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Institutionalized Inequality and Brain Drain: An Empirical Study of the Effects of Women's Rights on the Gender Gap in High-Skilled Migration

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ABSTRACT

Institutionalized Inequality and Brain Drain: An Empirical Study of the Effects of Women's Rights on the Gender Gap in High-Skilled Migration[1]

This paper investigates the effects of institutionalized gender inequality, proxied by a women's rights index, on the female high-skilled migration rates relative to that of male (the *female brain drain ratio*). By developing a model of migration choice I find non-linear effects of gender inequality on the female brain drain ratio as a result of effects of gender inequality on both costs and benefits of migration. At low levels of women's rights, increases in the index lead to increases in the female brain drain ratio. This is consistent with, at low levels of women's rights, prohibitively high costs of migration for females. Once a certain level of protections has been afforded to them, the costs to migration are low enough that many women then decide to leave the oppressive society and migrate where the benefits associated with their human capital are higher. However, as women's rights continue to strengthen, those benefits to migration then tend to decrease. The effect on female brain drain then turns negative. Using a panel of up to 195 countries I find evidence consistent with this model which is robust to instrumental variable approach. A one-point increase in the above average level of this index is associated with an average of about a 25-percentage point decrease in the female brain drain ratio.

JEL Classification: F22, J11, J61, J16, O17, O43

Keywords: high skilled female migration, women's rights, institutional quality

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1. **Introduction:**

Why are migration flows of high-skilled women from developing countries so high? Based on the dataset constructed by Docquier, Lowell, and Marfouk (2009), female migration rates are higher than male migration rates in 88 percent of non-OECD countries. Moreover, the difference is most pronounced in the case of high-skilled migration (*brain drain*). (See figure 1.) Female brain drain rates are, on average, 17 percent higher than those of men (Docquier et al., 2009). Based on this dataset, the ratio of female-to-male brain drain rates *(the female brain drain ratio)* is greater than unity in each of the five continents[2]. (See figure 2.)

(Figures 1, & 2 here)

What explains the relatively high rates of female brain drain in developing countries? Answering this question is of clear interest to students of development and policy-makers. Human capital losses are costly in general, but female brain drain may be particularly so. Higher educational attainment by females is associated with reduced fertility and infant mortality; also improved health and increased educational attainment for their children (Schultz (1988), Behrman and Deolalikar (1988), Haveman & Wolfe (1995), and Subbarao and Raney (1995)). Abu-Ghaida and Klasen (2004) estimate that the lost "social gains" from gender inequality in education amount to between 0.1 and 0.3 in income growth per capita[3]. Losing a large percentage of high educated women for these countries could be especially harmful.

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[2] Asia, Africa, America, Europe and Pacific are the five possible continents associated with each country. Pacific refers to Australia and Pacific island countries (Mayer and Zignago , 2006)..

3 Also, Knowles, Lorgelly, and Owen (2002) estimate a neoclassical growth model that explicitly includes both female and male human capital. Using cross-country data they find that

In this paper I show that levels of women's rights are a quantitatively important determinant of female brain drain. Based on an extension of the utility maximization model employed by Borjas (1987), Grogger and Hanson (2011), and Beine and Salomone (2011), theoretically I derive the effect of institutionalized gender inequality on the ratio of female to male migration rates (the *female brain drain ratio*). Gender inequality lowers the benefits that women receive for a given level of human capital in their origin countries. However, unlike Borjas (1987), Grogger and Hanson (2011), and Beine and Salomone (2011), I also assume that the costs of migration are increasing in institutionalized gender inequality. I use an index of women's rights levels to proxy for institutionalized gender inequality. At very low levels of women's rights, it is often prohibitively costly for females to migrate. They may face onerous legal restrictions or lack protection from males seeking to prevent their migration. This modeling of migration costs as a function of institutionalized gender inequality drives the nonlinear relationship between gender inequality and the female brain drain ratio and constitutes one novel contribution of this paper.

When institutionalized gender inequality affects both the relative benefits and costs to migration, the effect of gender inequality on female migration relative to that of males is likely to be non-linear. At initially low levels of women's rights, increases in rights can be associated with *increases* in female brain drain relative to that of males. Starting from higher levels of women's rights, the effect on the female brain drain ratio becomes negative.

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increases in female education positively affect labor productivity while the effect of male education is often statistically insignificant or even negative.

A nonlinear, "hump-shaped" relationship is plausible given the plot of female brain drain ratios (Docquier et al., 2009) against the women's rights index values published by the CIRI Human Rights Dataset (Cingranelli & Richards, 2010) in figure 3. The women's rights variable serves as a (inverse) proxy for gender inequality. More formally, in this paper I employ data on up to 195 origin countries for the years 1990 and 2000 to estimate the relationship between the female brain drain ratio and the CIRI women's rights index. The estimated relationship is nonlinear. Women's rights and its squared value are both statistically significant determinants. This result is robust to an instrumental variables identification strategy and the estimation of random effects. The per capita GDP, political characteristics (Polity variable), and civil liberties index of origin countries are the instrumental variables to overcome the possible endogenity of women's rights variable. Starting from very low levels of women's rights, increases in the index lead to increases in the female brain drain ratio. However, at higher levels of women's rights, increases in the index are associated with decreases in the female brain drain ratio. These latter effects are particularly large. Specifically, a one-point increase in the index is associated with about a 25-percentage point decrease in the female-to-male brain drain ratio.

The results are consistent with a world where, at very low levels of women's rights, women face prohibitively high costs to migration. However, once a certain level of protection has been afforded to them, the costs to migration are low enough that women may decide to migrate to countries where the returns to their human capital are higher and they enjoy more freedoms. But as women's rights continue to strengthen, those benefits to migration then tend to decrease. The marginal effect on female brain drain of increased women's rights then turns negative.

This paper proceeds as follows; section 2 contains a review of some relevant literature. The theoretical model of migration choice that motivates my empirical model is then found in section 3. Section 4 describes the data and the empirical framework that I employ using that data. Results of the empirical analysis are found in section 5. I conclude the paper in section 6 with some summary discussion.

