Are skilled women more migratory than skilled men?

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Abstract

This paper empirically studies emigration patterns of skilled males and females. In the most relevant model accounting for interdependencies between women and men's decisions, we derive the gendered responses to traditional push factors. Females and males do not respond with the same intensity to the traditional determinants of labor mobility and gender-specific characteristics of the population at origin. Moreover, being other factors equal, the female willingness to follow the spouse seems to be much more pronounced with respect to the male one. From a quantitative perspective, our model reveals that skilled women are not more migratory than skilled men internationally, thus rejecting the existence of a genetic or social gender gap in international skilled migration.

1 Introduction

So far, little research has addressed the issue of female migration. Women have generally been viewed as dependents, moving as wives, mothers or daughters of male migrants[1]. This is a paradox since the share of women in international migration increased from 46.8% to 49.6% between 1960 and 2005 (see United Nations, 2005). By 2005, the stock of female international immigrants outnumbered the stock of males in developed countries, including Europe and North America. A more recent report of the United Nations (2006) also

[1]Exceptions are Zlotnik (1990, 1997), Cobb-Clark (1993), Cerrutti and Massey (2001) or, more recently, Morrison et al. (2007).

shows that women predominate men in migration annual outflows from many developing countries[2].

The feminization of international migration raises specific economic issues related to the gendered determinants and consequences of migration. In particular, women's brain drain is likely to affect sending countries in a very peculiar way. Many studies have emphasized the role of female education in raising labor productivity and economic growth, suggesting that educational gender gaps are an impediment to economic development[3]. Klasen (1999) or Dollar and Gatti (1999) demonstrated that gender inequality acts as a significant constraint on growth in cross-country regressions, a result confirmed by Blackden et al. (2006) in the case of sub-Saharan Africa. In sum, societies that have a preference for not investing in girls or that loose a high proportion of skilled women through emigration may experience slower growth and reduced income.

Recently, new data sets documenting the gender structure of the brain drain were made available (see Docquier, Lowell and Marfouk, 2007, or Dumont, Martin and Spielvogel, 2007). Both confirm the feminization of international migration and show that skilled women exhibit higher emigration rates than skilled men, suggesting that skilled women have higher propensities to emigrate. This seemingly counterintuitive result is not new in the literature. In 1885, the geographer Ernst Georg Ravenstein stated seven laws governing human migration[4]. The seventh law said that '[...] females are more migratory than males within the kingdom of their birth, but males more frequently venture beyond. In other words more females than males leave the county in which they were born in order to seek employment in some other county of the same kingdom, but more males leave the kingdom of their birth for one of the sister kingdoms' (Ravenstein, 1885). Transposed to the contemporaneous world, it means that women are more mobile on shorter distances and are likely to migrate more internally or between geographically close countries. A few decades ago, Macisco and Pryor (1963) surveyed 39 empirical studies on migration by gender. They found that 29 authors agreed that women are more migratory than men, 5 disagreed and 5 found no difference. They also confirmed that women move on shorter

[2]Two examples are Sri Lanka and Indonesia, where the shares of female migrant workers leaving the country is equal respectively to 69.0% and 70.4% in 2000 (UN 2006).

[3]This is the result obtained in Knowles et al. (2000) who use Barro and Lee's human capital indicators, or Coulombe and Tremblay (2006) who relied on the International Adult Literacy Survey to build an homogenized indicator of human capital.

[4]Ravenstein's laws of migration can be summarized as following: (1) Most migrants move only a short distance. (2) There is a process of absorption, whereby people immediately surrounding a rapidly growing town move into it and the gaps they leave are filled by migrants from more distant areas, and so on until the attractive force is spent. (3) There is a process of dispersion, which is the inverse of absorption. (4) Each migration flow produces a compensating counter-flow. (5) Long-distance migrants go to one of the great centers of commerce and industry. (6) Natives of towns are less migratory than those from rural areas. (7) Females are more migratory than males.

distances than men. A more recent study on UK graduates by Faggian, McCann and Sheppard (2007) shows that female graduates migrate more than male graduates in the UK. There are several explanations for this result. Faggiani et al. argue that migration can be used as a partial compensation mechanism for gender discrimination in the labor market. Seielstad et al (1998) have a more striking interpretation. They provide 'genetic evidence for a higher female migration rate in humans'. Their argument relies on the fact that mtDNA is transmitted exclusively by females, whereas the Y chromosome is passed only among males. They found that Y chromosome variants tend to be more localized geographically than those of mtDNA and the autosomes. According to their study, a higher female than male migration rate explains most of this discrepancy, 'because diverse Y chromosomes would enter a population at a lower rate than mtDNA or the autosomes'.

Ravenstein's seventh law suggests that women migrate more within nations, but less on longer distances. This is compatible with Curran and Rivero-Fuentes (2003) and Davis and Winters (2001) who argue that social networks are more important for women in international migration. Hence, men would migrate first on longer distances and, in a second stage, bring women into the host country. International migration rates should then reasonably be higher for males, except perhaps for contiguous countries. As we will show in the next section, the data computed by Docquier, Lowell and Marfouk (2007) does not contradict this result, at least at the low-skill level. However, at the high-skill level, emigration rates are much stronger for females, both in developed and developing countries.

The goal of our paper is to test for the existence of a gender gap in international skilled migration, meaning whether skilled women are more migratory than skiled men internationally. We build an empirical model describing the determinants of males and females migration rates. Only accounting for country-specific and gender-specific explanatory variables, standard 'separate' regressions reveal that skilled women are more migratory than skilled men. But in a correctly specified model, that accounts for interdependencies between males and females, the existence of a gender gap in international skilled migration is rejected. In addition to that, two qualitative insights have shown up. First of all, women and men exhibit heterogeneous responses to the same traditional push factors and, more importantly, skilled women are more responsive to the emigration of skilled men than the opposite. The latter issue would explain why at a first glance, even if men are more likely to emigrate for economic reasons (because they are on average more educated than females), women seem to be relatively more mobile than them.

The remainder of this paper is organized as follows. Section 2 presents the data sources, concepts and stylized facts. In Section 3, we describe the two empirical models and discriminate between the different results. Finally, Section 4 concludes.

