connections to the home country, perception of the job markets and career values. It also includes a question related to the future immigration plans (i.e. the dependent variable). Secondly, connections to the home country were classified as professional links and research partnerships. Respondents who reported having any of these connections were also required to provide additional information on the type of professional links and the funding bodies supporting the research partnership. In the data analysis phase, professional links were further classified as being public, private, ad hoc (e.g. consultancy and research project), or other (not specified). Finally, we asked all participants' opinion on what could further facilitate the development of partnerships between institutions in Brazil and the UK.
The questionnaire was conceived to broadly capture the characteristics, preferences and intentions of researchers and post-graduate students and the connections they had with Brazilian institutions. Therefore, a group of researchers and post-graduate students from different areas (economics, engineering, medicine and law) was consulted about the breadth and depth of the questions. After adjustments, a paper-based pilot study was conducted at University of Oxford during the III Conference of Brazilian Researchers and Post-graduate students in the UK on the 20th of November 2010. The results of the pilot were compiled and made available through the webpage of the Brazilian Association of Researchers and Post-graduate students in the UK (ABEP-UK). Its associates were invited to discuss the pilot results and to provide additional input to the structure of the questionnaire.

3.1 Data collection

One of the greatest challenges of this study was to reach a representative group of Brazilian academics currently working or studying in the UK. After discussions with representatives of the Brazilian Embassy, Brazilian societies and international offices of universities in the UK, it was defined that the most efficient strategy to reach potential participants would be an online questionnaire. This online questionnaire was structured and tested among the board of directors of ABEP-UK and later used for data collection. Data collections occurred from the 22 May to 22 July 2011.
The call to participate in the study was publicized through various channels. It was send via e-mail to the members of ABEP-UK. The Brazilian Embassy sent the call to all registered Brazilian researchers and post-graduate students. The international offices of 119 UK universities were also instrumental in publicizing the call among Brazilian nationals studying or working in those institutions. A total of 52 Brazilian societies from UK universities were also asked to circulate the call among its members. Additionally, the two main scholarship funding bodies in Brazil, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and

Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), were asked to email the call to their post-graduate students and researchers in the UK. Social media like Twitter and Facebook were also used to publicize the call. All individuals that answered the questionnaire were also asked to provide an institutional e-mail that was used to verify that they were eligible for the study.

3.2 Data analysis

Data analysis was performed in different software according the nature of data. Quantitative analyses of socio-economic data (i.e. binary logistic regression model, Pearson's correlation coefficients matrix, and descriptive statistics) were performed in Stata/IC 12.1 for Windows (StataCorp LP, Texas, USA). The list of variables derived from above discussed hypotheses and their possible values can be found in table 2. The geographic distribution of participants using density maps was examined using ArcGIS Desktop 10 (Esri, Redlands, USA). Qualitative analysis of questions regarding what could facilitate partnerships with Brazilian institutions was performed using NVivo 9.2 (QSR International, Melbourne, Australia). The software helped us to identify frequent themes in the written answers by participants.

5. Results

A total of 155 individuals answered the questionnaire. Three of them could not provide adequate proof of eligibility, therefore were not included in the analysis. As can be observed in table 1, the gender distribution was quite even and so were the fields of science represented. Looking at the individual areas of knowledge, we identify that Law and Applied Social Sciences were very popular as well as Economics and Finance. This can be explained by the fact that Britain has a long tradition in Social Sciences and London is one of the most important financial centers in the world. Post-graduate students constituted the majority of the studied sample. This may be explained by the higher opportunity cost for those more qualified. Looking at the financial support of Brazilian post-graduate students and researchers in the UK, we found that 37% were self-financed. Almost 30% were supported by international research funding bodies, and only 10% were financed by Brazilian funding bodies. The remaining 23% were funded by different sources, including partial scholarships and self-funding.