2. Previous research on female brain drain

The gender aspect of brain drain has been relatively unexplored in the migration literature, mainly due to a lack of gender- and education-specific migration data. Dumont, Martin and Spielvogel (2007) provide the first data on gender-specific brain drain using OECD census databases for emigrants from 109 countries (25 OECD and 79 non-OECD). They show that high-skilled women are more likely to migrate than men in almost all continents but the gender gap in brain drain rates is the highest in the case of African countries while there is almost no gender gap in the brain drain rate of people migrating from Europe. Dumont et al. (2007) also find that high-skilled women respond differently to the traditional brain drain push factors such as GDP. However, they do not explain what might affect and determine these differences in migration behavior of women and men. They also find a statistically significant positive impact of female brain drain ratios on mortality rates, and a negative impact on female secondary school enrollment relative to male. They do not find similar harmful effects associated with the emigration of less-educated women. This emphasizes the negative impact of female brain drain on the health and education of children and motivates the importance of investigating the female brain drain.

Docquier et al. (2009) provide a more extensive dataset for education- and gender-specific migration from 174 origin countries in 1990 and from 195 countries in 2000. Using this

data, Docquier, Marfouk, Salomone, and Sekkat (2012) find that women respond differently than men to conventional "push" factors. For example, while male brain drain is negatively associated with an origin country's average human capital level, all else equal, the analogous relationship is positive in the case of women. Also, the distance from an origin country to the OECD area is negatively associated with male brain drain but positively associated with high-skilled female emigration. Relevant to the present research, Docquier et al. (2012) suggest that both of these anomalies may be related to gender inequality.

To the best of my knowledge, there are only two other papers that address the impact of gender inequality on female brain. First, Bang and Mitra (2010) attempt to proxy, separately, for "access to economic opportunities"[4] and "economic outcomes"[5]. Based on Docquier et al.'s (2009) data on emigration rates to the OECD they find that only "opportunities" are related to female brain drain and the estimated relationship is a negative one However, their "opportunity" variables include fertility rates and gender gaps in schooling and literacy. These variables might just as easily be interpreted as "outcomes". In the present paper I utilize the CIRI women's rights indices. These indices are directly based on the economic rights (e.g., the right to work without a husband's consent), political rights (e.g., the right to vote), and social rights (e.g., the right to initiate a divorce) that women have in a given country. These rights are institutional and more clearly interpreted in terms of opportunities open to women. Also, because Bang and Mitra do not motivate their empirics with a formal model of how gender inequality affects the costs and benefits of migration choices, they do not allow for the type of nonlinear effects that I report below.

[4] Literacy, enrolment, and fertility

[5] Labor force participation, income share, and parliamentary representation

Second, Baudassé and Baziller (2011) use a principal components analysis (PCA) to aggregate variables such as female-male income and education differentials and female labor market participation rates into indices of gender inequality. The data necessary for their PCA limits them to a relatively small sample from 51 countries.[6] Also, their underlying variables are, again, easily interpretable as outcomes rather than opportunities. Similar to this paper, they suggest that the theoretical sign of the effect of gender inequality on female brain drain is ambiguous. Gender inequality may be a push factor, increasing the benefits to migration; however, it may also create a selection bias against women at the household or village levels in collective decisions concerning who will get to migrate. However, empirically they find that reducing gender inequality is associated with increases in female migration rates, especially those of the high-skilled. One shortcoming of Baudassé and Baziller (2011) is that they do not allow for the sort of nonlinear relationship that logically follows from their discussion of push factor versus selection bias effects.

The results of this paper are one way to reconcile Bang and Mitra's (2011) and Baudassé and Baziller's (2011) contradictory findings. By theoretically deriving and estimating a non-linear relationship between women's rights and female brain drain, I claim that both pairs of authors are capturing part of the truth. Both the costs and the benefits of migration for females are a function of the rights that their home countries provide. Whether the negative effect of smaller migration benefits or the positive effect of lower migration costs dominates, depends on the level of women's rights that the country is starting from.

[6] Baudassé and Baziller also use numbers of migrants rather than migration *rates*. Even though they do control for population on the right-hand-side of their empirical specifications, not using a rate of the dependent variable is inconsistent with the bulk of existing studies.

None of these previous studies have explicitly explored the effect of variation in women's rights on female brain drain. This is an important lacuna in the literature that this paper aims to address. Gender inequality is, in general, harmful to a country's economic growth (Dollar & Gatti, 1999; Klasen, 2000). These results support the view that participation of women in the labor force is crucial for economic development. This general result is reinforced for the specific case of India by Esteve-Volart (2004) and for sub-Saharan Africa by Blackden, Canagarajah, Klasen, and Lawson (2006). If gender inequality is also associated with the flight of female human capital, this could another economically important channel through which gender inequality harms development.

Furthermore, if female brain drain reinforces gender inequality, then this may suggest that female brain drain is more nefarious than brain drain generally. While the negative effects of brain drain through human capital losses have been noted, others emphasize positive effects through remittances or return migration after accumulating additional human capital. However, Niimi, Özden, and Schiff (2008) show that remittances decrease as the percentage of the highly-educated increases in the migrants' population. Docquier and Rapoport (2008) investigate the claim that the prospect of migration helps the human capital formation in developing countries. They conclude that the countries starting with low levels of human capital and a low high-skilled migration rate gain the most formation of human capital from brain drain. Beine, Docquier, and Schiff (2008) find that smaller countries (1.5 million people or less) with high rates of brain drain are the definite losers of human capital.

Moreover, Mountford (1997) and Schaeffer (2005) argue that the potential for migration encourages human capital accumulation in the origin countries. The prospect of migration increases the return to human capital, and thus, in the long run induces more people to obtain

more education. Docquier (2006) argues that a small positive level of brain drain between five and ten percent can be beneficial for the origin countries. However, this may not be the case when brain drain is predominantly constituted by women.

3. Theoretical framework

The importance of gender has been long overlooked in the economic theory of migration. Pfeiffer, Richter, Fletcher, and Taylor (2007) review the literature and conclude that, given the dissimilar migration patterns of women and men, "[s]eparate modeling approaches allowing for variables that differently affect migration benefits and costs for the sexes may be needed" (p. 18). One contribution of this paper is to address precisely this concern in regards to women's rights in the neoclassical theory of international migration.

