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Women in Politics: A New Instrument for Studying the Impact of Education on Growth

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This paper tests the growth model of distance to the technological frontier, which states that the closer an economy is to the frontier, the more important is innovation relative to imitation as a source of productivity growth. Hence, an economy that is closer to the technological frontier should invest more in skilled labor, since innovation is a skill-intensive activity. I use the proportion of female legislators as an instrument for skilled labor, in contrast to the lagged educational expenditures used in Vandenbussche *et al*. (2006). The results with the new instrument are consistent with the theoretical prediction and the earlier results of Vandenbussche *et al*. (2006).

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1 Introduction

Within the rich literature that discusses the determinants of economic performance, one line of the macro growth models treats the stock of human capital as a factor in improving technology, which in turn plays a role in the production function and contributes to growth. The assumption is that certain kinds of education equip a person to perform certain jobs or functions, or enable a person to perform a given function more effectively. Based on this assumption, Nelson and Phelps (1966) suggest that educated people make good innovators, so that education speeds up the forces of technological diffusion. Furthermore, if it is true that innovation produces externalities by pointing the way to imitators, then this implies that education also yields externalities by stimulating innovation. This provides a way to view the effect of education on growth.

However, it is not effective for countries with different technological levels to adopt the same strategy for improving productivity. Acemoglu *et al*. (2006) claim that the closer an economy is to the world technological frontier, the more important is innovation (relative to imitation) as a source of productivity growth because there is less room to copy and adopt well-established technologies. Their statement is based on the assumption that innovation is a more skill-intensive activity than imitation. In other words, skilled labor has a higher growth-enhancing effect for countries closer to the technological frontier, and vice versa.

Vandenbussche *et al*. (henceforth VAM) (2006) examine the contribution of human capital to growth by combining distance to the frontier and human capital. They use a 5-year-interval dataset covering 19 OECD countries between 1960 and 2000, and deal with the endogeneity problem by using lagged public expenditures on education as an instrument for levels of human capital. Although the results are significant, their instrument may not be credible due to its endogenous characteristics being linked to the dependent variable. Aghion *et al*. (2009) attempt to find an exogenous source of variation in spending on education, and construct a set of political factors consisting of the detailed composition of political committees as instruments within their power that are used to decide the allocation of federal funding.

By building on the idea that political factors may influence educational investments, this paper re-examines the theoretical predictions of the growth model in VAM (2006) by using a new instrument: women in politics. The social transformation taking place regarding attitudes to marriage may explain different policy preferences between women and men. Women may be encouraged to be self-supporting and enter the labor market accompanied by an increasing divorce rate, which, in turn, may raise their demand for policies that take care of their responsibilities in the family, such as social affairs, health, and education. Therefore, women tend to give priority to legislation related to traditional areas of concern to women once they are able to participate in the decision-making process (e.g., Lott and Kenny, 1999; Besley and Case, 2000; Edlund and Pande, 2002; Pande, 2003; Chattopadhyay and Duflo, 2004; Svaleryd, 2009; Clots-Figureas, 2012).

Chen (2011) provides evidence of a positive effect of women's participation in politics on public educational expenditures. It seems reasonable to expect that women support educational policies related to people's basic needs at lower stages of economic development, such as increasing accessibility to schooling and the literacy rate, while it is also more likely that women will support policies concerned with improving the quality of education once the infrastructure of compulsory education becomes well-established. Increasing the accessibility to higher education may be one of their secondary goals. This not only promotes the development of knowledge, but also addresses long-standing inequalities. I, therefore, use the proportion of female legislators as an instrument for human capital.

In this paper, the analysis exploits the fact that women's political involvement may affect the fraction of people with higher education, primarily through their influence on the budgetary process during their period in office. Thereafter, women's political involvement tends to have effects on 10-year growth, but may not, in itself, be driven by future growth. It is not necessary, however, for countries with higher productivity growth to have more female legislators. While the proportion of female legislators seems to be a good instrument for assessing human capital, there is nevertheless a trade-off between relevance and exogeneity for an instrument. While the share of female legislators provides an exogenous source of skilled labor, it may be less relevant in explaining the fraction of people with higher education.

This paper is organized as follows. Section 2 provides the theoretical

framework of distance to the frontier in VAM (2006). Section 3 describes the motivation behind using women in politics as a new instrument and investigates its correlation with education. Section 4 presents the empirical method, including the empirical model, data description, and potential endogeneity problem. Section 5 reports the results, where I replicate the results of VAM (2006) and compare those results with the results of using female legislators as a new instrument. Section 6 concludes.

2 Theoretical Framework

Technological frontier models assume ability-biased technological change, and are natural frameworks with which to think about the importance of skill selection, especially as an economy comes closer to the frontier. The technological improvement results from a combination of imitation and innovation. The former activities are aimed at adopting a world-frontier technology, while the latter activities are aimed at pushing forward the technological frontier. Both activities have unskilled and skilled labor as inputs. Following VAM (2006), technological progress is a linear function of imitation and innovation:

$$A_{i,t} = A_{i,t-1} + \lambda[(\bar{A}_{t-1} - A_{t-1})u_{m,i,t}^{\sigma} s_{m,i,t}^{1-\sigma} + \gamma u_{n,i,t}^{\varphi} s_{n,i,t}^{1-\varphi}], \quad (1)^1$$

where $A_{i,t}$ is the productivity in sector i at time t, $\bar{A}_{t-1}$ is the world productivity frontier at time $t-1$, A_{t-1} is the country's productivity frontier at the end of period $t-1$, $u_{m,i,t}$ ($s_{m,i,t}$) is the amount of unskilled (skilled) labor input used in imitation in sector i at time t and $u_{n,i,t}$ ($s_{n,i,t}$) is the amount of unskilled (skilled) labor input used in innovation in sector i at time t. The parameter σ (φ) is the elasticity of unskilled labor in imitation (innovation). γ measures the relative efficiency of innovation compared to imitation in generating productivity growth, and λ measures the efficiency of the overall process of technological