As can be seen in figure 1, most of the participants come from São Paulo, which is the richest and most populous state in Brazil. The second most frequent place of origin was the state of Rio de Janeiro, which is the second state in wealth and third in population. In figure 2, we observed that most researchers and post-graduate students are based in the southern regions of England. The three most popular host institutions among the participants were University of London (42%), University of Oxford (12%) and University of Cambridge (10%).

As can be observed in table 2, most participants intend to return to Brazil at some point in the future (67%). We can also observe that the majority of participants seem well adapted to the UK and satisfied with British academic institutions. Social and family ties seem to be more frequent than professional and research ties to Brazil. Approximately 80% of respondents reported having strong ties to their friends in Brazil. However, only 19% reported having professional ties with institutions in Brazil. Another interesting finding is the relatively small number of participants that reported having received many job advertisements from institutions in Brazil compared to Europe. Additionally, most participants define high level of income and institutional mobility as signs of professional success. The correlation matrix for the explanatory variables in pairs can be found in table 3. The low correlation coefficients observed do not suggest strong collinearity in our data.

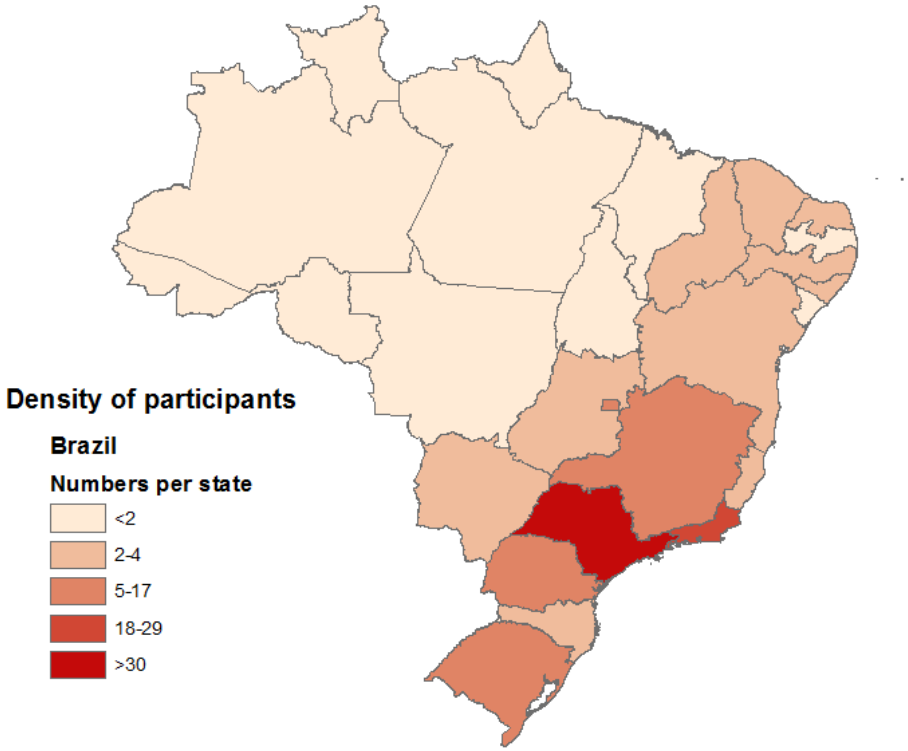

Figure 1. Origin of Brazilian researchers and post-graduate students by state

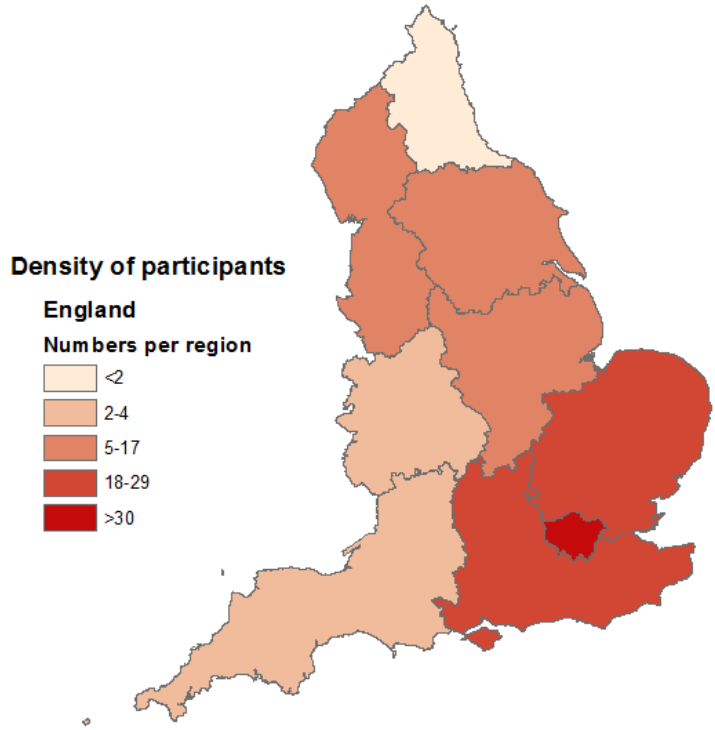

Figure 2. Destination of Brazilian researchers and post-graduate students by region

Table 1. Descriptive statistics

Parameter	Value	SE	95% CI lower bound	95% CI upper bound
Age	32.7	6.99[a]	22 [b]	61 [b]
Gender				
Male	55%	0.04	0.47	0.63
Female	45%	0.04	0.36	0.57
Field of Science				
Exact Sciences	41%	0.03	32%	48%
Humanities	59%	0.03	51%	67%
Areas of Knowledge				
Physics, Maths & Computer Sci.	10%	0.02	4%	13%
Engineering	12%	0.02	7%	17%
Agronomy & Environmental Sci.	4%	0.01	1%	7%
Biology, Chemistry & Pharmacy	5%	0.01	1%	8%
Medicine & Psychology	10%	0.02	5%	14%
Economics & Finance	12%	0.02	7%	17%
Law & Applied Social Sciences	35%	0.03	27%	42%