Neoclassical economic theory of migration assumes that individuals view the migration decision as a utility-maximization problem. Each individual makes her or his migration decision based on the expected net gains relative to no migration. Here, I follow the framework developed by Borjas (1987), Grogger and Hanson (2011), and Beine and Salomone (2011). A high-skilled individual of gender *g* (= *m* or = *f*), living in country *i*, faces a utility-maximizing problem to decide whether or not to migrate to country *j*. The expected utility function of an individual that lives in country *i* and chooses to remain there is:

$$u_{ii,g=\gamma(W_i+E_i-D_{i,g})+\ \epsilon_{ii,g}} \qquad (1)$$

The utility model follows a simple linear function of country-specific wages *W* and other country-specific characteristics *E*; γ is a strictly positive coefficient and $\epsilon_{ii,g}$ is the unobserved idiosyncratic term. Lastly, the term $D_{i,g}$ is a gender inequality component that is equal to zero

for $g = m$ and non-negative for $g = f$. Based on this assumption, a woman residing in a country with a $D_{i,g} > 0$ enjoys lower utility than of a man with the same wage. By assumption, there is no gender wage differential. However, the linear form of the utility function means that $D_{i,g}$ can be interpreted to, in part, include such a wage differential.

The expected utility function of an individual from *i* migrating to country *j* is:

$$u_{ij,g=\gamma(W_j+E_j-C_{ij,g})+v_{ij,g}} \quad (2)$$

$C_{ij,g}$ is the cost of migrating from country *i* to *j*. Since the empirical analysis below will examine migration flows to OECD countries, the gender inequality is normalized to zero for all OECD destination countries.

The costs associated with migrating to *j* include the monetary cost of moving[7], the opportunity cost of moving, the challenges of learning a new language, the psychological cost of moving and many other observable and unobservable factors. Beine and Salomone (2011) argue these costs can affect women and men differently. Here, I define the cost function for women to be a strictly increasing convex function of gender inequality:

$$C_{ij,f} = f\left(T_{ij,f}, D_{i,f}\right) \quad (3)$$

$$\frac{\partial C_{ij,f}}{\partial D_{i,f}} > 0 \quad (4)$$

7 Some examples for the monetary cost of moving includes: the cost of obtaining a passport, the cost of travel to the destination country and other monetary costs of adjusting to the new environment.

$$\frac{\partial^2 C_{ij,f}}{\partial D_{i,f}^2} > 0 \qquad (5)$$

$T_{ij,f}$ is the other factors (other than gender inequality) that affect migration costs for women which I assume they would be similar to those costs fort men. These costs could be proxied by cultural and geographical proximities between origin and destination countries. I assume that as the level of gender inequality increases, the cost of migration for women increases at an increasing rate[8], (5). This is plausible if, as gender inequality worsens (or women's right decrease) the barriers to migration accumulate from primarily cultural norms (e.g., discouragement from family and friends); to norms and legal restrictions (e.g., difficulties in obtaining a passport); and then eventually to the lack of basic protection from the threat of physical harm or death (e.g., a woman's husband can physically restrain her with impunity). On the margin, each of these barriers seems to present increasingly large costs. From this, the net gain from moving from country *i* to *j* would be:

$$NG_{ij,g} = \gamma(W_j - W_i) + \gamma(E_j - E_i) + \gamma D_{i,f} - \gamma(C_{ij,g}) + \tau_{ij,g} \quad (6)$$

Following the results from McFadden (1984) and assuming $W_{j,g} = e^{\mu_0 + \theta_{jg}}$[9], the log odds of migrating to *j* rather than staying in an origin country *i* are,

$$\ln \frac{M_{ij}^g}{M_i^g} = \gamma(W_j - W_i) + \gamma(E_j - E_i) - \gamma(C_{ij,g}) + \gamma D_{i,f} \qquad (7)$$

[8] Here, I assume that the net costs increase with lack of women's rights, though some individual costs may not.

[9] In $W_{j,g} = e^{\mu_0 + \theta_{jg}}$, μ_0 is the mean of wage and θ is the standard deviation.

where $\frac{M_{ij}^{g}}{M_{i}^{g}}$ is the proportion of population of gender group *g* that migrates from country *i* to country *j*. M_{i}^{g} is the population share of gender group *g* in country *i* that remains in *i*. By subtracting of the log odds of migration rates of men from women, we arrive at:

$$\ln\frac{M_{ij}^{f}}{M_{i}^{f}} - ln\frac{M_{ij}^{m}}{M_{i}^{m}} = -\gamma(C_{ij,f} - C_{ij,m}) + \gamma\left(D_{i,f}\right) \qquad (8)$$

The left hand side of the formula is the difference between the log of female and male high-skilled migration rates. This is equivalent to the log of the ratio of female migration rates to male migration rates. Based on the above formula this ratio which I will refer to as the female brain drain ratio is related to gender inequality in the origin country.

Differentiating (8) with respect to gender inequality:

$$\frac{\partial}{\partial D_{i,f}}(\ln\frac{M_{ij}^{f}}{M_{i}^{f}} - ln\frac{M_{ij}^{m}}{M_{i}^{m}}) = -\gamma(\frac{\partial C_{ij,f}}{\partial D_{i,f}}) + \gamma \quad (9)$$

In (9), γ is positive and based on (3), the right hand side of (9) is positive if $\frac{\partial C_{ij,f}}{\partial D_{i,f}} < 1$ and is negative if $\frac{\partial C_{ij,f}}{\partial D_{i,f}} > 1$. At low levels of gender inequality, $\frac{\partial C_{ij,f}}{\partial D_{i,f}}$ is relatively small. Alternatively, at high levels of gender inequality $\frac{\partial C_{ij,f}}{\partial D_{i,f}}$ will be a relatively large. As a result, at lower levels of gender inequality, the right hand side of (9) will be larger and, perhaps, positive. On the other hand, at higher levels of gender inequality, the right hand side of (9) will be smaller and more likely negative. Consistent with this nonlinear relationship is the scenario where, starting from low levels of gender inequality, a decrease in gender inequality is associated with increases in the female brain drain ratio; while at higher initial gender inequality levels the effect

is reversed. In other words, an increase in gender inequality increases the female brain drain ratio unless the gender inequality predominantly manifests as an increased cost of migration for women.

I use the index of women's rights as an inverse proxy for gender inequality against women in origin countries. Lower levels of support for women's rights correspond to higher levels of gender inequality and higher levels of women's rights correspond to lower levels of gender inequality. One scenario consistent with the model's predictions occurs where, starting from very low levels of women's rights, an increase in women's rights in an origin country increases the female brain drain ratio while becomes negative at higher levels of women's rights. The empirical findings confirm this result.

4. Data and empirical work

4.1 *Dependent Variable*

The dependent variable of interest is the natural log of female-to-male brain drain ratio. This variable is constructed from the dataset gathered by Docquier et al. (2009) based on census data from OECD countries in 1990 and 2000. This dataset excludes migration flows from south to south, which contains some of the large immigrant receiving countries such as South Africa, members of the Gulf Corporation council, and some East Asian countries including Hong Kong and Singapore. Because there is such a small number of educated migrants between these countries, they argue that their dataset covers 90 percent of the highly educated migration around the world.

