Comparative Advantage, International Trade, and Fertility*

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October 8, 2015

Abstract

We analyze theoretically and empirically the impact of comparative advantage in international trade on fertility. We build a model in which industries differ in the extent to which they use female relative to male labor, and countries are characterized by Ricardian comparative advantage in either female-labor or male-labor intensive goods. The main prediction of the model is that countries with comparative advantage in female-labor intensive goods are characterized by lower fertility. This is because female wages, and therefore the opportunity cost of children are higher in those countries. We demonstrate empirically that countries with comparative advantage in industries employing primarily women exhibit lower fertility. We use a geography-based instrument for trade patterns to isolate the causal effect of comparative advantage on fertility.

Keywords: Fertility, trade integration, comparative advantage.

JEL Codes: F16, J13, O11.

*We are grateful to the editor (Nathan Nunn), two anonymous referees, Raj Arunachalam, Martha Bailey, Francesco Caselli, Francisco Ferreira, Elisa Gamberoni, Gene Grossman, David Lam, Carolina Sanchez-Paramo, and seminar participants at various institutions for helpful suggestions. Çağatay Bircan, Aaron Flaaen, Dimitrije Ruzic, and Nitya Pandalai-Nayar provided outstanding research assistance. The project has been funded in part by the World Bank's Research Support Budget. The views expressed in the paper are those of the authors and need not represent either the views of the World Bank, its Executive Directors or the countries they represent, or those of the Central Bank of Chile or the members of its board. This document is an output from a project funded by the UK Department for International Development (DFID) and the Institute for the Study of Labor (IZA) for the benefit of developing countries. The views expressed are not necessarily those of DFID or IZA. Email: qdo@worldbank.org, alev@umich.edu, craddatz@bcentral.cl.

1 Introduction

Attempts to understand population growth and the determinants of fertility date as far back as Thomas Malthus. Postulating that fertility decisions are influenced by women's opportunity cost of time (Becker, 1960), choice over fertility has been incorporated into growth models in order to understand the joint behavior of population and economic development throughout history (see e.g. Barro and Becker 1989; Becker et al. 1990; Kremer 1993; Galor and Weil 1996, 2000; Greenwood and Seshadri 2002; Doepke 2004; Hazan and Zoabi 2006; Jones and Tertilt 2008; Doepke et al. 2015). The large majority of existing analyses examine individual countries in a closed-economy setting. However, in an era of ever-increasing integration of world markets, the role of globalization in determining fertility can no longer be ignored.

This paper studies both theoretically and empirically the impact of comparative advantage in international trade on fertility outcomes. Our conceptual framework is based on three assumptions. First, goods differ in the intensity of female labor: some industries employ primarily women, others primarily men. This assumption is standard in theories of gender and the labor market (Galor and Weil, 1996; Black and Juhn, 2000; Qian, 2008; Black and Spitz-Oener, 2010; Rendall, 2010; Pitt et al., 2012; Alesina et al., 2013), and as we show below finds ample support in the data. In the rest of the paper, we refer to goods that employ primarily (fe)male labor as the (fe)male-intensive goods. Second, women bear a disproportionate burden of raising children. That is, a child reduces a woman's labor market supply more than a man's. This assumption is also well-accepted (Becker, 1981, 1985; Galor and Weil, 2000), and is consistent with a great deal of empirical evidence (see, e.g., Angrist and Evans, 1998; Guryan et al., 2008). Finally, differences in technologies and resource endowments imply that some countries have a comparative advantage in the female-intensive goods, and others in the male-intensive goods. Our paper is the first to both provide empirical evidence that countries indeed differ in the gender composition of their comparative advantage, and to explore the impact of comparative advantage in international trade on fertility in a broad sample of countries.

The main theoretical result is that countries with comparative advantage in female-intensive goods exhibit lower fertility. The result thus combines Becker's hypothesis that fertility is affected by women's opportunity cost of time with the insight that this opportunity cost is higher in countries with a comparative advantage in female-intensive industries.

We then provide empirical evidence for the main prediction of the model using industry-level export data for 79 manufacturing and non-manufacturing sectors in 146 developed and developing countries over 5 decades. We use sector-level data on the share of female workers in total employment to classify sectors as female- and male- intensive. The variation across sectors in the share of female workers is substantial: it ranges from 5-6 percent in industries such as logging and coal mining to 55-65 percent in some types of textiles and apparel. We then combine this industry-level information with data on countries' export shares to construct, for each country and time period, a measure of its *female labor needs of exports* that captures the degree to which a country's comparative advantage is in female-intensive sectors. We use this measure to test the main prediction of the model: fertility is lower in countries with a comparative advantage in female-intensive sectors.

The key aspect of the empirical strategy is how it deals with the reverse causality problem. After all, it could be that countries where fertility is lower for other reasons export more in female-intensive sectors. To address this issue, we follow Do and Levchenko (2007) and construct an instrument for each country's trade pattern based on geography and a gravity-like specification. Exogenous geographical characteristics such as bilateral distance or common border have long been known to affect bilateral trade flows. The influential insight of Frankel and Romer (1999) is that those exogenous characteristics and the strong explanatory power of the gravity relationship can be used to build an instrument for the overall trade openness at the country level. Do and Levchenko (2007)'s point of departure is that the gravity coefficients on the same exogenous geographical characteristics such as distance also vary across industries – a feature of the data long known in the international trade literature. This variation in industries' sensitivity to the common geographical variables allows us to construct an instrument for trade *patterns* rather than the overall trade *volumes*. Section 3.1 describes the construction of the instrument and justifies the identification strategy at length. As an alternative approach, we supplement the cross-sectional 2SLS evidence with panel estimates that include country and time fixed effects.