Linguistics & Arts	12%	0.02	6%	17%
Professional Status				
Master's student	37%	0.03	29%	45%
Doctoral student	24%	0.03	16%	30%
Research Assistant/Fellow	28%	0.03	21%	35%
Professor	11%	0.02	5%	15%

SE – Standard Error, Number of observations = 152, [a] Standard Deviation. [b]Minimum and maximum values.

Table 2. Description of variables used in the regression model

Variable	Possible values	Proportion (95% CI)
1. Age	Years	[c]
2. Gender	Male=1, Female=0	[c]
3. Field of Science	Exact=1, Humanities= 0	[c]
4. Academic status	Researcher or Professor=1, Post-grad student=0,	[c]
5. Funding source	Any scholarship=1, Self-funded=0	0.62 (0.54-0.70)
Integration to the host country		
6. I feel well integrated to the UK	Agree=1, Disagree=0	0.78 (0.72-0.85)
7. I am very satisfied with my research institution in the UK	Agree=1, Disagree=0	0.86 (0.80-0.91)
8. I live with my family in the UK	Yes=1, No=0	0.31 (0.23-0.38)
Connections to the home country		
9. I have strong ties to my family in BR	Agree=1, Disagree=0	0.89 (0.84-0.94)
10. I have strong ties to my friends in BR	Agree=1, Disagree=0	0.77 (0.71-0.84)
11. Do you still have professional links to institutions in BR?	Yes=1, No=0	0.26 (0.19-0.33)
12. Do you have research partnerships with institutions in BR?	Yes=1, No=0	0.19 (0.13-0.25)
Perception of the job market		
13. I receive many job advertisements from EU institutions	Agree=1, Disagree=0	0.57 (0.49-0.65)
14. I receive many job advertisements from BR institutions	Agree=1, Disagree=0	0.37 (0.29-0.45)
15. I have better chances of getting a good job in EU than BR	Agree=1, Disagree=0	0.33 (0.25-0.40)
16. I have better chances of growing professionally in EU than BR	Agree=1, Disagree=0	0.40 (0.33-0.48)
Career values		
17. Professional success is to have high income	Agree=1, Disagree=0	0.92 (0.87-0.96)
18. Professional success is to have autonomy at work	Agree=1, Disagree=0	0.60 (0.52-0.68)
19. Professional success is to be have flexible working hours	Agree=1, Disagree=0	0.68 (0.61-0.76)
20. Professional success is to be able to move up in the institution	Agree=1, Disagree=0	0.90 (0.85-0.94)
Inclination to return (Dependent variable)		
Do you have plans to move back to BR by the end of your current commitment in the UK or anytime in the future?	Yes=1, No=0	0.67 (0.59-0.74)