Docquier et al. (2009) combine data from census and population surveys in OECD countries in 1990 and 2000. Their data covers 195 origin countries in 2000 and 174 origin countries in 1990. They focus on the population over the age of 25 in an attempt to exclude students from their data. Migrants are identified by their country of birth rather than their citizenship status. Migrants are categorized by level of education (low-, medium-, or high-skilled) and gender. In this data set high-skilled, medium-skilled, and low-skilled refers to individuals with at least post-secondary education or higher, completed upper-secondary, and less than upper-secondary education respectively. The data are aggregated from all OECD countries and used to calculate the stock of migrants in each category from each specific source country. Docquier et al. (2009) compute migration rates by finding the proportion of migrants from each source country compared with all nationals of the source country that hold the same level of education and the same gender.

Based on this the dependent variable "female brain drain ratio" is calculated as follows:

$$female\ brain\ drain\ ratio_{i,t} = \ln\left(\frac{female\ high-skilled\ migration\ rates_{i,t}}{male\ high-skilled\ migration\ rates_{i.t}}\right) \quad (10)$$

Where *i* stands for country of origin and *t* is the year that data is collected, 1990 or 2000.

4.2 Independent Variables

Women's rights: The Cingranelli-Richards (CIRI) Human Rights Database contains various annual human rights indexes developed primarily by using US State Department Country

Reports on Human Rights Practices[10]. The coders focus on the human rights practices of governments which are defined as human rights related actions of a government and all its agents rather than only focusing in government policies. In other words, in the evaluation of the US State Department Report for a country in a specific year the focus would be on actual government human rights practices rather than focusing on the referrals for human rights protection in a country's constitution.

CIRI publishes three indexes concerning the status of women: women's social rights, women's economic rights, and women's political rights. Each of these indexes varies from 0 to 3. A 0 value implies that women's rights are not recognized at all by law (high degrees of gender inequality against women are present both culturally and by law) and 3 if they are fully recognized and the government thoroughly enforces those laws (Cingranelli & Richards, 2010). For the intermediary values; a score of 1 implies that a government has very weak laws and little enforcement; a score of 2 implies that there are adequate laws but that enforcement is weak.

The women's economic rights index focuses on the right to get and choose a job without a husband or male relative's consent. It also includes the equality in hiring, pay, promotion, and job security in the workplace. Moreover, this index includes the freedom from sexual harassment at work, as well as the right to work at night, in dangerous conditions, and in the military and police force. Women's political rights include the right to vote and engage in

[10] Reports covering the years from 1993 to 1999 (issued from 1994 to 2000) can be found at: http://www.state.gov/www/global/human_rights/hrp_reports_mainhp.html
Reports covering the years 2000 to the present (released from 2001 on) can be found at: http://www.state.gov/g/drl/hr/c1470.htm

political activities such as running a political office, hold government positions, join political parties, and petition government officials. Women's social rights consider gender inequalities in inheritance, marriage, and divorce as well as the women's rights to travel, obtain education, and choose a residence. This index also takes into account a variety of other freedoms including genital mutilation and forced sterilization (Cingranelli & Richards, 2010). To calculate a comprehensive women's rights variable, I add the three different indexes from the CIRI dataset. I then add one to the resulting sum. This creates a comprehensive score that is on the interval of 1 to 10.

Unemployment rate: In the migration literature, the unemployment rate has been often referred to as a push factor in the developing countries. I use the origin countries' unemployment rates from World Bank (2012a) as a proxy to show the job market characteristics. A high level of unemployment is likely to provide an incentive to migrate especially in the case of the high-skilled individuals.

Number of conflicts: Residing in a country with high number of conflicts is likely to incentivize migration. The number of conflicts variable counts the conflicts in each specific country in which the government of the country is involved. (Gleditsch et al. 2002)

Internet users per 100 population: Higher number of internet users might be associated to higher probability to migrate due to higher exposure to information especially about other countries and possible job opportunities. The variable here counts the number of internet users per 100 people in each country. World Bank (2012b)

Geographic characteristics of origin countries: I use dummy variables for *landlocked* and *small island* countries from Mayer and Zignago (2011). Countries that are landlocked are

geographically isolated and have shown lower migration flows in general. Docquier, et al. (2012) use this variable as a proxy for geographically disadvantaged countries. Also, small islands have a much higher migration flows and have shown very different behavior in migration analysis. Docquier (2006) reports that the brain drain rates from the small islands are typically higher than from other countries.

Cost factors: Colonial relationships lower the costs of migration. To control for this, I follow Mayer and Zignago (2011) and construct two dummy variables. First, countries that have been a colony of OECD countries are more likely to have similar cultures, religions and/or institutions. Colonizer countries often have a similar system of education, a high cultural influence, and a historically higher stock of migrants from the colonized countries. Having a similar education system eases finding a job in the destination country due to the likelihood of acceptance of documentation and skill sets. Also, cultural similarities make the transition process easier for immigrants. A network of previous migrants from the home country in the destination country reduces the monetary and non-monetary costs of migration. A *colony dummy* takes the value of one for countries that have been a colony of an OECD country; zero otherwise. Second, if individuals already speak the languages that are commonly spoken in OECD countries, then cost to migrate is lower for similar reasons. A *language dummy* takes the value of one if 20 percent or more of the population in the origin country speak English or French (Mayer & Zignago, 2011). The summary statistics of all the variables are in table 1.

(Table 1 here)

4.3 Instrumental Variables

One concern in addressing social effects, such as women's rights in this paper, is the presence of unobservable effects. It is possible that unobservable social conditions and cultural institutions affect women's rights and the female brain drain ratio. The Hausman test for endogeneity of women's rights in my regressions can be rejected at the 10% but not at the 5% level. I use instrumental variables for women's rights and its square to overcome the potential for endogeneity. Instrumental variables should be first, highly correlated with the endogenous variable (women's rights); second, they should be uncorrelated with error term. In other words an ideal instrument should affect the dependent variable (here female brain drain ratio) only through the channel of women's rights. The instrumental variables here consist of GDP per capita, a polity variable and the civil liberties index. Fernandez (2009) finds a strong positive relationship between per capita wealth and women's rights in the United States. Focusing on a key economic right, property rights, she investigates the simultaneity of economic development and improvements of women's rights. She argues that lower fertility and capital accumulation affect the balance between men's two conflicting interests as husbands versus fathers, which finally lead men to favor greater rights for women. The empirical test on married women earning property rights in the U.S. states between 1850 and 1920 confirm the theoretical model. Following her results, I use the levels of GDP per capita as instrumental variable for women's rights. *Gross Domestic Product per Capita* data is obtained through the World Bank (2012c). While GDP is highly correlated with women's rights it affects women and men's migration rates in the same way. Consequently, one can expect that GDP affects female brain drain ratio only through women's rights channel.