2 Data and stylized facts

This paper relies on the database described in Docquier, Lowell and Marfouk (2007), henceforth labeled DLM. This data set characterizes the gender composition of skilled and unskilled migration of all the world countries to the OECD in 1990 and 2000. It is based on the aggregation of harmonized immigration data collected in host countries, where information about the birth country, gender, age and educational attainment of immigrants is available. This information is found in national population censuses and registers (or samples of them). More precisely, DLM collected gender-disaggregated data from the 30 members of the OECD, with the highest level of detail on birth countries and three levels of educational attainment: $s = m$ for immigrants with upper-seconday education, $s = h$ for those with post-secondary education and $s = l$ for those with less than upper-secondary education (including lower-secondary, primary and no schooling). Let $M_{t,g,s}^{i,j}$ denotes the stock of adults aged 25+ born in i, of gender g, skill s, living in country j at time t. Aggregating these numbers over destination countries j gives the stock of emigrants from country i:

$$M_{t,g,s}^{i} = \sum_{j} M_{t,g,s}^{i,j} \tag{1}$$

Table 1 gives the emigration stocks observed in 2000. There are 58.2 million adult immigrants in the OECD and 51 percent of women. The majority of them (37.3 million, i.e. 64 percent of the total stock) originate from developing countries. About 35 percent of these immigrants have post-secondary education, i.e. 20.4 million skilled immigrants (60 percent of them born in developing countries). The proportion of women in total and skilled immigration are 50.9 and 49.3 percent, respectively. The same proportion in total and skilled immigrants from developing countries are 49.8 and 33.1 percent. Regarding immigrants from high-income countries, the proportions are 52.8 and 50.3 percent. Women are thus under-represented (resp. over-represented) in South-North (resp. North-North) migration stocks. At the regional level, the average proportion of women in total migration varies between 42 percent (in the MENA region) and 56 percent (in South-Eastern Asia and the Caribbean). The share of women in skilled migration varies between 38 percent (in the MENA region) and 57 percent (in Central Asia).

From the last columns, the proportion of skilled among women immigrants is lower than the proportion of skilled among men. The difference is particulary strong in low-income regions such as sub-Saharan Africa and East Asia. There are a few exceptions to this rule: women immigrants from the Caribbean, Central America and Central Asia are more educated than men.

Table 1. Stocks of emigrants and skilled emigrants in 2000

	Total emigrants		Skilled emigrants		Share of skilled among emigrants	
	Women	Men	Women	Men	Women	Men
World	29622766	28623500	10069460	10372052	34.0%	36.2%
Income groups						
High-income	10414893	9301932	3976966	3934102	38.2%	42.3%
Developing countries	18582465	18706210	6003972	6335002	32.3%	33.9%
Upper-middle income	7481652	7857709	1839212	1890082	24.6%	24.1%
Lower-middle income	8037249	7467353	2929390	2761904	36.4%	37.0%
Low-income	3063564	3381147	1235370	1683016	40.3%	49.8%
Least developed countries	1127312	1237022	340131	473343	30.2%	38.3%
Groups of interest						
OECD	14215299	13832444	4300756	4355637	30.3%	31.5%
EU27	9019786	8259258	2836686	2944646	31.4%	35.7%
North America	836988	696551	502001	447565	60.0%	64.3%
Small island dev. states	2206172	1812310	819471	672461	37.1%	37.1%
Large Countries ($\succ$75M)	9458748	9138026	3548647	3509853	37.5%	38.4%
Landlocked countries	652276	681069	241380	282249	37.0%	41.4%
Islamic Countries	3933697	4924019	1008891	1491109	25.6%	30.3%
Selected regions						
Sub-Saharan Africa	1006559	1130226	394052	540223	39.1%	47.8%
MENA	1497870	2089208	423787	700892	28.3%	33.5%
Caribbean	1663354	1347127	643430	506794	38.7%	37.6%
Central America	3749058	4301054	669879	707132	17.9%	16.4%
South America	1576637	1322495	613143	541418	38.9%	40.9%
Central Asia	45903	36547	23031	16979	50.2%	46.5%
East Asia	2278154	1844943	1174327	1077039	51.5%	58.4%
South-Eastern Asia	2464241	1889272	1166915	981352	47.4%	51.9%
Eastern europe	2445361	1990316	826343	744904	33.8%	37.4%
Pacific Islands	119774	107981	43398	42929	36.2%	39.8%

Source: Docquier, Lowell and Marfouk (2007)

Obviously, the stock of skilled emigrants (absolute measure brain drain) is positively correlated with the size of the country and its level of development (reflecting the average educational level of natives). The pressure exerted on the sending country is better captured by comparing the emigration stocks to the total number of people born in the source country and belonging to the same gender and educational category. Hence, the DLM data set also provides a relative measure of the brain drain, defined as the ratio of the stock of skilled emigrants to the educated population born in the source country. Although their analysis is based on stocks (rather than flows), DLM refers to these proportions as emigration rates.

Denoting $N^i_{t,g,s}$ as the stock of individuals aged 25+ at time t, of skill s, gender g, born in source country i, the emigration rate is defined as:

$$m^i_{t,g,s} = \frac{M^i_{t,g,s}}{N^i_{t,g,s}} \tag{2}$$

where the native population $N^i_{t,g,s}$ is proxied by the sum of the resident population living in country i ($R^i_{t,g,s}$) and the stock of emigrants from i: $N^i_{t,g,s} \equiv R^i_{t,g,s} + M^i_{t,g,s}$. To compute $R^i_{t,g,s}$, DLM uses population data by age provided by the United Nations and several sources on the average educational attainment of the resident population.

Figure 1 compares the skilled emigration rates of women and men in 2000. Each observation characterizes a country and the the bold line represents the trend (the intercept is not significantly different from zero). The figure clearly reveals that skilled emigration rates are high in many countries, exceeding 50 percent in many cases. The fitted line is well above the 45 degree line. Hence, women's average brain drain (one-country-one-vote) is on average 17 percent above men's. There are only a few exceptions where men have higher brain drain rates (typically, high-income countries). Figure 2 gives the same comparison but focusing on low - skilled emigration rates. The rates are much lower than the skilled and do not exceed 5 percent in many countries. On average, they are 6 percent lower for women than for men. These figures suggest that low-skilled men are relatively more migratory than low-skilled women (which is more or less in line with Ravenstein's law on international migration), while skilled women have a higher propensity to emigrate internationally than skilled men.

The question are: how can we explain this difference in skilled migration rates? Are skilled women more mobile internationally than skilled men?