CI – confidence interval, BR – Brazil, EU- European Union, UK – United Kingdom, [c] In the previous table.

Table 3. Correlation coefficients

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
1.	1.00																			
2.	-0.02	1.00																		
3.	0.01	0.12	1.00																	
4.	[d]0.48	-0.04	[d]0.19	1.00																
5.	0.07	[e]0.15	[d]0.25	0.11	1.00															
6.	[e]0.13	0.07	0.11	[d]0.18	-0.04	1.00														
7.	0.02	0.00	0.08	0.07	-0.02	[d]0.34	1.00													
8.	[d]0.30	0.01	0.09	[d]0.16	0.09	0.04	0.02	1.00												
9.	0.03	[e]-0.13	[e]-0.15	0.09	-0.04	-0.02	0.11	-0.09	1.00											
10.	-0.06	-0.04	-0.03	[e]-0.14	0.10	[d]-0.16	-0.02	-0.11	[d]0.22	1.00										
11.	[d]0.20	0.00	0.01	¯0.02	0.03	-0.04	-0.06	0.07	0.01	[d]0.17	1.00									
12.	[e]0.15	0.01	0.12	[d]0.28	[d]0.18	0.09	0.09	0.12	0.06	0.10	[e]0.14	1.00								
13.	-0.03	[d]0.15	0.12	[d]0.16	0.06	-0.03	0.11	0.01	0.04	-0.08	-0.04	[e]0.29	1.00							
14.	-0.02	0.06	0.00	0.05	0.03	0.11	-0.08	-0.03	0.04	0.05	[d] 0.28	[d]0.13	-0.01	1.00						
15.	[d]0.15	0.04	[d]0.18	[e]0.13	-0.03	[e]0.13	[d]0.27	0.06	-0.07	-0.09	[d]-0.17	-0.03	[d]0.16	-0.34	1.00					
16.	0.09	-0.01	[d]0.17	[d]0.20	0.01	[e]0.14	[d]0.29	0.09	[e]-0.14	-0.13	[d]-0.17	-0.01	0.05	-0.34	[d]0.64	1.00				
17.	-0.07	0.06	0.02	0.03	0.02	-0.09	-0.01	[d]-0.20	0.07	[d]0.17	0.03	0.09	-0.11	0.08	0.03	-0.08	1.00			
18.	0.08	-0.11	0.09	0.12	0.02	0.02	0.02	0.03	[e]0.13	0.02	0.12	0.02	0.04	-0.07	-0.01	0.04	0.01	1.00		
19.	0.01	[e]-0.13	0.01	-0.01	0.05	-0.04	[e]0.14	0.05	0.00	0.01	0.02	0.05	[d]0.12	0.01	0.05	0.07	[d]0.17	[d]0.37	1.00	
20.	0.11	-0.03	-0.03	0.08	[d]-0.16	0.04	0.06	-0.10	0.03	[e]0.14	-0.01	0.10	-0.01	0.07	0.09	0.05	0.09	-0.01	0.01	1.00

The numbers defining rows and columns correspond to the explanatory variables displayed in table 2, [d] statistical significance at 5% level, [e] statistical significance at 10% level