Similarly, the political situations in a country can affect women's rights. Democratic countries have stronger institutions to protect women's rights. A country where individuals do

not have the freedom to speak for themselves is less likely to provide a desirable environment for women. *The origin countries' political factors (Polity)* variable is the proxy for the level of democracy in the origin country. It is the revised combined polity score which ranges from -10 to 10, with -10 referring to a strongly autocratic government and 10 referring to a strongly democratic government (Marshall & Jaggers, 2002). The third instrumental variable is the civil liberties index.

The countries who lack civil liberties are more often the ones that do not protect women's rights. *The civil liberties index* comes from the annual Freedom in the World report published by Freedom House (Freedom House, 2012). This index varies from one to seven. A score of one indicates the highest level of freedom, and a score of seven refers to the lowest. The Freedom House assigns the civil liberties score based on freedom of expression, assembly, association, education and religion. Table 2 shows the result of estimating women's rights with these three variables. The result shows that, all the coefficients are highly significant along with expected signs. As levels of per capita GDP and Democracy increase, women's rights increase. In contrast, as the index of civil liberties increases (less civil freedom), women's rights decrease.

(Table 2 here)

4.4 Econometric Model and Estimation Techniques

The empirical model is shown below,

$$Female\_Brain\_Drain\_Ratio_{i,t} = \alpha + \beta_1 \boldsymbol{w_{i,t}} + \beta_2 \boldsymbol{w^2_{i,t}} + \beta_3 \boldsymbol{x_{i,t}} + \beta_4 \boldsymbol{z_i} + \beta_5 \boldsymbol{g_i} + u_{i,t} \quad (11).$$

In (10), *i* refers to a migrant's origin country and *t* refers to the year (1990 or 2000). $\boldsymbol{w_{i,t}}$ is the women's rights variable. $\boldsymbol{x_{i,t}}$ is the vector of origin countries' economic characteristics, $\boldsymbol{z_i}$ is the cost factors and $\boldsymbol{g_i}$ are the geographical characteristics of the origin country.

The dependent variable (*Female Brain Drain Ratio*) is the natural logarithm of the female to male brain drain rates. The women's rights variable is a proxy for gender inequality and the variable of interest. Consistent with the predictions of the model in section 3 above, women's rights appear in the empirical model in both linear and quadratic terms. As discussed earlier, this allows for a possibly hump-shaped relationship between women's rights and female brain drain ratio.

I estimate (10) using panel data and both pooled OLS and OLS including the estimation of random effects. Using a fixed effects model here is problematic due to a large number of time invariant variables. Also, Hausman (1978) test supports using the random effect model. The Breusch-Pagan test rejects the null hypothesis of no group (i.e. country) random effects; therefore, random effects estimation is an appropriate method here to correct for serial correlation between the two observations of the same country (Breusch & Pagan, 1979). Subsequent to the OLS estimations, I address the potential endogeneity of women's rights with a generalized two stage-least squares estimation using the instrumental variables described in sub-section c above.

5. Effects of women's rights on female brain drain ratio:

Using a panel data pooled OLS and random effects model, I find statistically significant hump shaped effects for the women's rights variable and its square. The results of OLS and

random effects estimations are in Table 2. Starting from very low levels of women's rights index, increases in the index lead to increases in the female brain drain ratio. However, at higher levels of women's rights, increases in the index are associated with decreases in the female brain drain ratio. This non-linear relationship makes sense if, at very low levels of human rights, it is often prohibitively costly for females to migrate. They may face onerous legal restrictions or lack of protection from males seeking to prevent their leaving. Once a certain level of protections has been afforded to them, the costs to migration are low enough that many women then decide to leave the oppressive society and migrate where the benefits associated with their human capital are higher. However, as women's rights continue to strengthen, those benefits to migration then tend to decrease. The effect on female brain drain then turns negative.

The first Column of table 3 shows the results of OLS estimation. The unemployment rate variable is statistically significant. The coefficient is negative, which means when unemployment is high, both women and men are looking to find jobs elsewhere so their brain drain rates are closer. However, when unemployment decreases, the female brain drain ratio increases. This suggests that even when the unemployment rate is low in the source economy, women are more likely to migrate than men, hinting that other social factors play key roles in the decision of women to migrate. The landlocked, small island and colony variables are never significant, indicating that those variables are not effective in evaluating the difference between men and women brain drain rates. Controlling everything else the official language dummy is significant and positive, which is consistent with the findings of Dumont et al. (2007). Language barriers are one of the important costs of migration. Based on these results, women tend to migrate relatively more than men when they are living in a country with English or French as the common language. This is consistent with the hypothesis that women respond to cost variables

differently. Column 2 of table 3 shows the random effect estimation results. The result from random effect estimation is very similar to pooled OLS results.

(Table 3 here)

Table 4 shows the results of regressions with instrumental variables. Using three instruments allows me to check the empirical validity of the instruments to be uncorrelated with error term through over-identification tests. All the first stage F-stats are indeed higher than the commonly recognized threshold of 10 and the instruments also pass Stock and Yogo (2002) weak identification tests. The results of Hansen-Sargan over-identification tests as well as the first stage F statistics are reported in table 4. Hansen-Sargan over-identification test do not reject the null of exogeniety of the instruments. The results of generalized two stage least square estimations are qualitatively similar to those resulting from the random effect and OLS estimations. In table 4 column one, three, and four are estimated using all three instruments. Column 2 is estimated using only GDP and Polity variables as instruments. The results are consistent using different sets of instrumental variables and different exogenous independent variables. In column three and four the results are estimated using number of conflicts and internet users per 100 populations as additional control variables respectively. Residing in a country with high number of conflicts is likely to incentivize migration. However, the estimated coefficient of number of conflicts is insignificant hinting that this variable affects women and men migration behavior in a similar manner. Higher number of internet users might be associated to higher probability to migrate due to higher exposure to information especially about other countries and possible job opportunities. The coefficient of this variable is insignificant as well. (Column 4 of table 3)

In all of the specifications in table 4 the non-linear effects of women's rights on female brain drain ratio reaches a maximum at around the mean value of women's rights variable in both two stage least square and OLS and random effects estimation. While the estimation results with instrumental variables are qualitatively very similar to OLS and random effects estimations, the magnitude of the coefficients on the women's right variable and this variable squared are larger (in absolute value) using instrumental variables. This suggests underestimation of OLS and random effects due to the presence of endogeneity.