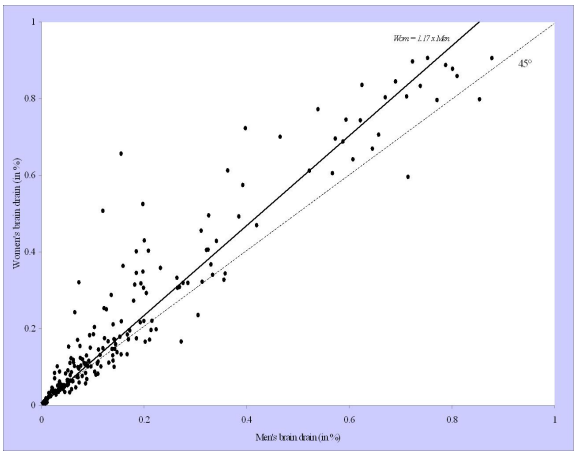

Figure 1: Skilled emigration rates by gender

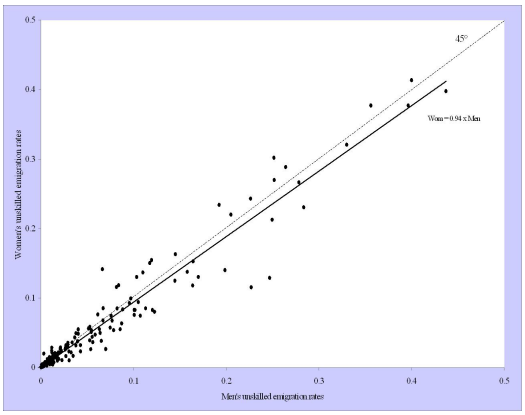

Figure 2: Low - skilled emigration rates by gender

To understand the determinants of the brain drain, Docquier, Lohest and Marfouk (2007) use a simple multiplicative decomposition of the brain drain into two components: (i) the degree of openness of sending countries, as measured by the average or total emigration rate, and (ii) the schooling gap, as measured by the relative education level of emigrants compared with natives. The approach based on such a decomposition is justified by the facts that no country has both strong openness and a high schooling gap, and that these two variables vary with specific determinants. The new version of the data set allows us to apply this decomposition to gender-disaggregated emigration rates. By definition and from (2), the skilled emigration rate in the gender group g can be decomposed as follows:

$$m^i_{t,g,h} \equiv \left[\frac{\sum_s M^i_{t,g,s}}{\sum_s N^i_{t,g,s}}\right] / \left[\frac{M^i_{t,g,h}/\sum_s M^i_{t,g,s}}{N^i_{t,g,h}/\sum_s N^i_{t,g,s}}\right] \tag{3}$$

The first multiplicative component is the ratio of emigrants to natives - the average or total emigration rate of all types of individuals. It reflects the degree of openness of the sending country. The second multiplicative component - the schooling gap - is the ratio of the proportion of skilled emigrants by the same proportion among natives. This ratio reflects the positive selection among emigrants. This ratio is always higher than one, indicating that emigrants are more educated than natives.

Table 2 shows emigration rates of the skilled and average emigration rate as well as the schooling gap, defined as the ratio of the two. The average emigration rate is linked to the level of development: the highest rates are observed in upper-middle income countries (where incentive to emigrate exist and people can afford paying emigration costs). They are lower in the least developed countries and, to a lower extent, high-income countries. At the world level, women and men exihibit identical average emigration rates. However, women have lower (resp. higher) average emigration rates in developing countries (resp. high-income countries), except in the Caribbean. Figure 3 provides a scatterplot of the world countries. The unweighted (one country-one vote) average emigration rate is slightly higher for women but the difference is small.

In all regions, skilled emigration rates are much bigger than average emigration rates, meaning that migrants are positively selected within the native population. The schooling gap is thus higher than one in all regions. It is particularly strong in poor countries where the propensity to move of skilled workers is 10 to 20 times larger than the low - skilled. At the world level, the schooling gap is much stronger for women. This regularity is observed in all developing regions. The difference between women and men is very large in the least developed regions of the world. Figure 4 provides a scatterplot of the world countries. The unweighted (one country-one vote) schooling gap of women is twice as large as for men. Since the range of variation of the schooling gap is very large (for women it goes from

1.11 for Canada and other high income countries to about 180 for Mozambique and other developing countries), we use a representation in logs. On average, the log of females' schooling gap is equal to 1.19 times the log of males' schooling gap.

Table 2. Rates of emigration and skilled emigration in 2000

	Skilled emigr. rates		Average emigr. rates		Schooling gap	
	Women	Men	Women	Men	Women	Men
World	6.0%	5.0%	1.8%	1.8%	3.3	2.8
Income groups						
High-income	4.0%	3.7%	3.0%	2.8%	1.3	1.3
Developing countries	8.9%	6.3%	1.4%	1.5%	6.1	4.2
Upper-middle-income	6.5%	5.9%	3.2%	3.8%	2.0	1.6
Lower-middle-income	10.7%	6.5%	1.3%	1.2%	8.0	5.2
Low-income	10.2%	6.3%	0.7%	0.7%	15.1	8.6
Least developed countries	17.1%	10.3%	0.9%	1.0%	19.5	10.3
Groups of interest						
OECD	4.2%	4.0%	3.6%	3.7%	1.2	1.1
EU27	9.1%	8.9%	4.8%	4.8%	1.9	1.8
North America	0.9%	0.9%	0.8%	0.7%	1.2	1.2
Small island dev. states	47.8%	37.3%	14.9%	12.8%	3.2	2.9
Large Countries ($\succ$75M)	3.5%	2.7%	0.9%	0.9%	3.9	3.2
Landlocked countries	6.7%	5.5%	0.9%	1.0%	7.3	5.4
Islamic Countries	8.9%	6.6%	1.4%	1.8%	6.1	3.7
Selected regions						
Sub-Saharan Africa	16.4%	10.4%	0.8%	1.0%	20.0	10.7
MENA	9.7%	8.7%	2.3%	3.0%	4.2	2.9
Caribbean	47.9%	38.0%	16.6%	14.3%	2.9	2.7
Central America	19.0%	15.6%	10.6%	13.0%	1.8	1.2
South America	5.5%	4.8%	1.7%	1.6%	3.2	3.1
Central Asia	1.2%	0.7%	0.3%	0.3%	3.5	2.3
East Asia	6.0%	3.1%	0.5%	0.4%	11.8	7.6
South-Eastern Asia	11.4%	8.5%	1.9%	1.5%	6.0	5.6
Eastern europe	4.9%	4.0%	2.2%	2.1%	2.3	1.9
Pacific Islands	63.1%	44.6%	7.7%	6.7%	8.2	6.6

Source: Docquier, Lowell and Marfouk (2007)

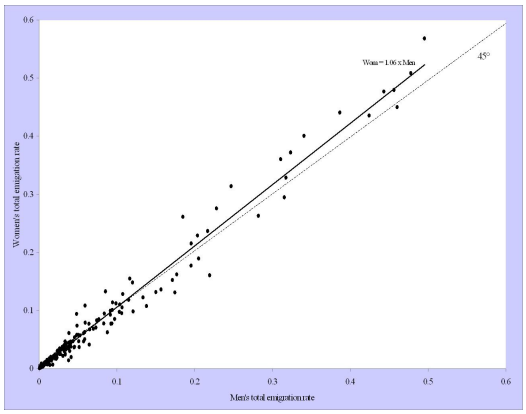

Figure 3: Average emigration rates by gender

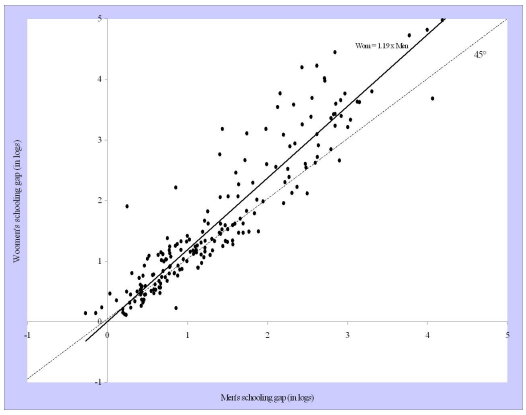

Figure 4: Schooling gaps by gender

In sum, if women exhibit stronger brain drain rates than men, it is because they are much more positively selected and exhibit much higher schooling gaps. How can we explain this difference in schooling gaps?