Table 4. Logistic regression results

Variable	Odds ratio	SE	P value
1. Age	0.96	0.03	0.30
2. Gender	0.76	0.36	0.58
3. Field of Science	1.37	0.71	0.53
4. Academic status	0.48	0.36	0.33
5. Funding source	1.42	0.74	0.49
Integration to the host country			
6. I feel well integrated to the UK	0.79	0.48	0.70
7. I am very satisfied with my research institution in the UK	0.76	0.63	0.74
8. I live with my family in the UK	0.41	0.21	0.08
Connections to the home country			
9. I have strong ties to my family in BR	1.56	1.38	0.61
10. I have strong ties to my friends in BR	2.55	1.47	0.10
11. Do you still have professional links to institutions in BR?	1.97	1.31	0.30
12. Do you have research partnerships with institutions in BR?	2.07	1.41	0.28
Perception of the job market			
13. I receive many job advertisements from EU institutions	0.32	0.17	0.03
14. I receive many job advertisements from BR institutions	1.68	0.94	0.35
15. I have better chances of getting a good job in EU than BR	0.34	0.21	0.09
16. I have better chances of growing professionally in EU than BR	0.43	0.26	0.16
Career values			
17. Professional success is to have high income	0.35	0.19	0.05
18. Professional success is to have autonomy at work	3.00	2.58	0.20
19. Professional success is to be have flexible working hours	1.05	0.57	0.92
20. Professional success is to be able to move up in the institution	0.65	0.51	0.59
Inclination to return (Dependent variable)			
Do you have plans to move back to BR by the end of your current commitment in the UK or anytime in the future?	-	-	-

SE – Standard Error, BR – Brazil, EU- European Union, UK – United Kingdom. McFadden $R^2 = 0.310$, Pearson chi-squared=56.12, p=0.000, Test for model specification error (Link test) p=0.63. Cronbach´s alpha reliability scores for: 1) Integration to the host country- 0.465; 2) Connections to the home country- 0.449; 3) Perception of the job market- 0.517; 4) Career values- 0.509.

Table 5. Characteristics of participants in respect to professional and research links to Brazil

Characteristic	Professional link		Research link	
	Yes %(95%CI)	*No* %(95%CI)	*Yes* %(95%CI)	*No* %(95%CI)
1. Age	35(22-54)*	31(23-61)*	34(26-61)*	32(22-57)*
2. Gender	55% (38-71%)	54%(45-64%)	56%(37-75%)	54%(45-63%)
3. Field of Science	42%(26-58%)	40%(31-49%)	53%(34-72%)	38%(29-46%)
4. Academic status	14%(3-25%)	16%(9-23%)	36%(18-54%)	10%(5-16%)
5. Funding source	65%(49-80%)	61%(52-70%)	80%(64-85%)	57%(48-66%)

Obs: Percentages and confidence intervals refer to values=1, as found in table 2, CI – confidence interval, *mean (range)

If we look at the logistic regression results in table 4, we find that, at high level statistical significance ($p<0.05$), only two factors regarding the perception of job markets and career values seem to be associated with inclination to return: 1) to receive many job advertisements from EU institutions and 2) to identify high income as professional success, respectively. Both factors seem to confer a reduction in the odds of participants being inclined to return of approximately 70%. At lower levels of statistical significance ($p<0.10$) but presenting a similar odds ratio, to perceive to have better chances of getting a good job in the EU also seems to be reduce participants´ willingness to return. This corroborates with the hypothesis that some aspects of individuals´ career values and perceptions of the job market play a role in the decision to engage in return migration. When considering integration to the host, we only found that those leaving with their families in the UK are less inclined to return ($p=0.08$).

In our analysis, we did not find the source of funding (i.e. having a scholarship) to be a statistically significant factor influencing the decision to return. The number of participants receiving scholarships from Brazilian funding bodies, who are usually required to return, was small (10%). This limited the comparison of those funded and non-funded through Brazilian scholarships in the regression analysis. When looking at the influence of connections to the home country, we found that social linkages such as friendship ties seem to play a more important role in the decision to return than professional and research ties. Despite greater uncertainty of the odds ratio ($p=0.10$), having strong ties to friends in Brazil was heavily correlated to the inclination to return, OR=2.55. Different than our initial hypothesis on professional or research links, we did not find statistically significant association between them and participants inclination to return.