Both cross-sectional and panel results support the main empirical prediction of the model: countries with a higher female-labor intensity of exports exhibit lower fertility. The effect is robust to the inclusion of a large number of other covariates of fertility, and is economically significant. Moving from the 25th to the 75th percentile in the distribution of the female-labor needs of exports lowers fertility by as much as 20 percent, or about 0.36 standard deviations of fertility across countries.

Our paper contributes to two lines of research in fertility. The first is the empirical testing of Becker's hypothesis that fertility is affected by women's opportunity cost of time. The key hurdle in this literature is to identify plausibly exogenous variation in this opportunity cost. While the negative correlation between women's wages and fertility is very well-documented (Jones et al., 2010), it cannot be interpreted causally, since wages are only observed for women who work.[1,2] Some authors have used educational attainment as an instrument for female wages after estimating a Mincer equation (Schultz, 1986) or directly as a proxy for productivity (Jones and Tertilt, 2008). However, as emphasized by Jones et al. (2010), education and occupational choices are potentially endogenous to fertility: women with a preference for large families might decide to invest less in education or choose occupations with lower market returns. Alternatively, to avoid using endogenous individual characteristics, some studies use median and/or mean female wages to proxy for women's opportunity cost of time (Fleisher and Rhodes, 1979; Heckman and Walker, 1990; Merrigan and St.-Pierre, 1998; Blau and van der Klaauw, 2007). Still, when the wage statistics are computed from the selected sample of working women, they may not be representative of women's opportunity cost of time when it comes to fertility decisions.[3] Our approach avoids these limitations. By constructing country-level measures of female labor needs of exports, and instrumenting these using exogenous (and arguably excludable) geographical variables, we build a proxy for women's opportunity cost of time that is exogenous to individual fertility, education, or labor force participation.[4] Our paper thus provides novel empirical evidence on Becker's influential hypothesis.

The second is the (still sparse) literature on fertility in the context of international integration. Schultz (1985) shows that the large changes in world agricultural prices and the gender division of labor in agriculture affected fertility in 19th-century Sweden, while Alesina et al. (2011) test the hypothesis that historical prevalence of the plough use affected fertility. Galor and Mountford (2009) study the impact of initial comparative advantage on the dynamics of fertility and human capital investments. Sauré and Zoabi (2011, 2014) examine how trade affects female labor share, wage gap, and fertility in a factor proportions framework featuring complementarity between capital and female labor. Rees and Riezman (2012) argue that when foreign direct investment improves work opportunities for women, fertility will fall. Our framework is the first to combine the Ricardian motive for trade with

[1]While some studies have argued – implicitly or explicitly – that levels of female labor force participation are "high enough" in the US so that censoring is not a significant issue (Cho, 1968; Fleisher and Rhodes, 1979), this assumption would be more problematic to make in the context of low and middle-income countries, that typically exhibit low levels of female labor force participation and for which data on female wages are scarce and imprecise in part due to the large size of the informal sector (World Bank, 2012).

[2]At very high levels of household income, Hazan and Zoabi (2014) provide evidence that the usual negative relationship between women's opportunity cost of time and fertility does not hold, as high-earning women can have more children by purchasing childcare services in the market.

[3]Heckman and Walker (1990) argue that "[i]t is plausible that in Sweden the wage process is exogenous to the fertility process. Sweden uses centralized bargaining agreements to set wages and salaries" (p.1422). Since this institutional feature is specific to Sweden, this approach is difficult to extend to other contexts.

[4]Our methodology is thus similar in spirit to Alesina et al. (2013), who also use a geography-based variable (soil crop suitability in this case) as an instrument for the adoption of a female-labor-intensive technology: the plough.

differences in female-labor intensity across sectors, and explore its role in the demand for female labor.

Our paper also relates to the small but growing literature on the impact of globalization on gender outcomes more broadly (Black and Brainerd, 2004; Oostendorp, 2009; Aguayo-Tellez et al., 2013; Marchand et al., 2013; Juhn et al., 2014). Closest to our paper is Ross (2008), who shows empirically that oil-abundant countries have lower female labor force participation (FLFP). Ross (2008)'s explanation for this empirical pattern is that Dutch disease in oil-exporting countries shrinks the tradable sector, and expands the non-tradable sector. If the tradable sector is more female-intensive than the non-tradable sector, oil lowers demand for female labor and therefore FLFP. Our theoretical mechanism relies instead on variation in female-labor intensity within the tradable sector. On the empirical side, the effect we demonstrate is much more general: it is present when excluding natural resource exporters, as well as excluding the Middle East-North Africa region.