Docquier, Lohest and Marfouk (2007) empirically analyze the determinants of openness and the schooling gap. The degree of openness is found to increase with country smallness, natives' human capital, political instability, colonial links, and geographic proximity to major OECD countries. The schooling gap depends on natives' human capital, the type of destination countries (with or without selective-immigration programs), distances, and religious fractionalization in the country of origin. Geographic proximity and natives' human capital have ambiguous effects on the brain drain (they increases openness and reduce the schooling gap). On the whole, the brain drain is stronger in countries that are not too distant from OECD countries and where the average level of schooling of natives is low. The same regularities are observed for both men and women.

Most of these factors are not gender-specific. The exception is the level of schooling of natives. In Docquier, Lohest and Marfouk (2007), the schooling gap is shown to be negatively correlated with natives' human capital (with a correlation of -90 percent). Hence, if women are less educated than men, we can expect that they will suffer from a higher schooling gap. This is confirmed on Figure 5 which clearly shows that the gender gap in the brain drain (vertical axis) is strongly and negatively correlated with the gender gap in educational attainment of residents (horizontal axis). A simple regression of the log of the female/male ratio in skilled emigration rates on the log of the female/male ratio in post-secondary educated adult population gives an elasticity of -50 percent ($R^2 = .46$) and an intercept which is positive but small. Equating men and women's educational attainment is likely to strongly reduce the gender gap in skilled migration.

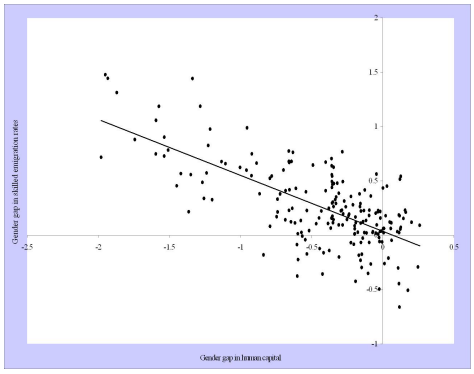

Figure 5: Gender gap in human capital and brain drain

3 Empirical analysis

The stylized facts above show that women exhibit higher brain drain than men. An important part of the gender gap can be explained by the unequal access to education at origin. But obviously, it is also likely that women respond to push and pull factor with different intensities. A rigorous empirical analysis is required to detect the existence and assess the determinants of the gender gap in skilled migration. Our empirical strategy is the following:

- First, we use standard empirical analysis (two independent cross sections for males and females and a pooled regression with a gender specific dummy variable) to characterize the determinants of the brain drain of men and women. Two types of explanatory variables are introduced: country-specific characteristics and gender-specific characteristics (including gendered levels of schooling).
- Second, we revisit the determinants of the brain drain in a more sophisticated model with interdependencies between males and females' decisions. It is highly plausible that women and men's decisions are closely connected, given the importance of family reunion programs at destinations and the endogeneity of migration costs. This induces chain migration movements. Our analysis relies on the reasonable assumption of an assortative matching between skilled men and women. Hence, when skilled men (resp. skilled women) migrate, they sponsor or inspire skilled women (resp. skilled men) to move with them (Celikaksoy, A., S.H. Nielsen, and M. Verner, (2006))

Let us now describe the results obtained with these two approaches.

3.1 Standard model

The standard approach consists of a pooled cross section for year 2000[5] where the brain drain is regressed over a gender specific dummy variable and two distinct sets of explanatories:

$$\log\left(\frac{m^i_{2000,g,h}}{1-m^i_{2000,g,h}}\right) = \alpha_0 + \delta_0 female + \sum_z \beta_z Z_z + \sum_x \alpha_x X_x + \epsilon^i_{2000,h} \qquad (4)$$

[5]Although the DLM database contains two years (1990 and 2000), the temporal information, meaning the within variability is null. This is why we just work with a cross section for the most recent year.

The dependent variable is the logistic transformation of the skilled migration rate by gender in (2). The logistic transformation allows to expand the range of the dependent variable from $(0, 1)$ to $(-\infty, +\infty)$. Note that $\frac{m}{1-m}$ is commonly known as odds ratio, or 'favourable probability'. Our estimates can be estimated as the semi-elasticity (or elasticity just in case the regressor is also expressed in log) of the odds ratio to explanatory variables[6]. On the right hand side of the model, there is a dummy variable for females (having chosen males as base group), and two sets of controls, named Z_z and X_x.

The former set contains three gender-specific control variables referring respectively to the level of human capital at origin, the gender composition of the native population and the initial labor market conditions. The first two variables have been calculated from the DLM dataset and correspond respectively to the ratio of skilled natives by gender at origin over total natives by gender (gendered human capital), and to the ratio of the total natives by gender over total natives (gendered population shares). The third indicator, the employment to population ratio at origin, has been collected from the International Labour Office (ILO)' KILM 5th edition database and represents the ratio of the employed people by gender over the total population by gender (gendered employment rate)[7].

Beside that, the X_x set contains some of the standard potential time-invariant determinants of international labor mobility. The first group, describing the country size at origin, encounters the log of the native population and a dummy for a country being a small island. Population is the average of the annual number of people residing in the home country during 1985-2000 and the total number of working-age emigrants living in an OECD country in 2000. Data on population size are from the World Bank (2005) and data on emigrants are from the DLM dataset. Although emigrants are likely to exhibit a different mortality and fertility patterns than natives, using the native population rather than resident population minimizes the risk of endogeneity. On the other hand, the small island developing economies dummy variable is based on the 2000 United

[6]In other terms the interpretation of the estimated coefficients have to be as follows: $\%\Delta Y = (100\beta_i)\Delta x$ for semi - elasticities and $\%\Delta Y = \beta_i \%\Delta x$ for elasticities. Where Y equals the odds in both cases.