Only 26% of participants reported having professional links to institutions in Brazil, and the number was even smaller (19%) for those that reported ongoing research partnerships with Brazilian institutions. Among those who reported having professional links to Brazil, 32% have contracts with public institutions, 15% have contracts with private institutions, 28% have ad hoc appointments (e.g. research projects and consultancy work), and 25% did not specify their professional links. When we compare the characteristics of participants in respect to professional and research links to Brazilian institutions, we found more individuals of higher academic status and funded through scholarships among those who reported having research projects with Brazilian institutions. Thirteen of the reported research partnerships where funded by Brazilian public funding bodies such as CNPq, CAPES and BNDES and seven were funded by international funding bodies such as the Wellcome Trust, Bill & Melinda Gates Foundation and Santander Group.

When asked what could further facilitate existing and potential partnerships between the two countries, even though the answers varied in form, there were three more frequent themes. The first was to increase the funding opportunities for research projects and courses between academics from both countries. The second was to booster the advertisement of funding opportunities as well as ongoing projects through media such as: social networks, mailing lists, webpages, professional and alumni associations. The third was to improve the efficiency in processing visa applications of researchers and post-graduate students in both countries.

5. Discussion

As globalization intensifies and new scientific hubs emerge, the international mobility of researchers is also likely to increase. Despite its importance, there is still limited evidence on this phenomenon in respect to emerging economies like Brazil. To our knowledge no other study has focused on the brain drain between Europe and Brazil using individual-level data. This paper is the first to focus on the determinants of return migration among Brazilian researchers and post-graduate students living abroad. It is also the first study to examine their professional and research links to the home country. The findings provide new and useful

information to assist policy making as well as to direct future research.

The results showed that the majority of participants are based in traditional universities in the south of England. When looking at the origin of participants in Brazil, regional inequality was also evident, with most participants coming from wealthier states in the South-East and South regions. The great majority of participants (67%) reported having plans to return to Brazil in the near future. This finding is similar to previous studies looking at nationals from European countries, particularly Portugal and Italy (Ackers 2005; Morano-Foadi 2005; Gill 2005; Pereira et al 2007; Fontes 2007). Our findings are in accordance with Finn´s, who found that approximately 30% of Brazilians ended up staying in the US after obtaining a PhD (Finn 2010). Similar to Baruch et al, we found that the perception of the job market and career values play an important role in post-graduate students and researchers´ decision to engage in return migration (Baruch et al 2007). We also found that participants leaving with their families in the UK were less inclined to return. Different from Baruffaldi and Landoni, we did not find the existence of professional links and research partnerships with the home country to be correlated with the inclination to return (Baruffaldi and Landoni 2012). We found that strong ties to friends in the home country are more frequent and also have a greater impact on participants' willingness to return ($p=0.10$), when compared to professional and research ties. The percentage of participants who reported having professional links and research partnerships with institutions in Brazil were 26% and 19%, respectively.

5.1 Present and future policies on talent flow

The policy of granting scholarships with mandatory return has been in place in most developing countries as means of gaining from higher education of better quality in developed countries and at the same time minimizing the risk of losing talent to foreign labour markets (Didou-Aupetit and Gerard 2009). Examples of this policy in Latin America include the Colfuturo program in Colombia, (Angel-Urdinola et al, 2008) and the models traditionally adopted by CAPES and CNPq, which provide public-funded scholarship programs in Brazil. This policy reflects developing states motivation to foster and consolidate national intellectual elites able to interact with high-end scientific development in the world's top-universities, and transfer part of the acquired knowledge to a domestic audience after returning. In our study, among those academics receiving scholarships from Brazilian funding bodies, 93% were inclined to return to Brazil at some point in the future. However, we also found that even among those academics without Brazilian scholarships, the inclination to return was high (64%).