The rest of the paper is organized as follows. Section 2 presents a simple two-country two-sector model of comparative advantage in trade and endogenous fertility. Section 3 lays out our empirical strategy to test the predictions of the model. Section 4 describes the data, while section 5 presents estimation results. Section 6 concludes. Detailed model exposition and the proofs are collected in Appendix A.

2 Theoretical Framework

Consider a two-country two-sector model. The two countries are indexed by $c \in \{X, Y\}$, and the two sectors by $i = \{F, M\}$. The representative household in c values consumption C_F^c and C_M^c of the two goods, as well as the number of children N^c it has according to the utility function

$$u\left(C_F^c, C_M^c, N^c\right) = \left(C_F^c\right)^{\eta}\left(C_M^c\right)^{1-\eta} + v\left(N^c\right), \tag{1}$$

with $v\left(.\right)$ is increasing and concave. To guarantee interior solutions, we further assume that $\lim_{N\to 0} v'\left(N\right) = +\infty$.

We adopt the simplest form of the gender division of labor, and assume that production in sector F only requires female labor and capital, while sector M only requires male labor and capital. Technology in sector i is therefore given by

$$Y_i^c\left(K_i, L_i\right) = i^c K_i^{\alpha} L_i^{1-\alpha},$$

where L_i is the sector's employment of female labor (in sector F) and male labor (in sector M), K_i is the amount of capital used by sector i, and $\{i^c\}_{i\in\{M,F\}}^{c\in\{X,Y\}}$ are total factor productivities in the two sectors and countries. Formally, this is the specific-factors model of production and trade (Jones, 1971; Mussa, 1974), in which female and male labor are specific to sectors F and M respectively, while K can move between the sectors.[5] Thus, we take the arguably simplistic view that men supply "brawn-only" labor, while women supply "brain-only" labor, and men and women are not substitutes for each other in production within each individual sector. Of course, there is still substitution between male and female labor in the economy as a whole, since goods F and M are substitutable in consumption.[6]

The key to our results is the assumption that countries differ in their relative productivities F^c/M^c. For convenience, we normalize

$$(F^c)^\eta (M^c)^{1-\eta} = 1 \tag{2}$$

in both countries. Since the impact of relative country sizes is not the focus of our analysis, and the aggregate gender imbalances in the population tend to be small, we set the country endowments of male and female labor and capital to be $\bar{L}_M^c = \bar{L}_F^c = 1$ and $\bar{K}^c = 1$ for $c \in \{X, Y\}$. Capital can move freely between sectors, and the market clearing condition for capital is $K_F^c + K_M^c = 1$. Men supply labor to the goods production sector only, and hence supply it inelastically: $L_M^c = 1$. On the other hand, childrearing requires female labor, and women split their time between goods production and childrearing. N^c children require spending λN^c units of female labor at home, so that $N^c \in \left[0, \frac{1}{\lambda}\right]$. Female market labor force participation is then

$$L_F^c = 1 - \lambda N^c. \tag{3}$$

All goods and factor markets are competitive. International trade is costless, while capital and labor cannot move across countries.[7] In country c, capital earns return r^c and female

[5]While the canonical specific-factors model has a factor mobile across sectors (capital here), it is not strictly necessary for the main results to hold. For simplicity, we abstract from differences in the elasticity of substitution between female labor and capital, and between male labor and capital (Goldin, 1990; Galor and Weil, 1996). Sauré and Zoabi (2011, 2014) contain a comprehensive treatment of how this difference in elasticities affects the impact of international trade on gender outcomes.

[6]The necessary condition for obtaining our results is that in equilibrium, women's relative wages are higher in the country with a Ricardian comparative advantage in the female-intensive good. This plausible equilibrium outcome obtains under more general production functions in which both types of labor are used in both sectors (see, for instance, Morrow, 2010). On the other hand, our result is inconsistent with models that feature Factor Price Equalization (FPE). FPE is ruled out in our model by cross-country productivity differences in all sectors, which implies that generically FPE does not hold in our model.

[7]The assumption of no international capital mobility is not crucial for our results. In fact, our results can be even more transparent with perfect capital mobility. When capital is internationally mobile, relative female wages in the two countries depend only on the relative Total Factor Productivities in the female sector (when the solution is interior): $w_F^X/w_F^Y = \left(F^X/F^Y\right)^{1/(1-\alpha)}$. This expression relates relative female wages to absolute advantage in the female-intensive sector. Thus, as long as a country's Ricardian comparative advantage is the same as its absolute advantage (that is, as long as M^X/M^Y is such that $F^X/F^Y \lesseqgtr 1 \Rightarrow$

and male workers are paid wages w_F^c and w_M^c, respectively. Let the price of goods $i \in \{M, F\}$ be denoted by p_i, and set the price of the goods consumption basket to be numeraire:

$$p_F^{\eta} p_M^{1-\eta} = 1. \tag{4}$$

A **competitive equilibrium** in this economy is a set of prices $\{p_i, r^c, w_i^c\}_{i\in\{M,F\}}^{c\in\{X,Y\}}$, capital allocations $\{K_i^c\}_{i\in\{M,F\}}^{c\in\{X,Y\}}$, and fertility levels $\{N^c\}^{c\in\{X,Y\}}$, such that (i) consumers maximize utility; (ii) firms maximize profits; (iii) goods and factor markets clear.