[7]The employment-to-population ratio is defined by the ILO as the proportion of a country's working-age population that is employed. A high ratio means that a large proportion of a country's population is employed, while a low ratio means that a large share of the population is not involved directly in market-related activities, because they are either unemployed or (more likely) out of the labour force altogether. The employment-to-population ratio provides information on the ability of an economy to create employment, but the type of employment that is created, meaning high, medium or low skilled, cannot be identified. This is why although a high overall ratio is typically considered as positive, the indicator alone is not sufficient for assessing the level of decent work or the level of a decent work deficit. In fact, the ratio could be high for reasons that are not necessarily positive - for example, where education options are limited so that young people take up any work available rather than staying in school to build their human capital.

Nations classification. The second group accounts for geographic and cultural proximity between the countries of origin and the OECD area. The log of the distance between the departure point and the OECD area, a linguistic variable (English speaking), plus two dummies, one for a country being landlocked and one for being an ex-colony of an OECD member[8]. Except for the first dummy variable that comes from the 2000 United Nations classification, the others are taken from a study of the Centre d'ètudes prospectives et d'informations internationales-CEPII (see Clair et al., 2004). Finally, the third group, capturing the sociopolitical environment at origin, contains the political instability and the percentage of Christians at origin. The first indicator is from Kaufmann, Kraay, and Mastruzzi (2003) and measures the perception of the likelihood that the government in power will be destabilized or overthrown by uncostitutional or violent means, including domestic violence and terrorism. The second indicator, instead, has been computed by ourselves from Alesina et al. (2003), discriminating among the percentage of Christians, Muslims and other religions over the total population at origin[9]. In this kind of analysis, GDP per capita is usually used as an additional explanatory variable accounting for the level of development of the sending country. Because of strong collinearity with the level of human capital (the correlation between the two is 0,69 for males and 0,71 for females) we had to drop it.

Table 3 presents the estimation results of Eq (4). There are two sets of results. One pertains to the whole sample and the other concerns only developing countries. The results are quite similar in the 2 sets. The overall quality of fit is good (adjusted-R^2 between 61% and 64%) especially for cross-section regressions. The control variables have, in general, significant coefficients with the expected sign. One exception is the employment to population ratio. One expects a negative sign, instead of a positive and significant one, meaning that the higher the employment rate the lower the incentive to migrate. One possible reason may be the mismatch between offered and demanded jobs by skill. The type of available jobs is not 'good' enough to satisfy highly skilled people expectations. For this reason they may decide to leave the country. This seems consistent with the correlation between the level of human capital and the employment to population ratio which we computed and found negative (either for females and males). But also with the liquidity constraints story that can affect the decision to migrate from the beginning. In other words, a migrant with a job could better afford migration costs. The coefficient of human capital is negative and significant. A high level of human capital at origin is associated with lower positive selection of emigrants (i.e. lower schooling gaps). Other things being equal, the geographical characteristics of the origin country

[8]We can interpret this dummy as a proxy of cultural proximity as well as the distance between the educational system at origin and that at destination (i.e. human capital transferability).

[9]The rationale of including a religious variable accounting for the number of Christians at origin was to see if some peculiarities were in place with respect to females' migration in Muslim countries.

significantly affect skilled migration. Countries that are either landlocked, large or distant from the OECD (a major receiver of skilled migration) witness less skilled migration. The 'cultural' characteristics of the origin country are also significant determinants of skilled migration. Former OECD colonies, English speaking or Christian countries send more skilled migrants than other countries. Political instability pushes skilled workers to settle abroad. Our main interest is on the comparison of males and females' skilled migration. The coefficient of the variable 'female' is significant and positive implying that, other determinants held constant, skilled females are more migratory than skilled males. Contrary to expectations and what Figure 5 suggests, equating men and women's educational attainment is not sufficient to eliminate the gender gap in skilled migration.

Table 3: Pooled regressions

	Full sample		Developing	
Female dummy	0.513	***	0,796	***
	(0,018)		(0,223)	
Gendered human capital	-5.29	***	-3,864	***
	(0,631)		(1,048)	
Gendered population share	-1.42		-2,225	
	(2,174)		(2,877)	
Gendered employement rate	0.011	**	0,017	***
	(0,004)		(0,005)	
Landlocked (dummy)	-0.519	***	0,467	***
	(0,169)		(0,168)	
Small island (dummy)	1.521	***	1,620	***
	(0,265)		(0,302)	
Population (in logs)	-0.205	***	-1,69	***
	(0,034)		(0,043)	
Political instability	0.023	***	0,021	***
	(0,008)		(0,007)	
Percentage of christians	0.648	***	0,576	***
	(0,164)		(0,204)	
Former colony of OECD	0.614	***	0,773	***
	(0,165)		(0,211)	
Distance to OECD (in logs)	-0.275	***	-0,406	***
	(0,043)		(0,064)	
English speaking	0.967	***	1,030	***
	(0,139)		(0,170)	
Constant	2.414	*	2,559	*
	(1,186)		(1,581)	
Obs	356		286	
$F_{(12,343-273)}$	43.45		41,94	
$Prob > F$	0		0	
R-squared	0.61		0.64	

Notes: * Significant at 10% level;** 5% level;*** 1% level

Robust standard errors in parenthesis

Beside this standard kind of analysis, for robustness reasons, we also perform a conterfactual exercise that is widely used in the labor economics literature to study the gender wage discrimination. It consists of three steps. First of all, a separate cross section estimation of the following type[10] is performed:

$$\log\left(\frac{m^i_{2000,g,h}}{1-m^i_{2000,g,h}}\right) = \alpha_{0,g} + \sum_x \alpha_{x,g} X_x + \sum_z \beta_{z,g} Z_{z,g} + \epsilon^i_{2000,g,h} \tag{5}$$

Then, the estimated coefficients for males are plugged into a symmetrical equation for females in order to generate a predicted distribution for females ('*females as if they were males'*, denoted as $(\hat{m}_{2000,f,h})$. Finally, the comparison between $\hat{m}_{2000,f,h}$ and the actual one, $m_{2000,f,h}$, is performed (Figure 6). If some kind of gender gap were in place, we should observe a statistically significant difference between the two distributions in the second one.