These later findings point to a view that there is a natural gravitation towards the home country and repatriation is likely to takes place once enough knowledge and financial resources have been gathered and when the socio-economic conditions in the home country is perceived as sufficiently favourable (Thorn and Holm-Nielsen 2008). As adverted by Portillo and Villanueva, strategies of attracting back post-graduates and researchers solely based on contractual obligations are likely to fail if those returning lack the opportunity to find suitable jobs where they can produce to their full potential (Portillo 2010; Villanueva 2009). Compulsory return immediately after the completion of the research period abroad may not always be the most beneficial option for the sending country. According to the connectionist approach, sending countries may end up benefiting more from allowing researchers to stay abroad, if they assume a diplomatic role to facilitate knowledge transfer and enterprise creation in the home country (Meyer 1999).

This way of thinking is already generating changes in policy in developing states. In 2012, CAPES scholarship programme (Brazil) issued a directive indicating the novel possibility of state-funded researchers to remain indefinitely abroad or having the return date postponed insofar as they are able to justify the stay on the basis that the scientific activity on the host state is 'relevant to Brazil or to humanity'. Changes like this signal the necessity to implement more flexible and comprehensive policies to maximize the benefits of international mobility of researchers. It is key to consider the profile, perceptions and attitudes of researchers and post-graduate students when devising efficient policies regarding international mobility of researchers. The findings of this study are useful in this sense at the institutional, national and international level.

Our findings showed that researchers living with their family abroad are less likely to engage in return migration. Therefore, institutions that provide better support for foreign researchers to live with their families will contribute to their willingness to stay in the host country, and possibly the institution. Measures to secure an attractive and suitable environment for the adaptation of researchers are also likely to increase their productivity and attract other researchers to these institutions (Shay and Baack 2004). The answers to the open questions highlighted the importance of advertising funding opportunities supporting international courses and research projects. Offices for international cooperation may have an important role in supporting courses as well as research collaborations in institutions in home and host countries.

One of the challenges of our study was to define the size of the population of Brazilian researchers and postgraduate students not funded by the Brazilian government currently in Britain, which it is likely to be substantial according to our sample. To create appropriate institutional mechanisms to promote comprehensive data collection on Brazilian researchers abroad would require a joint effort between research centres and competent agencies from home and host countries. This investment could yield multiple dividends. As it would

allow the creation of channels to better circulate job advertisements, which our study has shown to determine the decision to migrate. These channels could be used by scientists abroad to organise themselves not only for mutual aid and information sharing, but also to help institutions and scientists in the home country.

According to our results, it is still low the number of Brazilian researchers and post-graduate students actively engaged in research partnerships between institution in home and host countries (19%). Considering Chinese scientists in the US, Zweig and Changui (1995) found that approximately 30% have maintained partnerships with their home institutions in China. Laudable initiatives like the memorandum of understanding between the Research Councils UK and São Paulo Research Foundation (RCUK/FAPESP 2009), which promotes the joint analysis and funding of research projects between the two countries could be extended to other regions in order to help foster partnerships between institution in home and host countries. Visiting Scholars and Attraction of Young Talents programs, as those currently promoted by Science Without Boarders, can also help foster partnerships between home and host countries institutions, since they promote similar knowledge networks.

A thorough analysis of international scientific networks has been performed by Coe and Bunnell (2003), who argue that these networks are no less important than regional and national scientific networks. As suggested by Arocena and Sutz 2006, scientific diaspora networks may give support and help to empower national innovation systems in the home country. As pointed out by Robert Lucas, Economics Nobel Laureate 1995, expatriates are more likely to invest in their home country because they are better informed to analyze investment opportunities and have local contacts to assist in this process (Lucas 2001). For similar reasons, they may encourage and support foreign entrepreneurs to invest in their home country. An example of this phenomenon is the India´s Silicon Valley diaspora, which is responsible for much of the entrepreneurial vision and the foreign direct investment in the country´s emerging information technology hubs of Bangalore and Hyderabad (Mahroum et al 2006, Devan and Tewari 2001).