[1]There are other variables that play an important role in imitation and innovation, with all depending on the model's settings. For example, Segerstrom (1991) states that rates of both innovation and imitation are determined on the basis of the outcomes of R&D races (R&D investment is regarded as one kind of physical capital) between firms. In addition, government efforts to subsidize imitation may enhance the dynamic performance of the economy (Mukoyama, 2003), and the policy of tightening Intellectual Property Rights will increase the rate of innovation (Mondal and Gupta, 2006). These factors, including physical capital, will finally affect the growth rate.

improvement. Here it is assumed that $\varphi < \sigma$, in order to reflect the higher intensity of skilled labor in innovation than in imitation. Equation (1) states that the productivity in sector i today is based on its productivity yesterday adjusted by the technological progress, where the progress results from both innovation and imitation activities.

In an economy endowed with an exogenous stock of U units of unskilled labor and S units of skilled labor, the growth rate of productivity is given by:

$$g_A = \lambda\gamma\{Uh(a)^{1-\varphi} + Sh(a)^{-\varphi}(1-\varphi)\}, \quad (2)$$

where $h(a)$ is a decreasing function of the proximity to the frontier, $a \equiv A_t / \bar{A}_t$.[2] The effect of S on growth is increasing in a, while the effect of U on growth is decreasing in a.[3] This is the composition effect referred to in VAM (2006). That is, if a country is closer to the frontier, it should invest more in skilled labor in order to enhance the economy.

To summarize, the stronger that the growth-enhancing effect of a marginal increase in the stock of skilled human capital is, the closer the economy will be to the technological frontier, which is the main theoretical prediction by VAM (2006) and will be re-examined in the following empirical analysis.

3 A New Instrument for Human Capital: Women in Politics

During the 1960s-1980s, the second wave of the feminist movement, political parties across Western Europe came under pressure to adopt policies attractive to female voters and to provide greater opportunities for women to participate in the formal political arena. This was the case even in those countries in which a well-organized women's movement had not been developed. Women's perceptions of their role as representatives seem to differ from those of their male counterparts in some important ways.

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[2] $h(a) \equiv [\frac{(1-a)(1-\sigma)}{\gamma a(1-\varphi)}\phi^{\sigma}]^{\frac{1}{\sigma-\varphi}}$, and $\frac{dh(a)}{da} = \frac{1}{\sigma-\varphi}[\frac{(1-a)(1-\sigma)}{\gamma a(1-\varphi)}\phi^{\sigma}]^{\frac{1-\sigma+\varphi}{\sigma-\varphi}}\phi^{\sigma}[\frac{(1-\sigma)}{\gamma(1-\varphi)}][-\frac{1}{a^2}] < 0$.

[3] $\frac{\partial^2 g_A}{\partial S \partial a} = \lambda\gamma(1-\varphi)(-\varphi)h(a)^{-\varphi-1}h'(a) > 0$ and $\frac{\partial^2 g_A}{\partial U \partial a} = \lambda\gamma(1-\varphi)\varphi h(a)^{-\varphi}h'(a) < 0$.

Although women are just as likely as men to see themselves as delegates or trustees, women, in comparison to men, are more likely to see themselves as representatives of their gender. They might be more inclined, therefore, to give priority to legislation about women, and they take pride in legislative accomplishments in traditional areas of concern to women. Data collected by the Inter-Parliamentary Union (IPU) in 1992 highlight the fact that it is in the areas of family, social affairs, health and education that women are the most numerous in parliamentary committees among countries in Western Europe, and these are the areas that are related to women's traditional roles within the family. Although party discipline may restrict female legislators' work on women's issues, it appears that they are usually working across party lines to the extent that party discipline allows. As women achieve a more sizeable presence, their policy impact may be even greater. Male legislators who work with a sizeable number of female legislators are more likely to sponsor legislation concerned with the social, legal, and economic position of women than are male legislators in arenas in which women do not have a significant numerical presence. The dynamics of electoral competition may provide one interpretation. If male politicians do not sponsor more legislation concerning women, female politicians might take over the male legislators' vote shares from voters who care about women's needs.

Empirical studies, such as Lott and Kenny (1999) and Edlund and Pande (2002), discuss women's preferences regarding public policies. There are also empirical studies that analyze female politicians' influence on policy outcomes, such as Besley and Case (2000), Pande (2003), Chattopadhyay and Duflo (2004), Svaleryd (2009), and Clots-Figureas (2012). Overall, there is evidence that female politicians have systematically different preferences in relation to public policies than male politicians, which is likely to affect decision-making patterns and policy outcomes.