Fertility in both countries and production/consumption allocations are thus jointly determined in equilibrium, making it more difficult to handle than the typical model of international exchange in which factor supplies are fixed. For expositional purposes, we describe the equilibrium in two steps. We first characterize the global production and consumption allocations for a given fertility profile $\{N^c\}^{c\in\{X,Y\}}$. We then endogenize households' decisions over fertility.

Production and Trade Equilibrium Considering fertility choices $\{N^c\}^{c\in\{X,Y\}}$ as given, we look at the production and trade equilibrium. Fertility levels determine female labor supply according to (3), and thus countries' female labor "endowment". Thus, and as formally established in Proposition A1 in the Appendix, equilibrium production and trade are the result of comparative advantage, which can be decomposed into a *technological* or Ricardian component and a *factor-proportions* component.

Fertility equilibrium Letting fertility being determined endogenously, the central question is to establish whether fertility decisions exacerbate or mitigate exogenous Ricardian comparative advantage.

Labor supply First, functional form (1) for the representative agent's utility function makes it linear in income and additively separable in consumption and fertility. This implies that in every country, the female formal labor supply curves (and hence fertility choices) are solely driven by the substitution effect.[8] The resulting upward-sloping female labor supply curve and the associated negative relationship between female wages and fertility are in line

$\left(F^X/F^Y\right)\left(M^Y/M^X\right) \lesseqgtr 1$), it will have higher female wages, and the rest of the results follow.

[8] In general however, an increase in women's wages will have both income and substitution effects. Higher female wages represent a higher opportunity cost of having children, and thus the substitution effect implies that a rise in women's wages increases female labor supply and reduces fertility. However, higher female wages can also have an income effect: since children are a normal good, all else equal higher female wages can also lead to more children, and thus *lower* formal labor supply. Separability eliminates the income effect, but is sufficient albeit not necessary. A necessary condition for labor supply to be sloping upward is for the substitution effect to dominate, which is commonly assumed (see e.g. Galor and Weil 1996).

with a large body of both theoretical and empirical literature, going back to Becker (1965), Willis (1973), and Becker (1981). Jones et al. (2010) and Mookherjee et al. (2012) are recent discussions of the conditions necessary and sufficient to have the substitution effect dominate the income effect and hence generate a negative fertility-income relationship.

Labor demand An increase in female labor supply in country c increases c's comparative advantage in the female-labor intensive good (the factor-proportions effect). This will increase the size of the F-sector in country c and exert a downward pressure on female wages. By the same token, country $-c's$ comparative advantage in the female-labor intensive good is reduced, decreasing the size of the F-sector in that country, which in turn will put additional downward pressure on female wages in country c. The female labor demand curve is therefore downward-sloping.

Equilibrium fertility As a consequence, for a given fertility level in country $-c$, labor supply and demand curves in c intersect in a unique equilibrium fertility level (see Lemma A1 in the Appendix). Thus, for every fertility level N in country $-c$, there exists a unique equilibrium fertility $N^c(N)$ (see Lemma A2). Proposition A2 then formally establishes the uniqueness of a competitive equilibrium.

Comparative statics The main result of the model is that fertility choices unambiguously exacerbate initial Ricardian differences, leading to equilibrium differences in fertility.

Theorem 1: Cross-sectional comparison If country c has a Ricardian comparative advantage in the female-labor intensive sector ($\frac{F^c}{M^c} > \frac{F^{-c}}{M^{-c}}$), it will exhibit lower equilibrium fertility: $N^c < N^{-c}$.■

Theorem 1 is the main theoretical prediction, and one that will be tested empirically. The intuition for this result is as follows. Female wages will be higher in the country with the comparative advantage in the female-intensive sector because of higher relative productivity further exacerbated by a flow of capital to the sector with comparative advantage. Since a higher female wage increases the opportunity cost of childbearing in terms of goods consumption, equilibrium childbearing drops.

The theoretical exposition above makes clear what are the measurement and identification challenges for the empirical work. First, in order to test for the impact of gender-biased comparative advantage on fertility, we must develop a measure of comparative advantage in (fe)male sectors. Fortunately, the model presents us with a way of doing this: observed trade flows. Countries with a comparative advantage in the female-intensive good will export that good. Our empirical strategy thus starts by building a measure of the female intensity of exports based on observed export specialization. Second, the model shows quite clearly that observed specialization patterns, trade flows, and fertility levels are jointly determined. In particular, countries with higher technological comparative advantage in the female sector can potentially accentuate that comparative advantage with a higher female labor supply and will thus effectively exhibit relative factor proportions that also favor exports in the female-intensive sectors. Thus, in order to provide evidence for the causal impact of comparative advantage on fertility, we must find an exogenous source of variation in comparative advantage. We describe all parts of our empirical strategy and results below.