An increasing number of diaspora network initiatives are being promoted by international organizations. An example is the “Digital Diaspora Network”, which is part of the UN Information and Communication Technologies Task Force. It aims to accelerate socioeconomic development and to help the achievement of the Millennium Development Goals through mobilizing the intellectual and financial resources of diaspora scientists and entrepreneurs (Turner 2003). The UN High-level Dialogue on International Migration and Development to be held in September 2013 during the sixty-eight session of the General Assembly should continue to put forward a comprehensive agenda promoting studies of the global effects of talent flow and evidence-based policies to secure equitable and sustainable growth worldwide. Better-informed policies regarding international mobility of researchers can be important tools to help address the global challenges of the twenty-first century (OECD 2010c).

5.2 Limitations and future research

This study is subjected to constraints and limitations that are typical in this type of analysis. For example, the design relies on self-reports using an online platform. Hence, it is difficult to characterize the representativeness of the sample. Despite all efforts to reach a highly representative sample of Brazilian researchers in the UK through various channels, it is possible that those more connected to these channels were also the ones more inclined to return. However, if that were true, we would expect a greater proportion of participants funded by the Brazilian government, since they are required to return by the end of their studies. Nonetheless, these individuals represent only a small percentage of the study participants (10%).

Whenever relying on voluntary participation, it is crucial to strike a balance between breadth and depth of information requested. However, it is important to acknowledge the limited information obtained on the productivity of researchers and the nature of research partnerships between both countries. It would be particularly important to assess the impact of these research partnerships in terms of publications as well as patents generated (Edler et al. 2008). Future analysis should also evaluate the determinants of expatriate researchers’ participation in international scientific collaborations, particularly from emerging countries like Brazil. Although our study did not use social network analysis tools, we acknowledge that these could lead to important conceptual and empirical developments in the study of international scientific networks generated through brain circulation (Canibaño and Bozeman 2009; Abbasi 2011). Additional studies should attempt to analyze knowledge flow between home and host countries through these networks. It would also be important to assess the resilience of these international scientific networks, as many of the most influential hubs and authorities are elderly academics who may retire or pass away.

It would also be interesting to investigate how many of these research partnerships involve private and public institutions, since studies have shown that international scientist mobility affects their propensity to engage in knowledge and technology transfer with the private sector (Edler et al. 2008). Since some studies suggest that the length of stay of researchers in the host country is inversely related to the inclination of return, it would be informative to include this variable in future models (Williams 2007). Further studies are also encouraged to extend this analysis to other European countries as well as North American and Asian countries. This would

allow comparisons of conditions and perceptions of researchers across different settings. Given the recent changes in world economic outlook, emerging countries like Brazil are already experiencing an increase in the influx of highly qualified professionals from Europe. It would be particularly interesting to examine the patterns and effects of talent flow from Europe to emerging countries.

5.3 Conclusion and final remarks

Our findings suggest that most Brazilian researchers and post-graduate are inclined to return after a period abroad. Although we found that their perception of the job market and the career values seem to be associated to their willingness to return, we did not find a similar association in respect to the existence of professional or research connections to the home country. Social and personal ties to Brazil seem to be both more frequent and influential in return migration than professional and research ties. The number of Brazilian post-graduate students and researchers abroad that reported having professional or research links to their home country was also limited. Evidence-based policies to engage with the scientific diaspora and to foster international partnerships are both critical to generate benefits for both home and host countries. They could contribute to secure more equitable and sustainable development worldwide. In view of the lack of research in this field in emerging countries like Brazil, we hope to have made a helpful initial contribution and have highlighted some of the core aspects of the brain drain debate to be developed in future studies.

Acknowledgements

For the support in the data collection, we are grateful to the Brazilian Association of Researchers and Post-graduate Students in the United Kingdom (ABEP-UK), the Embassy of Brazil in London, and the Oxford University Brazilian Society. For the stimulating discussions, we thank the following: Luiz Marcelo Videro Vieira Santos, Jefferson Gomes and Triantafyllos Pliakas.

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