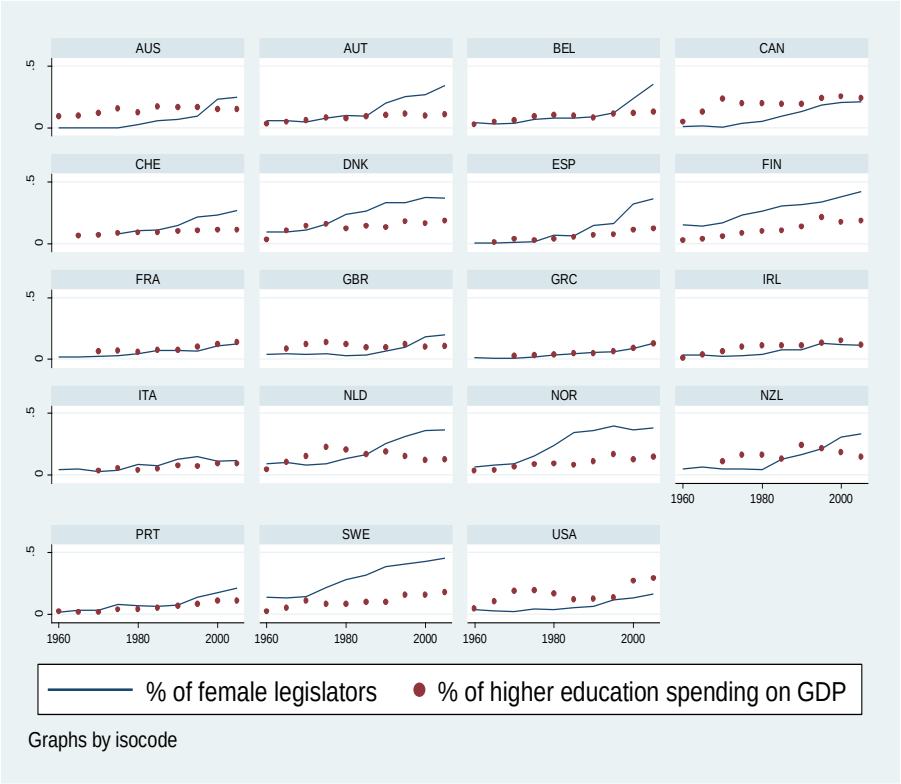
Chen (2011) provides evidence for developed countries that the greater the representation of women in parliament, the higher the educational expenditures, both as a share of GDP and in per capita terms. It seems reasonable to expect that women care about both the quantity and quality of children's education. Their educational policies tend to address people's basic needs when the economy is at the developing stage, and turn to improve quality when the infrastructure of compulsory education is well-established. Increasing the accessibility of higher education may be one of

the initiatives supported by female legislators. This support is not only aimed at increasing knowledge development, but also at addressing long-standing inequalities. In a developed country, the attention may be more focused on issues related to higher education than on policies regarding primary and secondary education, and the representation of female legislators may play a role in determining this focus. In other words, women may tend to influence policies related to higher education, which may thereafter impact the levels of human capital.

According to Edlund and Pande (2002), the increase in non-marriage in recent decades in Western society is likely to result in different policy preferences between women and men since men were previously thought to transfer resources to women in marriage. Therefore, women may be encouraged to be self-supporting and enter the labor market accompanied by an increasing divorce rate, which, in turn, may increase their demand for gender equality in their career. Hence, women may favor those policies related to the improvement of women's social status, such as increasing opportunities for women to pursue higher education, once more women are able to participate in the decision-making process. Even in the case where expenditures on higher education are earmarked for women, those expenditures may create a gender-neutral climate for participating in education beyond secondary school. In other words, in addition to women, men are likely to be influenced and to pursue tertiary education as well.

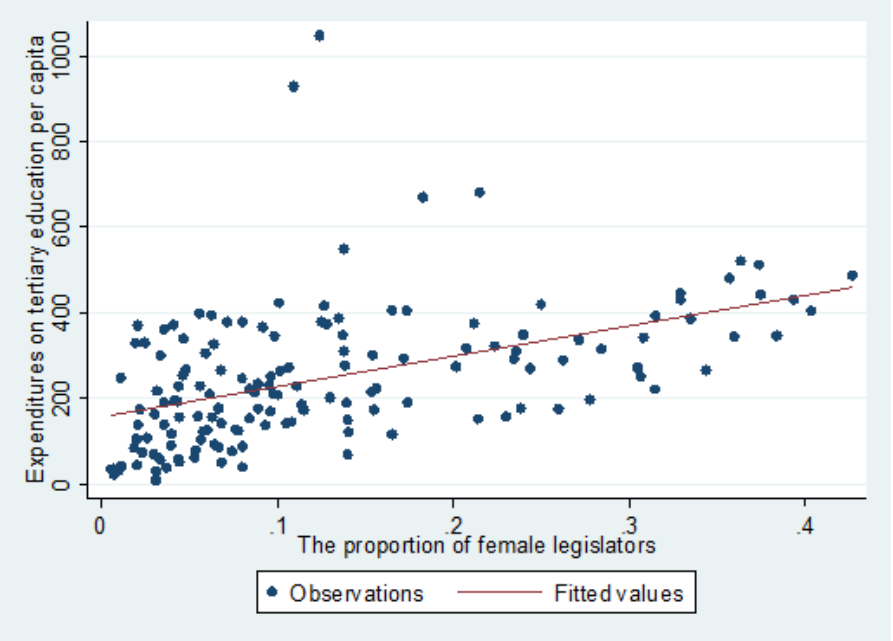
Figure 1 presents the fraction of female legislators and the ratio of public expenditures on higher education to GDP in 19 OECD countries from 1960 to 2005. The data are presented based on 5-year intervals. The fraction of female legislators comes from *Women in Parliaments: 1945-1995. World Statistical Survey* issued by the IPU. I only consider women's representation in the lower chamber. A positive correlation between the share of female legislators and educational investments is revealed for most of the countries.