Table 5 shows the estimation result using each component of women's rights variable separately. While using each one of the women's social right, women's political rights and women's economic rights separately might cause the potential omitted variable bias, Including all of them in the same regression as it is displayed on column 3 of table 3 might suffer from collinearity due to high correlation between the women's social, political and economic rights variables. Considering the result of estimation with each of women's rights component, it is women's political rights and it's squared that remain significant while the significance of women's economic rights disappears. This might be due to the fact that women's political rights such as women's rights to vote and participate in political activities are usually earned earlier than women's economic rights and women's social rights. And since they are the fundamental rights, they are present if women's social right or women's economic rights are protected in a country. In the sample of countries in this paper, the mean of women's political rights is higher than the mean of women's social or economic rights (1.71 versus 1.31). These results are consistent with Doepke, Tertilt, and Voena (2012).

(Table 4&5 here)

Starting from the lowest level of women's rights, increase in women's rights increases the female brain drain ratio. This increase dampens and eventually reaches a peak at around a point where the women's rights index is 5.17. This point, which also coincides with the mean value of women's rights variable, is consistent across different specifications. This is near the point where women's rights are recognized by law to some extent but the enforcement of these laws by government is still very weak. After this point, an increase in women's rights decreases the female brain drain ratio at an increasing rate.

To give some perspective on the size of these effects quantitatively, one has to look at examples both above and below the estimated 5.17 women's rights index threshold. (Table 6) Take for example a country like Malaysia or Turkey, both with a women's rights index value of six. A one unit increase in this index is associated with a decrease in the female brain drain ratio by about 11 percent. Starting from the mean female brain drain ratio value of 0.27, this is a decrease of the female brain drain ratio of about 3 percentage points. For Costa Rica or Greece, each with a women's rights index value of seven, the associated decrease in the female brain drain ratio is 25 percent, or about seven percentage points based on the mean value in my sample.[11]

What is equally interesting, from a policy perspective, is looking at the effect of increases in women's rights in countries below the 5.17 index value threshold. Take for example a country like Saudi Arabia where the women's right index is one, a one unit increase in the levels of women's rights leads to 56 percent increase in the female brain drain ratio from Saudi Arabia. If

[11] The numbers are calculated based on the results presented in column 3 of table 4.

that is considered relative to the mean value of the female brain drain ratio in my sample (0.27) this amounts to an over 15 percentage point increase in the female brain drain ratio.

Even if one believes that female brain drain is undesirable, advocating decreased women's rights to decrease brain drain in countries with already low levels of women's rights would be absurd. In countries at the lowest levels of women's rights, results of lower female brain drain can be attributed to multiple variables. When extreme conservatism and oppressive ideologies infiltrate politics and the legal system, a system of structural power and inequality is created, and the option of migration does not exist. If women, skilled or not, are not legally permitted to migrate on their own fruition, there will be obvious lower levels of brain drain. The data shows that anywhere above this threshold of deep structural inequality, any increase in the level of women's rights decreases female brain drain. Clearly culturally sensitive policies striving for equality and social justice that produce the desired result of decreased female brain drain are favorable to those that produce violations of fundamental human rights.

6. Discussion and Conclusion

Examining the migration data in 2000, Docquier, et al. (2009) found that female brain drain rates from developing countries are on average 17 percent higher than those of men. In fact women have higher brain drain rates in 88 percent of these countries. This paper provides evidence that the levels of women's rights are an important determinant of female brain drain from developing countries. Based on an extension of the utility maximization framework employed by Borjas (1987), Grogger and Hanson (2011), and Beine and Salomone (2011), I derive the effect of gender inequality, proxied by women's rights, on the ratio of female-to-male

migration rates. In this paper I employ migration data from Docquier, et al. (2009) on up to 195 origin countries for the years 1990 and 2000 to estimate the relationship between the female brain drain ratio and the CIRI women's rights index from Cingranelli and Richards (2010).

To refute those that argue against the agency of women saying that many women migrate to follow their spouse, I base my conclusion on varied social science disciplines' discussions regarding increasing women's education and these women's decisions on when, why and whether they start families. Women choose (or do not choose) to start families and have children later in life when they have more advanced education (Isen & Stevenson, 2010). The World Survey of the Role of Women in Development United Nations (2004) states, "As educational and employment opportunities open for women, they are also increasingly migrating as foreign students and workers." Therefore, as I am studying the migration of high-skilled (i.e. advanced education), it is very likely that these women fit this mold (likely unmarried and without children) when they migrate to find work after their education. Although we cannot be certain as to how many women do fit this mold because the quantitative data cannot show personal decisions, this concept is widely accepted throughout the social science world.

For those women emigrating with their spouses, the fact that I am examining high-skilled migrants, does not suggest that the only reason they are leaving is because of this spouse. There may be a joint decision in which both are emigrating to find employment. It is likely that these women will be working alongside their spouses in the receiving country because they are both high-skilled.

In conclusion, the main contributions of this paper are the incorporation of institutionalized gender inequality into the cost function of the migration decision and the

detection of the nonlinear, hump shaped relationship between the female brain drain ratio and the women's rights index. In countries with very low levels of support for women's rights, women do not have access to basic rights, and most often they lack the freedom to make the decision to migrate and seek jobs elsewhere. In these situations, when they have some of their rights protected by the government or cultural institutions, they have more access to education or the freedom to decide whether to migrate. Consequently, when there is very little support for women's rights, a small increase in this index actually leads to an increase in the female brain drain ratio. However, this increase reaches an apex around 5.17 which almost coincide with the mean of this variable in my sample. At this level, women have some of their rights protected but enforcements of these rights are somewhat weak. After this point, increases in women's rights decreases the female brain drain ratio at an increasing rate. In effect, before the 5.17 threshold, increases in women's rights liberate women to flee oppressive conditions. However, after a baseline of fundamental rights exist (around 5.17), any additional rights gained provide increasing hospitable environment in which the benefits of staying greatly outweigh the costs of migration.