3 Empirical Strategy

To test for the impact of comparative advantage on fertility, we must first construct a measure of the degree of female bias in a country's export pattern. We begin by classifying sectors according to their female intensity. Let an industry's female-labor intensity FL_i be measured as the share of female workers in the total employment in sector i. We take this measure as a technologically determined industry characteristic that does not vary across countries. We then construct for each country and time period a measure of the "female-labor needs of exports":

$$FLNX_{ct} = \sum_{i=1}^{I} \omega_{ict}^{X} FL_i, \tag{5}$$

where i indexes sectors, c countries, and t time periods. In this expression, ω_{ict}^{X} is the share of sector c exports in country c's total exports to the rest of the world in time period t. Thus, $FLNX_{ct}$ in effect measures the gender composition of exports in country c. This measure is meant to capture the female bias in each country's comparative advantage. It will be high if a country exports mostly in sectors with a large female share of employment, and vice versa.[9]

Using this variable, we would like to estimate the following equation in the cross-section of countries:

$$N^c = \alpha + \beta FLNX_c + \gamma \mathbf{Z}_c + \varepsilon_c. \tag{6}$$

The left-hand side variable N^c is, as in Section 2, the number of births per woman, and $\mathbf{Z}_c$ is a vector of controls. The main hypothesis is that the effect of comparative advantage in female-intensive sectors $FLNX_c$ on fertility is negative ($\beta < 0$). The potential for reverse causality

[9]The form of this index is based on Almeida and Wolfenzon (2005) and Do and Levchenko (2007), who build similar indices to capture the external finance needs of production and exports.

is immediate here: higher fertility will reduce women's formal labor force participation and therefore could also affect the country's export pattern. To deal with reverse causality, we implement an instrumentation strategy that follows Do and Levchenko (2007), described in the next subsection.

We also exploit the time variation in the variables to estimate a panel specification of the type

$$N_t^c = \alpha + \beta FLNX_{ct} + \gamma \mathbf{Z}_{ct} + \delta_c + \delta_t + \varepsilon_{ct}, \tag{7}$$

where country and time fixed effects are denoted by δ_c and δ_t respectively. The advantage of the panel specification is that the use of fixed effects allows us to control for a wide range of time-invariant omitted variables that vary at the country level, and identify the coefficient purely from the time variation in comparative advantage and fertility outcomes within a country over time.

The baseline controls include PPP-adjusted per capita income, overall trade openness, and, in the case of cross-sectional regressions, regional dummies. (We also check robustness of the results to a number of additional control variables.) The cross-sectional specifications are estimated on averages for the period 2000-2007. The panel specifications are estimated on non-overlapping 5-year and 10-year averages. As per standard practice, we take multi-year averages in order to sweep out any variation at the business cycle frequency. The panel data span 1962 to 2007 in the best of cases, though not all variables for all countries are available for all time periods.

3.1 The Instrument

The construction of the instrument exploits exogenous geographic characteristics of countries together with the empirically observed regularity that trade responds differentially to the standard gravity forces across sectors. The exposition here draws on, and extends, the material in Do and Levchenko (2007).

For each industry i, we estimate the Frankel and Romer (1999) gravity specification, which relates observed trade flows to exogenous geographic variables:

$$\begin{aligned} LogX_{icd} \;=\; & \alpha_i + \eta_i^1 ldist_{cd} + \eta_i^2 lpop_c + \eta_i^3 larea_c + \eta_i^4 lpop_d + \eta_i^5 larea_d + \\ & \eta_i^6 landlocked_{cd} + \eta_i^7 border_{cd} + \eta_i^8 border_{cd} \times ldist_{cd} + \\ & \eta_i^9 border_{cd} \times pop_c + \eta_i^{10} border_{cd} \times area_c + \eta_i^{11} border_{cd} \times pop_d + \\ & \eta_i^{12} border_{cd} \times area_d + \eta_i^{13} border_{cd} \times landlocked_{cd} + \epsilon_{icd}, \end{aligned} \tag{8}$$

where $LogX_{icd}$ is the log of exports as a share of GDP in industry i, from country c to country

d. The right-hand side consists of the geographical variables. In particular, $ldist_{cd}$ is the log of distance between the two countries, defined as distance between the major cities in the two countries, $lpop_c$ is the log of population of country c, $larea_c$ log of land area, $landlocked_{cd}$ takes the value of 0, 1, or 2 depending on whether none, one, or both of the trading countries are landlocked, and $border_{cd}$ is the dummy variable for common border. The right-hand side of the specification is identical to the one used by Frankel and Romer (1999). We use bilateral trade flows from the COMTRADE database, converted to the 3-digit ISIC Revision 3 classification. To estimate the gravity equation, the bilateral trade flows X_{icd} are averaged over the period 1980-2007. This allows us to smooth out any short-run variation in trade shares across sectors, and reduce the impact of zero observations.

Having estimated equation (8) for each industry, we then obtain the predicted logarithm of industry i exports to GDP from country c to each of its trading partners indexed by d, $\widehat{LogX}_{icd}$. In order to construct the predicted overall industry i exports as a share of GDP from country c, we then take the exponential of the predicted bilateral log of trade, and sum over the trading partner countries $d = 1, ..., C$, exactly as in Frankel and Romer (1999):

$$\widehat{X}_{ic} = \sum_{\substack{d=1 \\ d \neq c}}^{C} e^{\widehat{LogX}_{icd}}. \tag{9}$$

That is, predicted total trade as a share of GDP for each industry and country is the sum of the predicted bilateral trade to GDP over all trading partners.