I further pool all observations across countries and, in Figure 2, provide a simple graphical illustration of the relationship between the fraction of female legislators and expenditures on tertiary education per capita. While some caution is needed in interpreting this graph as nothing else is being controlled for, the figure shows that expenditures on tertiary education per capita are both significantly and positively correlated with the fraction of female legislators.



Notes: 1. The x-axis represents the year, and the y-axis the percentage. 2. In order to study the pattern of these two variables, I scale up the ratio of higher educational expenditures to GDP 10 times. 3. Country isocodes are "AUS" for Australia, " AUT" for Austria, "BEL" for Belgium, "CAN" for Canada, "DNK" for Denmark, "FIN" for Finland, "FRA" for France, "GRC" for Greece, "IRL" for Ireland, "ITA" for Italy, "NLD" for the Netherlands, "NZL" for New Zealand, "NOR" for Norway, "PRT" for Portugal, "ESP" for Spain, "SWE" for Sweden, "CHE" for Switzerland, "GBR" for the United Kingdom, and "USA" for the United States.

Figure 1: Female Legislators and Expenditures on Tertiary Education



Note: The x-axis is the percentage, and the y-axis is USD.

Figure 2: Correlation between Female Legislators and Expenditures on Tertiary Education Per Capita

VAM (2006) show that lagged expenditures on tertiary education are significantly and positively correlated with the fraction of people with higher education. Accordingly, I expect female legislators to have an influence on the proportion of people with higher education through the budgetary process. There may be concerns with endogeneity problems in regard to women in politics. That is, countries with policies that are less discriminatory against women would be expected to have both a higher proportion of women in politics and more women with a higher education degree, which consequently raises the proportion of people with higher education. If this is the case, it is doubtful whether higher levels of women in politics is the factor leading to an expansion in expenditures on education and an increase in the proportion of people with higher education. I, therefore, investigate whether there exists a significant degree of correlation between the share of female legislators and the incidence of higher education in the combined male and female populations. The results are reported in Table 1, which shows that the

proportion of female legislators is strongly correlated with both the incidence of higher education in the total population and also in the female population. Increasing the number of female legislators by one percentage point increases the incidence of higher education in the total population and in the female population by 0.221 and 0.284 percentage points, respectively. Although the statistical power is not as high as that in the correlation between the proportion of female legislators and the incidence of higher education in the total population and in the female population, there is a relevant correlation between the share of female legislators and the incidence of higher education in the male population. In other words, the greater share of women in politics not only reflects the increasing numbers of women with higher education degrees, but also benefits the educational status of the male population, with both being impacted by the female influence on the budgetary allocation.

Table 1: Correlation between the Share of Female Legislators and the Fraction of Higher Education in Different Categories of Population

	Total Population	Male Population	Female Population
	(1)	(2)	(3)
Share of female legislators	.221	.151	.284
	(0.75)***	(.087)*	(.084)***
R^2	0.98	0.97	0.97
Observations	132	132	132

Notes: 1. Standard errors are in parentheses. One, two and three * denote significance at the 10%, 5% and 1% levels, respectively. 2. Standard errors are corrected for clustering at the country level. 3. All of the regressions include group dummies and group trends. 4. The sample period extends from 1970 to 2000 at 5-year intervals.

In short, the proportion of female legislators is positively correlated with the amount of the budget allocated to higher education during their period in office. Since the economic growth rate today is less likely to affect the representation of women in politics 10 years ago and it is not necessarily true that countries with higher productivity growth have more female legislators, the proportion of female legislators seems to be a good instrument for human capital.

4 Empirical Method

4.1 Empirical Model

Equation (2) indicates that a country should take both the distance to the frontier (a) and the composition of labor types $\{U, S\}$ into account in order to improve economic performance. Given that this study investigates 19 OECD countries, which are well-developed and supposed to specialize in innovation as opposed to imitation, a relatively higher fraction of skilled labor (S) is assumed to be able to speed up economic growth. Therefore, the following equation for total factor productivity growth is estimated to represent the prediction in equation (2):

$$g_{j,t} = \alpha_{1,j} + \alpha_2 a_{j,t-1} + \alpha_3 f_{j,t-1} + a_4 a_{j,t-1} * f_{j,t-1} + \varepsilon_{j,t}, \quad (3)$$

where the dependent variable, $g_{j,t} = \log A_{j,t} - \log A_{j,t-1}$, is the labor productivity growth in country j in period t. The independent variables contain: 1) $a_{j,t-1} = \log A_{j,t-1} - \log \bar{A}_{t-1}$, the log of productivity in country j relative to the productivity frontier in the previous period; 2) $f_{j,t-1}$, the stock of skilled human capital in the previous period; and 3) the interaction of $a_{j,t-1}$ and $f_{j,t-1}$. $\alpha_{1,j}$ reflects country dummies. If the prediction from VAM (2006) is correct, we will see a positive sign for α_3 for countries closer to the frontier, and a positive sign for α_4 as well. That is, given that countries are a similar distance from the frontier, those countries with more skilled labor will exhibit a higher growth rate.