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Figures:

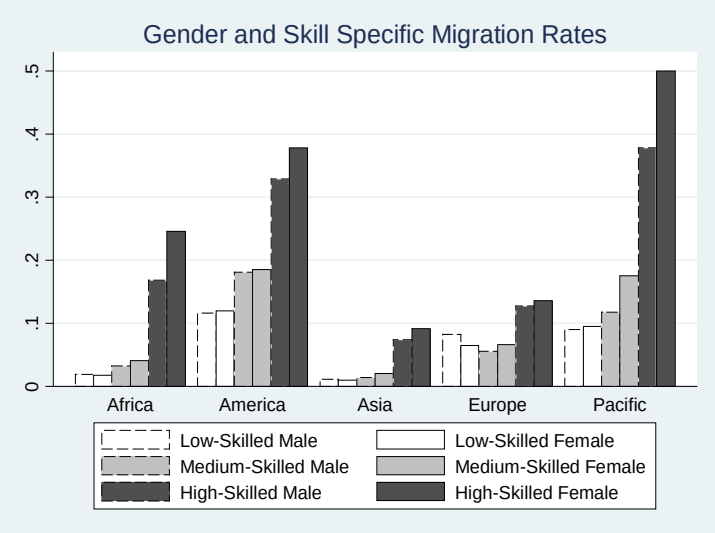

Figure 1. Gender and education specific migration rates across continents, year 2000, and data from Docquier, et al. (2009)

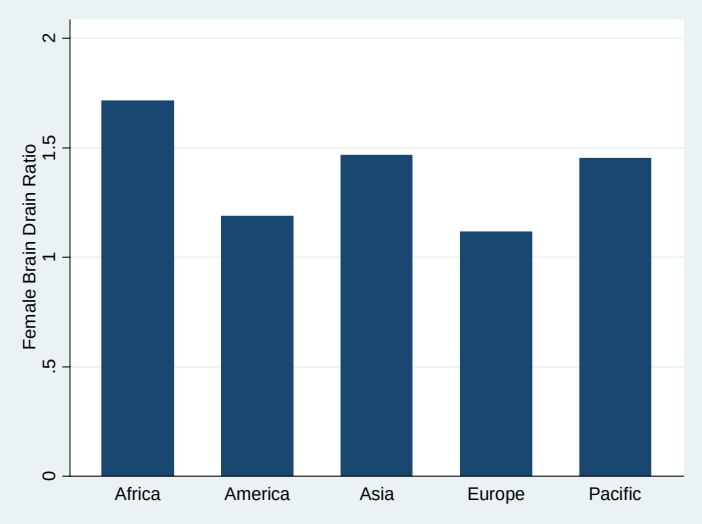

Figure 2. Female high-skilled migration rates relative to that of men (the female brain drain ratio) across origin countries' continents, year 2000, and data from Docquier, et al. (2009)

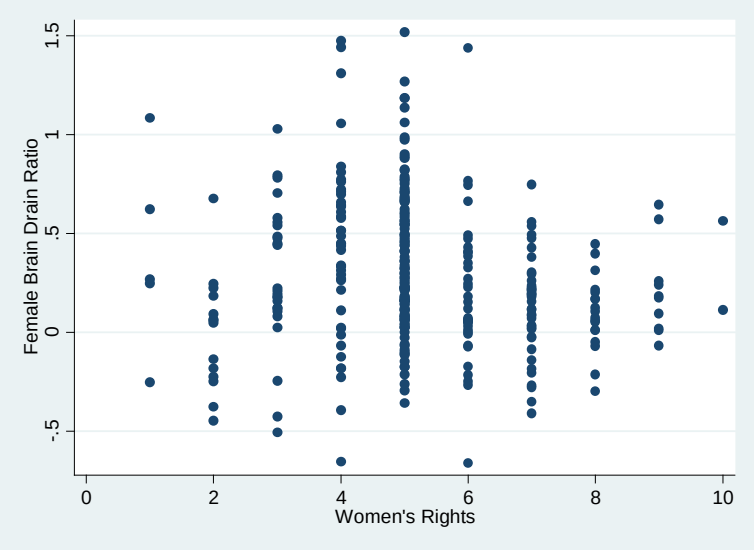

Figure 3. Female high-skilled migration rates relative to that of men (the female brain drain ratio) versus women's rights in origin countries, years 1990 and 2000, and data from Docquier, et al. (2009).

Tables:

Table 1- Summary statistics

	min	max	mean	sd	count
Female brain drain ratio	-0.66	1.52	0.27	0.36	345
Women's social rights	0.00	3.00	1.31	0.60	317
Women's political rights	0.00	3.00	1.72	0.66	314
Women's economic rights	0.00	3.00	1.31	0.60	317
Women's rights	1.00	10.00	5.21	1.71	312
Landlocked dummy	0.00	1.00	0.20	0.40	345
Language dummy	0.00	1.00	0.39	0.49	345
Colony dummy	0.00	1.00	0.82	0.38	345
Small Island dummy	0.00	1.00	0.14	0.35	345
Unemployment	0.45	43.50	9.67	7.26	299
Number of conflicts	0.00	8	0.29	0.76	294
Internet users per 100 people	0.00	47.89	3.78	9.32	340
Logarithm of GDP per capita	4.44	10.75	7.54	1.52	343
Polity variable	-10.00	10.00	2.22	7.09	271
Civil Liberties	1.00	7.00	3.57	1.81	321

Table 2. The result of OLS estimation with women's rights as dependent variable and the instrumental variables as independent variables

Estimation Model	OLS	OLS
Variable	(1)	(2)
Per Capita GDP	0.153**	0.244***
	(0.063)	(0.057)
Polity variable	0.063***	0.116***
	(0.021)	(0.013)
Civil Liberties	-0.301***	
	(0.095)	
Constant	5.058***	3.139***
	(0.735)	(0.422)
Observations	261	261
R-Squared	0.430	0.408

* p < 0.10, ** p < 0.05, *** p < .01. Robust Standard errors in parentheses.

Table 3. OLS and random effect results of the female brain drain ratio regressed on women's rights variables and other controls.