The instrument for $FLNX$ is constructed using the predicted export shares in each industry i, rather than actual ones, in a manner identical to equation (5):

$$\widehat{FLNX}_c = \sum_{i=1}^{I} \widehat{\omega}_{ic}^X FL_i,$$

where the predicted share of total exports in industry i in country c, $\widehat{\omega}_{ic}^X$, is computed from the predicted export ratios $\widehat{X}_{ic}$:

$$\widehat{\omega}_{ic}^X = \frac{\widehat{X}_{ic}}{\sum_{i=1}^{I} \widehat{X}_{ic}}. \tag{10}$$

Note that even though $\widehat{X}_{ic}$ is exports in industry i normalized by a country's GDP, every sector is normalized by the same GDP, and thus they cancel out when we compute the predicted export share.

3.1.1 Discussion

We require an instrument for trade patterns, not trade volumes, and thus our strategy will only work if it produces different predictions for $\widehat{X}_{ic}$ across sectors for the same exporter. All of the geographical characteristics on the right-hand side of (8) do not vary by sector. However, crucially for the identification strategy, if the vector of estimated gravity coefficients $\boldsymbol{\eta}_i$ differs across sectors, so will the predicted total exports $\widehat{X}_{ic}$ across sectors i within the same country. The strategy of relying on variation in coefficient estimates for the same geographical variables bears an affinity to Feyrer (2009), who uses the differential effect of gravity variables on ocean-shipped vs. air-shipped trade to build a time-varying instrument for overall trade openness, and to Ortega and Peri (2014), who exploit the fact that the same gravity variables affect goods trade and migration flows differently to build separate instruments for overall trade openness and immigrant population.

This subsection (i) discusses the intuition for how the instrument works; (ii) reviews the existing sector-level gravity literature to provide reasons to expect the gravity coefficients to vary across sectors; (iii) describes the variation in our own gravity coefficients from estimating (8) by sector.

The following simple numerical example illustrates the logic of the strategy. Suppose that there are four countries: the US, the EU, Canada, and Australia, and two sectors, Apparel and Metals. Suppose further that the distance from Australia to either the US or the EU is 10,000 miles, but Canada is only 1,000 miles away from both the US and the EU (these distances are not too far from the actual values). Suppose that there are only these country pairs, and that trade between them is given in Table A1. Let the gravity model include only bilateral distance. The trade values have been chosen in such a way that a gravity regression estimated on the entire "sample" yields a coefficient on distance equal to -1, a common finding in the gravity literature. The gravity model estimated separately for each of the two sectors yields the distance coefficient is -0.75 in Apparel and -1.25 in Metals (this amount of variation in the distance coefficients is reasonable, as we show below). Using these "estimates" of the distance coefficients, it is straightforward to take the exponent and sum across the trading partners as in (9), and to calculate the predicted shares of total exports to the rest of the world in each of the two sectors, as in (10). Now let the share of female labor in Apparel be $FL_{APP} = 0.66$, and of Metals, $FL_{MET} = 0.12$ (these are the actual values of FL_i for these two industries). Then, the predicted female labor need of exports of Canada is $\widehat{FLNX}_{CAN} = 0.20$, which is one-third lower than the predicted value for Australia of $\widehat{FLNX}_{AUS} = 0.31$.

The key intuition from this example is that countries located far away from their trading partners will have *relatively* lower predicted export shares in goods for which the coefficient on distance is higher, compared to countries located close to their trading partners. This information is combined with cross-industry variation in female employment to generate predicted $\widehat{FLNX}$. There are several important points to note about this procedure. First, while this simple example focuses on the variation in distance coefficients along with differences in distances between countries, our actual empirical procedure exploits variation in all 13 regression coefficients in (8), along with the entire battery of exporting and destination country characteristics. Thus, to the extent that coefficients on other regressors also differ across sectors, variation in predicted $\widehat{FLNX}$ will come from the full set of geography variables. Second, while this simple four-country illustrative example may appear somewhat circular – actual exports and distance affect the gravity coefficient, which in turn is used to predict trade – in the real implementation we estimate the gravity model with a sample of more than 150 countries, and thus the trade pattern of any individual country is unlikely to affect the estimated gravity coefficients and therefore its predicted trade. Third, it is crucial for this procedure that the gravity coefficients (hopefully all 13 of them) vary appreciably across sectors. Below we discuss the actual estimation results for our gravity regressions, and demonstrate that this is indeed the case.

Can we support the notion that the gravity coefficients would be expected to differ across sectors? Most of the research on the gravity model focuses on the effects of trade barriers on trade volumes. Thus, existing empirical research is most informative on whether we should expect significant variation in the coefficients on distance and common border variables, which are meant to proxy for bilateral trade barriers. Anderson and van Wincoop (2003, 2004) show that the estimated coefficient on log distance is the product of the elasticity of trade flows with respect to iceberg trade costs (commonly referred to as simply the "trade elasticity") and the elasticity of iceberg trade costs with respect to distance. Thus, the distance coefficient will differ across industries if either or both of those elasticities differ across industries.

A number of papers estimate trade elasticities by sector (see, among many others, Feenstra, 1994; Broda and Weinstein, 2006; Caliendo and Parro, 2015; Imbs and Méjean, 2015). Imbs and Méjean (2015) – the most recent and the most comprehensive study – reports sector-level trade elasticity estimates using both of the principal estimation methods proposed in the literature. The conservative range of trade elasticities across sectors reported in that paper is from 2 to 20, consistent with the other studies undertaking similar exercises.