4.2 Data Description

The panel data employed in this study include data for 19 OECD countries from 1970 to 2000 at 5-year intervals, which contain 133 observations. I use total factor productivity, obtained from VAM (2006), as a proxy for labor productivity, $A_{j,t}$, and acquire the productivity frontier $\bar{A}_t$ by calculating the maximum value of $A_{j,t}$ in each period. Consequently, $g_{j,t}$ and $a_{j,t-1}$ are found.

Furthermore, I assume the stock of skilled human capital to be the skilled fraction of the labor force. Following the methods adopted in VAM (2006), the

measure of the skilled human capital stock is the fraction of people with more than a secondary school education.[4] Data on education for $f_{j,t-1}$ are taken from Barro and Lee (2001), who provide the distribution of the population across schooling attainment levels at 5-year intervals.

4.3 Endogeneity Problem

Since the period of observation is every five years, being constrained by the availability of educational data from Barro and Lee (2001), quite a lot of persistence is allowed. The right-hand-side variables in equation (3) are therefore treated as endogenous, and may be solved by using instrumental variables.

The instrument for $a_{j,t-1}$ is the log of the proximity to the frontier lagged two periods $a_{j,t-2}$, just as in VAM (2006). As for the instruments for $f_{j,t-1}$ and $a_{j,t-1} * f_{j,t-1}$, VAM (2006) use expenditures on tertiary education per capita lagged two periods and its interaction with $a_{j,t-2}$ as candidates, respectively. However, their instrument for human capital may not be credible for two reasons. First, expenditures on higher education 10 years ago seem likely to influence the current growth rate through channels other than human capital. For example, increasing government expenditures on tertiary education may signify a government's intention to develop those industries with high R&D investment and thereafter raise private enterprises' incentives to engage in related domestic investments. Consequently, an increase in domestic demand 10 years ago may impact current economic growth. Secondly, a high growth country will end up being rich and close to the technological frontier, and may spend more on tertiary education as a luxury good. In other words, countries with higher productivity growth may have both higher investment in tertiary education and continuous higher growth in productivity. Hence, educational expenditures as an instrument may still be endogenous.

To deal with the potential endogeneity problem of VAM (2006) arising from the

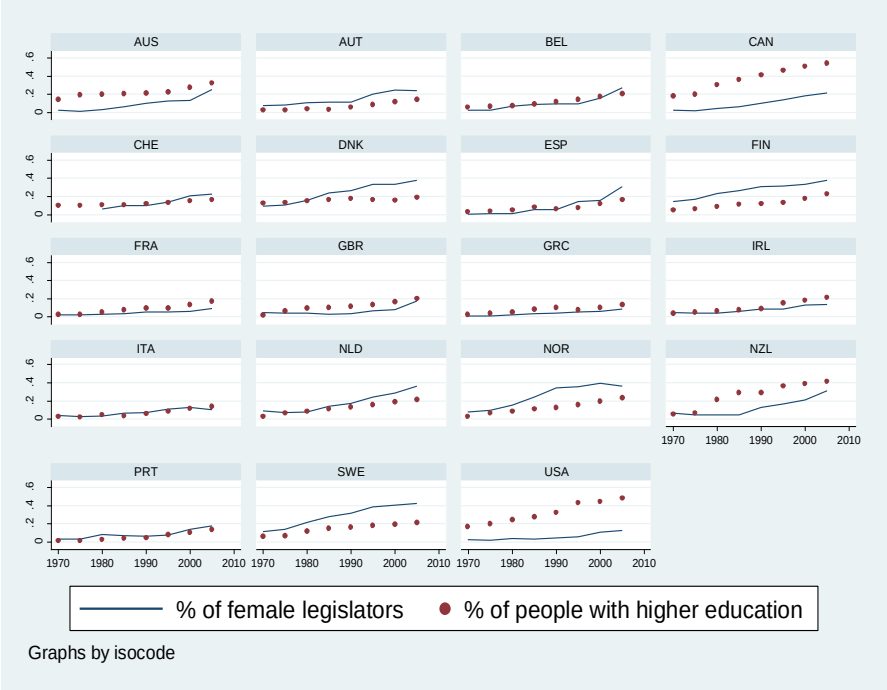
[4]There are direct measures for skilled labor in the literature. For studies using within country data, skilled labor is defined as those workers in specific industries who meet the skill criterion (e.g., schooling level), for example, Audretch and Feldman (1996) and Kahn and Lim (1998). Flug and Hercowitz (2000) study cross-country evidence and measure skilled labor using employment data and wage data in the International Labor Organization Statistical Database according to occupations reported for each industry. Nevertheless, all of these direct measures of skilled labor may still suffer from omitted variable bias in the growth regression since there are many factors driving growth. Therefore, instruments for human capital are required.

above concerns, a more exogenous variable is required to be the instrument for $f_{j,t-1}$. In this study, I use the proportion of female legislators in parliament as an instrument for human capital. Figure 3 presents the proportion of female legislators and the proportion of people with a higher education degree in each country from 1960 to 2000. The proportion of female legislators seems to be able to explain the proportion of people with a higher education degree given that the two variables share a similar growth pattern over time. Besides, a country with more women in politics does not necessarily correlate with its economic performance. Hence, the proportion of female legislators is likely to be a good candidate as an instrument for human capital. Descriptive statistics are provided in Table 2.