Estimation Model	OLS	Random Effect	Random Effect
Variable	(1)	(2)	(3)
Women's rights	0.112**	0.107**	
	(2.05)	(2.11)	
Women's rights squared	-0.0118**	-0.0106**	
	(-2.40)	(-2.32)	
Women's social rights			-0.146
			(0.097)
Women's social rights squared			0.020
			(0.019)
Women's political rights			0.412***
			(0.132)
Women's political rights squared			-0.082***
			(0.027)
Women's economic rights			0.328**
			(0.150)
Women's economic rights squared			-0.060**
			(0.030)
Landlocked dummy	-0.033	-0.024	-0.019
	(0.050)	(0.064)	(0.065)
Language dummy	0.170***	0.175***	0.175***
	(0.045)	(0.057)	(0.057)
Colony dummy	0.078	0.087	0.093
	(0.056)	(0.071)	(0.071)
Small island dummy	-0.100	-0.108	-0.105
	(0.071)	(0.086)	(0.086)
Unemployment	-0.015***	-0.014***	-0.015***
	(0.003)	(0.004)	(0.004)
Year 2000	0.004	-0.002	-0.007
	(0.039)	(0.021)	(0.021)
Constant	0.058	0.030	-0.409*
	(0.147)	(0.145)	(0.242)
Observations	275	275	275
R-Squared	0.166	0.164	0.163

* $p < 0.10$, ** $p < 0.05$, *** $p < .01$. Robust Standard errors in parentheses. Column 1 and two 2 are estimated using women's rights and women's rights squared as dependent variables. Column 3 is estimated using the components of women's rights (women's social rights, women's political rights, and women's economic rights) and the squared term of each variable as dependent variable.

Table 4. Two stage generalized least square results of the female brain drain ratio regressed on women's rights variables and other controls.

Estimation Model	2SGLS	2SGLS	2SGLS	2SGLS
Variable	(1)	(2)	(3)	(4)
Women's rights	0.703***	0.715***	0.737***	0.747**
	(0.238)	(0.240)	(0.241)	(0.328)
Women's rights squared	-0.068***	-0.069***	-0.072***	-0.073**
	(0.022)	(0.022)	(0.022)	(0.030)
Landlocked dummy	-0.047	-0.051	-0.050	-0.035
	(0.084)	(0.079)	(0.084)	(0.082)
Language dummy	0.189**	0.191***	0.201***	0.189**
	(0.076)	(0.072)	(0.077)	(0.075)
Colony dummy	-0.100	-0.109	-0.118	-0.097
	(0.116)	(0.113)	(0.117)	(0.124)
Small island dummy	-0.160	-0.159	-0.171	-0.161
	(0.147)	(0.138)	(0.147)	(0.146)
Unemployment	-0.014***	-0.014***	-0.014***	-0.012**
	(0.005)	(0.005)	(0.005)	(0.005)
Number of Conflicts			-0.033	
			(0.038)	
Internet Users per 100				0.005
				(0.004)
Year 2000	-0.002	0.001	-0.000	-0.046
	(0.033)	(0.035)	(0.035)	(0.049)
Constant	-1.191**	-1.207**	-1.238**	-1.299*
	(0.570)	(0.563)	(0.572)	(0.785)
Observations	238	238	236	237
chi2	30.25	33.11	31.86	29.64
P-value	0.000	0.000	0.000	0.000
R-Squared	0.079	0.078	0.076	0.077
First Stage F	22.532	24.102	19.611	23.081
Sargan test	1.352	1.347	1.372	3.185
Sargan test p-value	0.509	0.246	0.5037	0.2034

* $p < 0.10$, ** $p < 0.05$, *** $p < .01$. Robust Standard errors in parentheses. Column 1, 3 and 4 are estimated using per capita GDP, Polity, and civil liberties as instrumental variables. Column 2 is estimated using only per capita GDP and Polity as instruments.

Table 5. Two stage generalized least square results of the female brain drain ratio regressed on each component of women's rights and its squared value (women's social rights, women's political rights, and women's economic rights) separately.

Estimation Model	2SGLS	2SGLS	2SGLS	2SGLS
Variable	(1)	(2)	(3)	(4)
Women's social rights	1.379*			-0.058
	(0.712)			(2.654)
Women's social rights squared	-0.302**			-0.075
	(0.138)			(0.538)
Women's political rights		1.561***		1.061
		(0.465)		(2.411)
Women's political rights squared		-0.335***		-0.164
		(0.102)		(0.556)
Women's economic rights			3.067	-3.142
			(2.868)	(3.239)
Women's economic rights squared			-0.676	0.711
			(0.634)	(0.695)
Landlocked dummy	-0.012	-0.048	0.035	-0.108
	(0.081)	(0.081)	(0.126)	(0.127)
Language dummy	0.204***	0.155**	0.208*	0.150
	(0.073)	(0.074)	(0.119)	(0.113)
Colony dummy	-0.070	0.053	-0.014	0.046
	(0.106)	(0.093)	(0.220)	(0.222)
Small island dummy	-0.088	-0.137	-0.109	-0.052
	(0.109)	(0.141)	(0.219)	(0.250)
Unemployment	-0.009*	-0.019***	-0.016**	-0.021
	(0.005)	(0.005)	(0.007)	(0.016)
Year 2000	0.036	0.012	0.031	-0.052
	(0.037)	(0.040)	(0.064)	(0.097)
Constant	-1.052	-1.259**	-2.903	2.570
	(0.823)	(0.490)	(2.975)	(3.162)
Observations	262	240	240	238
chi2	27.97	31.23	10.30	20.92
P-value	0.000	0.000	0.244	0.051
R-Squared	0.044	0.099	0.049	0.040
First Stage F	23.187	12.788	11.120	
Sargan test	1.680	2.998	1.640	0.000
Sargan test p-value	0.1949	0.223	0.2003	

* $p < 0.10$, ** $p < 0.05$, *** $p < .01$. Robust Standard errors in parentheses. The per capita GDP, polity, and civil liberties are used in all 3 specifications.

Table 6 – Some examples of the effects of increases in women's rights index on the female brain drain ratio (FBDR)

	Percentage change in FBDR	Percentage point change on FBDR(mean=0.27)	Maximum Point
Women's rights =1 (Saudi Arabia)	+0.39	+0.10	5.07
Women's rights =6 (Malaysia or Turkey)	-0.09	-0.024	5.07
Women's rights =7 (Costa Rica or Greece)	-0.19	-0.05	5.07

One unit increase in women's rights index in a country with initial low levels of women's right like Saudi Arabia would be associated with increases in female brain drain ratio. On the other hand, in countries with women's rights levels above average, a one unit increase in women's rights would be associated with decreases in female brain drain ratio.