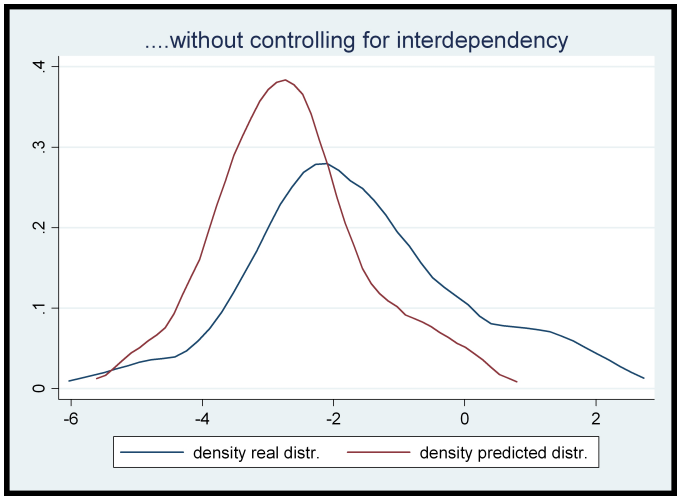

Figure 6: Graph of the distributions'comparison

Consistently with the above results, the outcomes of both a two-sided ($H_0 : \hat{m}_{2000,f,h} = m_{2000,f,h}$) and a one-sided ($H_0 : \hat{m}_{2000,f,h} \leq m_{2000,f,h}$) tests show a significant (at 1%) underestimation of the predicted distribution with respect to the real one. In other terms, the presence of a females' biased gender gap is confirmed. The technique, used to determine whether the two distribution functions associated with the two populations ('*females as if they were males*' and '*actual females*') are identical or not and then whether

[10]Obviously, the right hand side is identical to that in the pooled regression except for the gender specific dummy variable.

there is an under or over estimation between the two, is the Kolmogorov-Smirnov' equality of distributions test. While other tests, such as the median test, the Mann-Whitney test, or the parametric t test, might have also been appropriate, they would have been sensitive to differences between the two means or medians, but not to differences of other types, such as those in variances. On the other hand, the Kolmogorov-Smirnov's is consistent against all types of differences that may exist between the two distribution functions.

3.2 Model with interdependencies

The results of the first approach confirm that skilled females are more migratory than skilled males. A similar conclusion is reached by Dumont et al. (2007) who use a similar approach without accounting for gender-specific characteristics, $Z_{z,g}$. Although Ravenstein (1885) and others demonstrated that women are more migratory on shorter distances, it is commonly accepted that women migrate less internationally. According to UNESCO (2008) there is indeed a male-biased distribution in tertiary education that should bring females' skilled migration to be less widespread. Moreover, there is general agreement regarding the fact that females embed some peculiar inborn characteristics (such as need of protection, family attachment, involvement in domestic life, etc.) that could make them be less mobile than men internationally.

We are wondering whether the result obtained from the standard model fully describes what happens in reality or whether it is due to a mispecification or omitted variable bias. From an econometric viewpoint, this means that, if this were the case, meaning if an important determinant of females' migration (as well as the males'one) had been neglected, previous analysis would suffer from an omitted variable problem that would lead all the standard results to be biased. For example, family reunification policies play a very important role on the relative weight of females' migration with respect to the males' one. Our new empirical exercise model tackles this issue accounting for the presence of some reunification effects between husbands and wives that generate interdependency between the two migration decisions. Obviously, these family links work in both ways. Although family reunion programs admit many women in destination countries, women cannot be considered as passive companion migrants. For example, in the fiscal year 2004, 47.3 percent of all female immigrants legally admitted into the United States entered the country through the immediate-relative category of the family-based immigration system, compared to 37.6 percent for men. The same year, 26.8 percent of women who received employment-based visas were principal visa holders and 34.7% percent of men who received employment-based visas were dependents (see Pearce, 2006).

Consequently, the most suitable specification is a structural model of symultaneous equa-

tions as the one that follows where males' brain drain depends on females' one and viceversa:

$$\widetilde{M}^i_{2000,m,h} = \alpha_{0,m} + \sum_x \alpha_{x,m} X_x + \sum_z \beta_{z,m} Z_{z,m} + \gamma_m \widetilde{M}^i_{2000,f,h} + \phi_m E_f + \epsilon^i_{2000,m,h} \quad (6)$$

$$\widetilde{M}^i_{2000,f,h} = \alpha_{0,f} + \sum_x \alpha_{x,f} X_x + \sum_z \beta_{z,f} Z_{z,f} + \gamma_f \widetilde{M}^i_{2000,m,h} + \phi_f E_m + \epsilon^i_{2000,f,h} \quad (7)$$

The left hand side of the equations captures the stock[11] of brain drain by gender. These stocks $M^i_{2000,g,h}$ are divided by the total native population at origin in order to control for the size effect, and then the logistic transformation of the ratio is computed to be consistent with the specification we have used in the previous exercise (tilda stands for the logistic transformation of emigration-to-population ratios). The right hand side of the equations is exactly identical to that in the counterfactual cross sectional model, except for three issues. Two technical changes first. The gender composition variables (S_g) were dropped since their sum is equal to one. And for identification reasons both (for females and for males)the employment to population ratio have been plugged into each equation. But the most important change is due to the introduction of the stock of females at destination into the males equation and *viceversa*. An endogeneity issue naturally arises from a system like this and regards the $\widetilde{M}^i_{2000,m,h}$ and the $\widetilde{M}^i_{2000,f,h}$ variables. The most difficult task of this level of the analysis has been finding two proper instruments (one for each endogenous variable) that at the same time were relevant (i.e. highly correlated with $\widetilde{M}^i_{2000,f,h}$ and $\widetilde{M}^i_{2000,m,h}$ respectively) and exogenous (i.e. uncorrelated with the respective error terms, $\epsilon^i_{2000,m,h}$ and $\epsilon^i_{2000,f,h}$). As far as the females'equation is concerned, we instrumented $\widetilde{M}^i_{2000,m,h}$ using the mean value (between 1980-2000) of the male population aged 15-29 over the total population. The data come from the UNDP Development Indicators 2000 and represents the young males' incidence rate over the total male population. The relevance of the instrument is quite straighforward, meaning the more males between 15 and 29 years old the higher the migration rate of males aged 25 +. On the other hand, as far as males' equation is concerned, we instrumented $\widetilde{M}^i_{2000,f,h}$ using the contraceptive prevalence rate for females between 1995 and 2003. The data are from the World Bank and represent the use of contraception between 1995 and 2003 by married women aged 15 - 49. In this case, the relevance is a bit more obscure and requires some further explanation. The use of contraceptives can be seen

[11]The reason why we deal with stocks and no more with rate consists of the fact that we want to capture the 'one to one' relationship between males an females, as the reunification effect between an husband with his wife for example.

as a sort of 'women's empowerment' that allows women to choose by themselves without any constraints. A significant non-economic literature examines the relationship between international migration and the empowerment of women but the direction of the causality is still an open issue (Hugo, 2000) since it can hinge on many factors: the context in which the migration occurs, the type of movement, the characteristics of the female migrants, and last but not least on the definition of empowerment used. Using that given by the World Bank (2002) that defines empowerment as 'the expansion of assets and capabilities of poor people to participate in, negotiate with, influence, control, and hold accountable institutions that affect their lives' and complementing it with its other recent viewpoint (WB 2008) on women's reproductive health[12], we have just to check if from an econometric point of view the two variables are significantly correlated and if the direction of the correlation is that we had in mind. Consistently with our initial presumption, a positive and statistically significant relationship arises in the first stage regression between the females' brain drain and such 'empowerment instrument'[13]. All the following tests confirm the robustness of our instrumentation analysis:

[12]The World Bank reckons how prioritizing women's reproductive health helps countries meet many of the Millenium Development Goals. 'Keeping mothers alive is good for women, their families, and society. Reproductive health care can enhance poor people' s overall health care and help families to escape the poverty impact of having many children. When financial resources are divided among fewer family members, more is left for education, health care, and savings, decreasing vulnerability and insecurity' (UN Millenium Project 2005).