Table 2: Descriptive Statistics

	Mean	S.D.	Min	Max
Proximity				
TFP	-0.31	0.15	-0.68	0
Education				
% of people with higher education	13.40	10.72	1	54.30
Instrument of education				
% of female legislators	13.46	11.58	0	45.27

Nevertheless, there is a trade-off between relevance and exogeneity for an instrument. While the share of female legislators provides an exogenous source for skilled labor, it may be less relevant in explaining the fraction of people with higher education. As a result, the problem associated with weak instruments that results in tests of significance of incorrect size and wrong confidence intervals should be taken into consideration. Stock and Yogo (2005) provide useful rules of thumb regarding the null hypothesis of weak instruments based on a statistic due to Cragg and Donald (1993). Therefore, this study reports Cragg-Donald F statistics for the weak identification test, and provides a Stock-Yogo weak identification test critical value for reference.



Note: The x-axis is the year, and the y-axis the percentage.

Figure 3: Female Legislators and People with Higher Education

5 Empirical Analysis

5.1 Replication of VAM (2006)

Before comparing the estimation using the new instrument, namely, women in politics, with the one in VAM (2006), I first of all replicate Table 3 in VAM (2006) to verify the consistency of the empirical method. A replication of Table 3 from VAM (2006) is presented in Panel A of Table 3, which is also an estimation of equation (3) with the lagged educational expenditures serving as an instrument for assessing human capital, and a copy of Table 3 in VAM (2006) is provided in Panel B. The replication results with the same 122 observations are very close to the ones

in VAM (2006) in terms of scale and significance.[5]

Table 3: Replication of VAM (2006) with 122 Observations

Panel A: Replication of Table 3 in VAM (2006)					
	(1)	(2)	(3)	(4)	(5)
Proximity	-.077	-.230	-.158	-.251	-.329
	(.045)*	(.144)	(.041)***	(.139)*	(.049)***
Education	-.036	.381	.125	.481	.340
	(.079)	(.437)	(.048)***	(.388)	(.113)***
Prox*frac	-	-	.755	.599	1.314
			(.193)***	(.877)	(.303)***
Country dummies	N	Y	N	Y	Groups
Weak IV F statistics	23.277	4.979	18.373	3.084	6.431
(Critical value)	(4.39)	-	(4.28)	-	(4.37)
Observations	122	122	122	122	122
Panel B: Copy of Table 3 in VAM (2006)					
	(1)	(2)	(3)	(4)	(5)
Proximity	-.079	-.230	-.157	-.240	-.320
	(.050)	(.170)	(.044)***	(.170)	(.055)***
Education	-.032	.410	.123	.470	.331
	(.084)	(.490)	(.051)**	(.440)	(.120)**
Prox*frac	-	-	.740	.420	1.270
			(.210)***	(.960)	(.340)***
Country dummies	N	Y	N	Y	Groups
Observations	122	122	122	122	122

Notes: 1. Standard errors are in parentheses. One, two and three * denote significance at the 10%, 5% and 1% levels, respectively. 2. Standard errors are corrected for clustering at the country level. 3. Weak IV F statistics denote the Cragg-Donald F test critical value at 30% maximal IV relative bias. 4. All regressions at the first stage include country and year dummies.

5.2 Results with Women in Politics as an Instrument

Given the reliability in the replication of VAM (2006), I therefore estimate the model

[5]The trivial differences may be caused by the measure of tertiary educational expenditures where I calculate the value from total educational expenditures according to the statistical yearbook for each country, and VAM (2006) from GDP in UNESCO's Statistical Yearbook (1999).

based on their specification but use the new instrument, the proportion of female legislators lagged two periods. Table 4 presents the reduced form for the models, i.e., the first stage in Two Stage Least Squares. All the regressions include country dummies and year dummies. The independent variables of interest are the log of the proximity to the frontier lagged two periods (i.e., 10 years before), the proportion of female legislators lagged two periods, and the interaction of these two instruments.

Panel A presents the results with the proportion of female legislators as the instrument, and Panel B with tertiary educational expenditures, the same as in VAM (2006). To compare the results, the estimation in the two Panels has the same 120 observations. In column (1) of Panel A, lagged proximity explains proximity significantly. In the second reduced form for the proportion of people with higher education, the lagged representation of female legislators exhibits a positive relationship with the fraction of skilled adults when both country and year effects are included, although the relationship is not significant. This effect is relevant, however, if group dummies and group specific trends are controlled. In the third reduced form, the interaction of the lagged proximity and lagged proportion of female legislators is positively correlated with the interaction of proximity to the frontier and education.

Even though the reduced form in Table 4 shows that lagged expenditures on tertiary education are more relevant than the lagged representation of female legislators as an instrument for skilled labor, the new instruments may be more credible than the ones in VAM (2006). The increased credibility is conditional on the arguments that educational expenditures 10 years ago may influence current growth due to their side effect on domestic investment, and countries with higher productivity growth may have both higher investment in tertiary education and continuous higher growth in productivity. This is less likely to be the case for the level of female legislators.

Table 4: Reduced Form

Panel A: Female legislators as an instrument for skilled labor			
	Proximity	Fraction	Prox*Frac
	(1)	(2)	(3)
Lagged proximity	.670	-.126	.033
	(.091)***	(.118)	(.031)
Lagged fem	-.529	.320	.015
	(.285)*	(.277)	(.071)
Lagged prox*fem	-2.152	1.446	.134
	(1.084)*	(.991)	(.251)
R^2	0.99	0.98	0.95
Observations	120	120	120
Panel B: Educational expenditures as an instrument for skilled labor			
	Proximity	Fraction	Prox*Frac
	(1)	(2)	(3)
Lagged proximity	.594	-.054	.006
	(.111)***	(.088)	(.030)
Lagged exp	-.000	.000	.000
	(.000)***	(.000)**	(.000)
Lagged prox*exp	-.001	.001	.000
	(.000)**	(.000)	(.000)***
R^2	0.99	0.98	0.95
Observations	120	120	120

Notes: 1. Standard errors are in parentheses. One, two and three * denote significance at the 10%, 5% and 1% levels, respectively. 2. Standard errors are corrected for clustering at the country level. 3. The results in Panel B are comparable with Table 2 in VAM (2006) if tertiary expenditures are in thousands of dollars.