There is less direct evidence on whether the elasticity of iceberg trade costs with respect to distance varies across sectors. Trade costs do vary significantly across industries. Hummels (2001) compiles freight cost data, and shows that in 1994 these costs ranged between 1% and

27% across sectors in the US.[10] Hummels (2001, 2007) further provides evidence that the variation in freight costs is strongly related to the value-to-weight ratio: it is more expensive to ship goods that are heavy. Thus, it is plausible that the elasticity of trade costs with respect to distance is heterogeneous across sectors as well.

To summarize, there are strong reasons to expect the coefficients in (8) to vary across sectors. It is indeed typical to find variation in the gravity coefficients across sectors, though studies differ in the level of sectoral disaggregation and specifications (see, e.g. Rauch, 1999; Rauch and Trindade, 2002; Hummels, 2001; Evans, 2003; Feenstra et al., 2001; Berthelon and Freund, 2008). For instance, Hummels (2001) finds that the distance coefficients vary from zero to -1.07 in his sample of sectors, while the coefficients on the common border variable range from positive and significant (as high as 1.22) to negative and significant (as low as -1.23).

Table A2 reports the cross-sectoral variation in the gravity coefficients in our estimates. For each coefficient, it reports the mean, standard deviation, min, and max in our sample of sectors. The variation in all of the gravity coefficients across sectors is considerable. The distance coefficient, as expected, is on average around -1, but the range across sectors is from -2.42 to -0.10. The common border coefficient has a mean of 0.66, and a standard deviation of 3.68 across sectors. Our instrumentation strategy relies on this variation in sectoral coefficients.

There is another potentially important issue, namely the zero trade observations. In our gravity sample, only about two-thirds of the possible exporter-importer pairs record positive exports, in any sector. At the level of individual industry, on average only a third of possible country-pairs have strictly positive exports, in spite of the coarse level of aggregation.[11] We follow the Do and Levchenko (2007) procedure, and deal with zero observations in two ways. First, following the large majority of gravity studies, we take logs of trade values, and thus the baseline gravity estimation procedure ignores zeros. However, instead of predicting in-sample, we use the estimated gravity model to predict out-of-sample. Thus, for those observations that are zero or missing and are not used in the actual estimation, we still predict trade.[12] In the second approach, we instead estimate the gravity regression in levels using the Poisson pseudo-maximum likelihood estimator suggested by Santos Silva and Tenreyro

[10] In addition to the simple shipping costs, trade costs differ across industries in other ways. For instance, trade volumes in differentiated and homogeneous goods sectors react differently to informational barriers (Rauch, 1999; Rauch and Trindade, 2002), and to importing country institutions such as rule of law (Berkowitz et al., 2006; Ranjan and Lee, 2007).

[11] These two calculations make the common assumption that missing trade observations represent zeros (see Helpman et al., 2008).

[12] More precisely, for a given exporter-importer pair, we predict bilateral exports out-of-sample for all sectors as long as there is any bilateral exports for that country pair in at least one of the sectors.

(2006). The advantage of this procedure is that it actually includes zero observations in the estimation, and can predict both zero and non- zero trade values in-sample from the same estimated equation. Its disadvantage is that it assumes a particular likelihood function, and is not (yet) the standard way of estimating gravity equations found in the literature. Below we report the results of implementing both alternative approaches. It turns out that they deliver very similar results, an indication that the zeros problem is not an important one for this empirical strategy.

Finally, we stress that unfortunately this instrumentation strategy is only available in the cross-section. In principle, a time-varying instrument for trade patterns could be constructed in this way and used in a panel specification with country and time fixed effects. This procedure would rely on the sector-level gravity coefficients varying over time (differentially across sectors). Our attempt to implement this strategy revealed that there is simply not enough differential time variation in the gravity coefficients for this strategy to be feasible.

4 Data Sources and Summary Statistics

The key indicator required for the analysis is the share of female workers in the total employment in each sector, FL_i. The baseline measures of FL_i come from the Labor Force Statistics database of the US Bureau of Labor Statistics (BLS). The BLS has published "Women in the Labor Force: A Databook" on an annual basis since 2005. It contains information on total employment and the female share of employment in each industry covered by the Census, sourced from the Current Population Survey. The data are available at the 4-digit US Census 2007 classification comprised of 262 distinct sectors, covering both tradeables (manufacturing and non-manufacturing) and non-tradeables (services). In order to construct the share of female workers in total sectoral employment FL_i, we take the mean of this value across the years for which the data on the female share of employment are available (2004-2009). After dropping non-tradeables, the sector sample includes 79 sectors, 10 of which are in agriculture and mining, and the rest in manufacturing.