[13]It can be argued that the above correlation (between the migration of skilled females and the contraceptive prevalence rate) is spurious, maybe due to the level of development of the country of origin. If this were the case, our instrument would not be exogenous anymore since the level of GDP is also correlated with the migration of skilled males. In order to check for the presence of a possible spurious correlation we have performed two additional IV estimations. In the first one, we have included among the other regressors a dummy variable for developing countries and the validity tests in Table 4 do not change significantly. In the second one, we have plugged the level of GDP per capita at origin, but the results are exactly the same. This means that conditional on the level of development of a country (that we also control for through the level of gender specific human capital), the migration of skilled females and the contraceptive prevalence rate are significantly positively correlated.

Table 4. Key tests from the IV instrumentation

	Fem (1)	Fem (2)	Mal (1)	Mal (2)
First Stage F-stat :	26.38	10.37	25.45	19.45
(1-162/168) (1-127/131)	(0.00)	(0.0016)	(0.00)	(0.00)
Cragg-Donald F stat (weak id. test):	20.463	8.058	29.151	20.44
Stock-Yogo weak ID test crit value				
10% maximal	16.38	16.38	16.38	16.38
15% maximal	8.96	8.96	8.96	8.96
20% maximal	6.66	6.66	6.66	6.66
25% maximal	5.53	5.53	5.53	5.53
Endogeneity test of	13.187	5.993	11.486	10.283
Regressors tested:Lmig_M/Lmig_F	(0.0003)	(0.013)	(0.0007)	(0.0013)

Notes: P-value in parenthesis

(1) for full sample; (2) for restricted sample

Table 4 provides the results of the first stage. First of all, the Hausman test rejects at 1% the lack of endogeneity, either in the full and in the restricted sample. Then, as far as the relevance of the instruments is concerned, both the results of the first stage F-stat. and that of the Cragg-Donald F-stat. are consistent with each other. All the above first stage F-stat. are indeed higher than the commonly recognised threshold of 10 and the Stock and Yogo weak identification test passes, too.[14].

Tables 5 and 6 present the results for males and females respectively. Both OLS and IV estimation results are provided. The latter will be then the starting point for the final step of our analysis, meaning the counterfactual exercise (as the one we performed for the standard model) from the correctly identified model. Focusing on the IV results, the overall quality of fit appears very good (the adjusted-R^2 equals 95%). Regarding the males' equation (Table 5), almost all the coefficients are significant and have a sign similar to the one in Table 3, confirming what previous studies agree upon. With respect to the equation estimated in the standard analysis,there are two new explanatory variables: the migration of skilled females and the employment to population ratio for females at origin. Let us just comment on them. The former, meaning the migration of skilled females,

[14]The only critical value is that concerning the male incidence on the total population' instrument when we restrict the sample just to developing countries. The first stage F-stat. is at the border (equal to 10.37) and reasonably the Stock and Yogo weak identification test does not overcome the critical threshold at less than 20%. We could not find another instrument that worked better than this in the restricted sample. The list of the other instruments we dealt with as well as the respective instrumentation results are available on request.

captures the matching effect between males and females migrants and, as expected, it is positive and significant at 1%. So, other factors being equal, the more skilled females are located outside their country of origin, the more skilled male will be. Instead, the latter regressor, i.e. the employment to population ratio for females at origin, is negative and significant, suggesting some interaction between the male migration and the labor market conditions of the opposite gender. [15].

Beside that, the results for the females' equation are completely new and surprising at a first glance[16]. Compared to Table 3 or 5, some variables become insignificant even at the 10% level. These are political instability, landlock and religious dummies. More importantly, among the variables which have remained significant, most of them (except for the female's employment rate) exhibit an opposite sign with respect to the standard analysis where the matching process is not taken into account[17]. These regressors are the level of human capital for females, the population at origin, and the distance to OECD and the former colony variables. Regarding the level of human capital for females, the positive and significant sign may reflect some kind of gender discrimination (we are not able to control for), related to the access to the labor market in the country of origin. Everything being equal, females would tend to migrate more because even with a high skilled qualification they may have difficulties to find an adequate job. So in the end this

[15]The employment to population ratio for females at origin has just been added for a better model specification that accounts for the fact that none of the gender specific regressors could have been used as exclusion restrictions because of strong correlation with the symmetric regressand (see Wooldridge, J.M., (2002), 'Econometric Analysis of Cross Section and Panel Data', The MIT Press, Cambridge (Mass.), Ch.9). The other estimation results do not change if we drop it.

[16]Since our work is the first attempt to go through skilled female migration, there is no reason to expect the coefficients to have specific signs. But we are aware of the fact that a more detailed and advanced analysis have be pursued in order to confirm them. This leaves room for future work in which bilateral data are going to be used so to exploit at 100% the role of the geographical regressors and other country's fixed effects.

[17]Form a qualitative point of view, this is in line with Massey (1993). He assesses that whatever effects each traditional covariate has in promoting or inhibiting migration, they can be progressively overshadowed by the falling costs and risks of movement stemming from the growth of migrant network at destination over time. From a econometric viewpoint, instead, it could be argued that the results concerning females'migration are driven by the weakness that the instrument we use for instrumenting males'migration exhibits in the restricted sample - see Table 4, column 3. However, consistently with our instrumentation choice, we have to say that all the other instruments we managed provide the same outcomes. In particular, the more relevant the instruments, meaning the higher the First Stage F-stat and the other statistics, the higher the significance of the regressors of interest. In addition to that, the estimation of an overidentified system, in which a different set of instruments has been used, confirm the same results. The new sets of instruments are the following: the contraceptive prevalence rate plus the presence of poligamy at origin for instrumenting female brain drain; and the male incidence rate over total population plus the pre-enrollment of male children for instrumenting male brain drain. The Hansen test passes in the both cases. Estimation results are avilable on request.

hidden discrimination would lead to some kind of positive selection that characterizes skilled female migration. Secondly, the positive sign of the coefficient of the distance to the OECD may reflect, especially for migrants originating from the South, the relatively lower discrimination in furthest OECD countries as compared to closer ones. So, women would have to go further in order to reduce the risk of discrimination. It is widely admitted that women are relatively less discriminated in Northern European countries than in Southern ones. This holds if we compare Mexico and Canada for instance, both are members of the OECD but their geographical location is different. Finally, as far the English linguistic variable and the ex colony dummies are concerned, the discrimination argument is still in place. Irrespectively of migration costs (due to cultural proximity), skilled women would prefer to migrate where the return to schooling are higher (think about the Pakistan female migrants in the UK for example). Then, regarding the first new explanatory variable, skilled males'migration, the coefficient is positive and significant. As in the males' equation, skilled females tend to migrate more, the more their skilled co-citizen men are located outside the country. Moreover, the coefficient in Table 6 is significantly higher (almost twice) than the corresponding coefficient in Table 5. This suggests that within what we have named as assortative matching between males and females, there is a stronger effect of the former on females. In other words, women would be more willing to follow their spouse than the other way round. Finally, for the second new explanatory variable, meaning the employment rate of males, the same technical explanation we have provided for females holds.