Table 5: Total Factor Productivity Growth Equation

Panel A: The results with the new instrument					
	(1)	(2)	(3)	(4)	(5)
Proximity	-.057	-.213	-.136	-.016	-.334
	(.042)	(.457)	(.036)***	(2.062)	(.054)***
Education	-.063	.382	.090	1.185	.409
	(.071)	(2.414)	(.042)**	(5.837)	(.163)**
Prox*frac	-	-	.676	-1.959	1.482
			(.168)***	(22.907)	(.357)***
Country dummies	N	Y	N	Y	Groups
Weak IV F statistics	18.883	0.200	12.090	0.016	3.441
(Critical value)	(4.39)	-	(4.28)	-	(4.37)
Observations	120	120	120	120	120
Panel B: Replication of Table 3 in VAM (2006) with 120 observations					
	(1)	(2)	(3)	(4)	(5)
Proximity	-.065	-.197	-.144	-.211	-.313
	(.042)	(.183)	(.036)***	(.187)	(.047)***
Education	-.049	.500	.106	.567	.345
	(.073)	(.51)	(.040)***	(.488)	(.111)***
Prox*frac	-	-	.712	.398	1.285
			(.183)***	(.969)	(.305)***
Country dummies	N	Y	N	Y	Groups
Weak IV F statistics	23.237	3.319	18.113	2.168	6.670
(Critical value)	(4.39)	-	(4.28)	-	(4.37)
Observations	120	120	120	120	120

Notes: 1. Standard errors are in parentheses. One, two and three * denote significance at the 10%, 5% and 1% levels, respectively. 2. Standard errors are corrected for clustering at the country level. 3. Weak IV F statistics denote the Cragg-Donald F test critical value at 30% maximal IV relative bias. 4. All regressions at the first stage include country and year dummies.

Table 5 provides the results for the total factor productivity growth equation, i.e., the estimation of equation (3). All the regressions control for country and year dummies at the first stage, and control for year dummies at the second stage. Panel A reports the results with female legislators as an instrument for human capital, while

Panel B reports the replication of Table 3 in VAM (2006) using 120 observations.[6] Column (1) of Panel A displays the regression without the interaction term and country dummies. The effect of a lagged distance on growth is negative, which implies the convergence of labor productivity growth. Since the proximity is always negative except for the countries that are exactly on the frontier, the smaller that the absolute value of the proximity becomes, the closer the country is to the technological frontier. It can therefore be concluded that, for a country far away from the frontier, the growth rate is stronger than for a country close to the frontier. This may reflect the difficulty associated with innovation and the relative ease of imitation. Such an effect is not mediated by education.

When the interaction effect between proximity and the proportion of people with higher education is included and country dummies are excluded, which is the case in column (3), there is a positive and significant effect of education on growth. Skilled labor increases growth more in more developed countries compared to less developed countries. Furthermore, the interaction effect is positive and statistically significant, which leads to the same conclusion as VAM (2006) and is consistent with the prediction of the theoretical model. However, these effects vanish when the country dummies are included. This is also the case in the study by VAM (2006). Hence, those authors introduce group dummies by grouping countries according to geographical proximity and/or institutional proximity. The results are displayed in column (5), and are encouraging in this respect. The new instrument for human capital, the proportion of female legislators, provides support to the theoretical model in addition to the instrument adopted in VAM (2006).

However, there is concern about the relevance of the instrument given the value of 3.441 for the Cragg-Donald F test in column (6), which is lower than the critical value at 30% maximal IV relative bias. As a result, the conventional method for inference can be misleading as standard estimators can be severely biased. Therefore, I correct the size of the standard errors using the method proposed by Moreira (2009). Table 6 provides the results. In column (5), the estimate of the interaction term supports the theoretical prediction, i.e., given countries with similar distances to the frontier, those countries with more skilled labor will have higher growth rates.

[6]The change in the number of observations is due to the availability of data about women in politics. Therefore, I replicate Table 3 of VAM (2006) again in Panel B of Table 5 for the purpose of comparing my results with theirs.

Table 6: Total Factor Productivity Growth Equation with Correct Size of s.e.

	(1)	(2)	(3)	(4)	(5)
Proximity	-.057	-.213	-.136	-.016	-.334
	(.042)	(.416)	(.057)**	(1.430)	(.099)***
Education	-.063	.382	.090	1.185	.409
	(.072)	(2.711)	(.104)	(3.761)	(.295)
Prox*frac	-	-	.676	-1.959	1.482
			(.365)*	(14.943)	(.669)**
Country dummies	N	Y	N	Y	Groups
p-value	0.336†	0.888†	0.016‡	0.900‡	0.018‡
Observations	120	120	120	120	120

Notes: 1. Standard errors are in parentheses. One, two and three * denote significance at the 10%, 5% and 1% levels, respectively. 2. All regressions at the first stage include country and year dummies. 3. † refers to the conditional p-value for the estimate of *Fraction* estimated by LIML, and ‡ refers to the conditional p-value for the estimate of *Prox*frac* estimated by LIML.

To make a further comparison of the validity of these two instruments, I instrument human capital by both the lagged level of female legislators and lagged expenditures on tertiary education, and report Hansen J statistics for the over-identification test. The Hansen J test is based on the assumption that model parameters are identified via a priori restrictions on the coefficients, and tests the validity of over-identifying restrictions (Sargan, 1958; Sargan, 1975; Hansen, 1982). Under the null hypothesis that the over-identifying restrictions are valid, the statistic is asymptotically distributed as a χ^2 with (m-k) degrees of freedom (where m is the number of instruments and k is the number of endogenous variables). In column (5) of Table 7, the Hansen J statistic shows that both instruments are valid for assessing human capital, and the results continue to strongly support the growth model.

Table 7: Comparison of Instruments for Human Capital

	(1)	(2)	(3)	(4)	(5)
Proximity	-.065	-.198	-.146	-.213	-.315
	(.042)	(.205)	(.041)***	(.216)	(.057)***
Education	-.047	.490	.110	.565	.353
	(.071)	(.543)	(.062)*	(.534)	(.160)**
Prox*frac	-	-	.718	.384	1.295
			(.335)**	(.941)	(.386)***
Country dummies	N	Y	N	Y	Groups
Hansen J statistic	17.479	0.002	18.205	0.036	4.034
Chi-sq. p-value	0.558	0.965	0.574	0.982	0.995
Observations	120	120	120	120	120

Notes: 1. Robust standard errors are in parentheses. One, two and three * denote significance at the 10%, 5% and 1% levels, respectively. 2. The Hansen J test is a test of overidentifying restrictions. The joint null hypothesis is that the instruments are valid instruments. 3. All regressions at the first stage include country and year dummies.

6 Conclusion

The purpose of this paper is to look for a new instrument for assessing human capital in a growth model. I adopt the proportion of female legislators as the best candidate because there may be significant differences in the legislative priorities between men and women. Their traditional role in the family makes women more likely to give priority to legislation regarding issues about women, children, family, education, health, and welfare. Many studies have found that one critical factor in women's impact on policy is the size of their presence within the legislature, since they usually work across party lines, which is seldom observed with men occupying the same positions. Furthermore, the proportion of female legislators may influence the budget allocated to higher education during their period in office, which may be reflected in the increasing proportion of people with higher education degrees 5 years after and may generate an effect on economic growth another 5 years later. Since the economic growth rate today is less likely to affect the representation of

women in politics 10 years ago, and it is not necessarily the case that countries with higher productivity growth have more female legislators, the proportion of female legislators seems to be a good instrument for human capital.

I present evidence that the share of female legislators is positively correlated with tertiary educational expenditures, and VAM (2006) show that lagged educational expenditures are significantly and positively correlated with the fraction of people with higher education. I accordingly expect that female legislators have an influence on the proportion of people with higher education through the budgetary process. The estimate of the growth equation using the specification in VAM (2006) with the new instrument is consistent with the theoretical prediction after correcting for the sizes of the standard errors. Moreover, the Hansen J statistic shows that both lagged educational expenditures and the lagged representation of female legislators are valid instruments for human capital.

Basically, there are pros and cons for both instruments based on relevance and exogeneity. The reduced form shows that lagged representation of female legislators is less relevant to the fraction of skilled labor, compared to lagged educational expenditures. However, the former instrument may provide a more credible source for human capital in the growth model since educational expenditures 10 years ago may influence current growth due to their side effects on domestic investment, and countries with higher productivity growth may have both a higher level of investment in tertiary education and continuously higher growth in productivity. This is less likely to be the case for the level of female legislators.

In general, this study offers a view of the effect of women in politics that is conditional on the growth model of distance to the technological frontier. It would be interesting to analyze the general effect of female legislators on growth *per se*. Moreover, female legislators may show their preferences on certain issues in tertiary education, such as increasing the opportunities for women to enter higher education rather than raising R&D expenditures, which may influence the productivity of certain types of labor. For example, normal schools used to share a relatively lower proportion of the government budget on tertiary education in Taiwan, which is likely to negatively impact the quality of instruction in compulsory education. Since children are believed to benefit more from female teachers due to their patience in compulsory education and teacher education is a key factor determining the

achievement of educational reforms, the government may be required to seriously consider the problem of differentiated treatment in terms of the way in which the educational budget is distributed. Given that women care more about the issues related to their traditional role in the family, including children's education, to recruit more women in the parliament is very likely to address the concerns with the budget's distribution and to be an attempt to improve the resource allocation for different levels of education. As a consequence, more resources may be channeled to normal schools for teacher education and the quality of compulsory education will thereby be enhanced. Therefore, using the representation of female legislators as an instrument for certain types of skilled human capital may lead to another avenue of research on productivity growth.

Moreover, the results of this study support the view put forward in the literature that there exist gender differences in policy-making. Given that the total welfare in society will be higher as more possible concerns are taken into account, it is important for the government to encourage more women to participate in the political sphere, either through reservation policies in elections or by nominating women to participate in the government sector. As women come to have a sizeable and/or a valuable presence, their policy impact will be even greater because male politicians are also more likely to sponsor legislation that considers the social, legal, and economic position of women than are male politicians in arenas in which women do not have a significant numerical presence.

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