Table 5: IV regression for males

Dependent variable = Stock of male skilled emigrants (in logs)

	OLS		**IV**	
Males' human capital	-2.764	***	-1.014	
	(0.62)		(0.732)	
Males' employment rate	0.008	***	0.007	**
	(0.002)		(0.003)	
Population (in logs)	-0.033	**	-0.073	***
	(0.013)		(0.019)	
English speaking	0.031		0.152	**
	(0.046)		(0.063)	
Distance to OECD (in logs)	-0.103	***	-0.124	***
	(0.017)		(0.020)	
Former colony of OECD	0.216	***	0.251	***
	(0.054)		(0.067)	
Political Instability	0.003		0.005	*
	(0.002)		(0.003)	
Landlocked (dummy)	-0.035		-0.198	**
	(0.056)		(0.095)	
Percentage of christians	-0.225	***	-0.067	
	(0.061)		(0.093)	
Female skilled emig.(in logs)	0.886	***	0.737	***
	(0.018)		(0.051)	
Females' employment rate	-0.006	***	-0.006	***
	(0.001)		(0.001)	
Females' human capital				
Constant	0.546	*	0.361	
	(0.305)		(0.328)	
Obs	180		180	
F-stat/chi2	(11-168)		(11-168)	
	529.94		281.94	
R-squared	0.96		0.95	

Notes:* Significant at the 10% level; ** 5% level; *** 1% level.
Robust standard errors in par.

Table 6: IV regression for females

Dependent variable = Stock of female skilled emigrants (in logs)

	OLS		**IV**	
Females' human capital	4.059	***	2.422	***
	(0.879)		(0.88)	
Females' employment rate	0.005	***	0.008	***
	(0.0014)		(0.0024)	
Population (in logs)	0.017		0.070	***
	(0.013)		(0.0268)	
English speaking	0.007		-0.145	*
	(0.048)		(0.077)	
Distance to OECD (logs)	0.088	***	0.143	***
	(0.018)		(0.032)	
Former colony of OECD	-0.203	***	-0.307	***
	(0.059)		(0.08)	
Political instability	-0.003		-0.006	
	(0.0026)		(0.0034)	
Landlocked (dummy)	-0.029		0.179	
	(0.057)		(0.111)	
Percentage of christians	0.258	***	0.122	
	(0.065)		(0.0944)	
Male skilled emig. (in logs)	1.036	***	1.261	***
	(0.022)		(0.079)	
Males' employment rate	-0.007	***	-0.008	*
	(0.002)		(0.003)	
Males' human capital				
Constant	-0.712	*	-0.514	
	(0.37)		(0.381)	
Obs	180		174	
F-stat/chi2	(11-168)		(11-162)	
	593.69		243.4	
R-squared	0.97		0.95	

Notes:* Significant at the 10% level; ** 5% level; *** 1% level.
Robust standard errors in par.

Finally, as we have done in the first part of our work, we predict the female migrants' distribution from the males'one. Our aim is to see if, controlling for interdependency between males and females, the female biased gender gap is still in place. The simple comparison between the predicted and the real distribution suggests that there is an overestimation of the mean but an underestimation of the variance (Figure 7). In order to capture them jointly, we perform again the Kolmogorov-Smirnov equality of distributions test. In this case, the two - sided hypothesis of equality of distributions is not rejected at 5% suggesting that the difference between the two is not significant at all. The main conclusion we can draw from this last result is extremely important. We can indeed assess that after having controlled for interdipendency between males and females, the females' biased gender gap disappears.

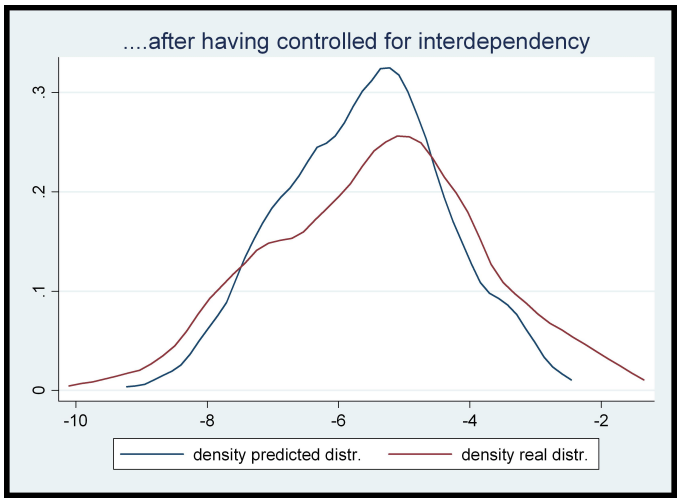

Figure 7: Distributions'comparison after the instrumentation

4 Conclusion

In this paper we have empirically addressed the following question: are skilled women qualitatively and quantitatively different from skilled men with respect to international migration? To do so, we have built on a structural system of symultaneous equations able to control not only for some gender specific characteristics beside the standard determinants of international labor mobility but also for the interdependencies between women and men's decisions. We had indeed in mind some kind of assortative matching process between females and males that cannot be neglected. Our results suggest that women and men do not respond in the same way to the same push factors. First of all, women tend to follow men in a more intensive way than the other way round. This corresponds to what happens in the context of family reunion programs for example, where many more women are admitted abroad with respect to men. It also reflects the common presumption that associates females to some 'biological vulnerability', in the sense that women would benefit more than do men from travelling accompanied or from information about safe routes. But, complementary to this outcome, our analysis has also shown that females cannot be seen just as passive migrants. Indeed, being other factors equal, they seem to be more positevely selected than men. Finally, from a quantitative viewpoint, the hypothesis that skilled women are more migratory than skilled men is rejected by both traditional and a counterfactual exercise, excluding the presence of a genetic or social female biased gender gap in the brain drain.

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