Table 1 reports the values of FL_i in our sample of sectors, in descending order. There is wide variation in the share of women in sectoral employment. While the mean is 27 percent, these values range from the high of 66 percent in wearing apparel and over 50 percent in footwear and other apparel-related sectors to the low of 5.5 percent in logging and coal mining.[13]

[13]A potential concern that these values may be very different across countries in general, and across developed and developing countries in particular. However, it turns out that the rankings of sectors are remarkably similar across countries. An earlier working paper version of this paper (Do et al., 2014) built measures of FL_i based on the multi-country UNIDO database that contains information on the female

The export shares ω_{ict}^X are calculated based on the COMTRADE database, which contains bilateral trade data covering manufacturing, agriculture, and mining sectors starting in 1962 in the 4-digit SITC revision 1 and 2 classification. The trade data are aggregated up to the US Census classification using a concordance developed by the authors.

Table 2 reports some summary statistics for the female labor needs of exports for the OECD and non-OECD country groups. For the OECD, the mean $FLNX$ rises modestly between the 1960s and the 2000s, from 0.272 to 0.279. For the non-OECD countries, the mean $FLNX$ increases somewhat more over this period, from 0.255 to 0.291. Notably, the dispersion in $FLNX$ among the non-OECD countries is both much greater than among the OECD, and increasing over time. In the OECD sample, the standard deviation is stable around 0.030-0.040, whereas in the non-OECD sample it rises monotonically from 0.055 to 0.094 between the 1960s and the 2000s.

Tables 3 reports the countries with the highest and lowest $FLNX$ values. Typically, countries with the highest values of female content of exports are those that export mostly textiles and wearing apparel, while countries with the lowest $FLNX$ are natural resource exporters.

Table 4 reports the countries with the largest positive and negative changes in $FLNX$ between the 1960s and today. Relative to the cross-sectional variation, the time variation is also considerable. For the countries with the largest observed increases in $FLNX$, the common pattern is that they change their specialization from agriculture-based sectors to wearing apparel. For instance, in the 1960s 80% of exports from Cambodia were in the agriculture and food products sectors. By the 2000s, 85% of Cambodian exports are in wearing apparel. The other countries in the top 10 largest positive changes in $FLNX$ follow this pattern as well. Since food products sectors are right in the middle of the FL_i distribution, and wearing apparel is the most female-intensive sector, this type of specialization change will lead to large increases in $FLNX$.

The largest observed decreases in $FLNX$ are driven by the discovery of natural resources.

employment shares for a sample of 22 developed and developing countries over the period 1993-2008. In that data, the values of FL_i computed on the OECD and non-OECD samples have a correlation of 0.9. The levels are similar as well, with the average FL_i in the OECD of 0.29, and in the non-OECD of 0.27 in this sample of countries. Pooling all the countries together, the first principal component explains 77 percent of the cross-sectoral variation across countries, suggesting that rankings are very similar. Another concern is that FL_i is measured based on data from the 2000s, whereas our panel estimation sample goes back several decades. We can examine how stable FL_i is over time in UNIDO data, where FL_i can be computed from 1993 to 2008. The average correlation between FL_i based on individual years is 0.964, with a minimum of 0.903. Taking the ends of the sample, both the simple and the Spearman rank correlation between FL_i in 1993 and in 2008 is 0.907. We conclude that the ranking of female labor intensity of sectors is quite stable over this period. Our measure of FL_i can be combined with data for earlier time periods as long as there are no "gender-intensity reversals" over time, that is, the ranking of industries by female intensity is stable.

For instance, in Tanzania the second largest export sector after agriculture in the 1960s was textiles, accounting for one-third of exports. By the 2000s, while agriculture retained its primacy, the second-largest sector is now aluminum. The natural resource-based sectors are among the least female-intensive, which accounts for why countries with major shifts towards natural resources exhibit reductions in their $FLNX$.

It turns out that these two groups of countries experienced very different changes in fertility. Among the 10 countries with the largest increases in $FLNX$, fertility fell on average by 3.7 children per woman, from 6.7 to 3.1 between the 1960s and the 2000s. By contrast, in the 10 countries with the largest decreases in $FLNX$, fertility fell by only 1.7 children per woman over the same period, from 5.5 to 3.8. Remarkably, while the latter group actually had lower fertility levels in the 1960s, their subsequent paths were very different. This is of course only an illustrative example, and the next section explores these patterns formally.

Data on fertility are sourced from the World Bank's World Development Indicators. The baseline controls – PPP-adjusted per capita income and overall trade openness – come from the Penn World Tables. Table 2 presents the summary statistics for fertility (number of births per women) in each decade and separately for OECD and non-OECD countries. There is considerable variation in fertility across countries: while the mean fertility in the 2000s is 3.1 births per woman in our sample of countries, the standard deviation is 1.7, and the 10th-90th percent range spans from 1.3 to 6.1. The table highlights the pronounced cross-sectional differences between high- and low-income countries, as well as the secular reductions in fertility over time in both groups of countries. Our final dataset contains country-level variables on up to 146 countries.

5 Empirical Results

5.1 Cross-sectional results

Table 5 reports the results of estimating the cross-sectional specification in equation (6). Both left-hand side and the right-hand side variables are in natural logs. All of the specifications control for income per capita and overall openness. Column 1 presents the OLS results. There is a pronounced negative relationship between the female-labor need of exports and fertility, significant at the one percent level. By contrast, the coefficient on overall trade openness is essentially zero and not significant. As is well known, income per capita is significantly negatively correlated with fertility. These three variables absorb a great deal of variation in fertility across countries: the R^2 in this regression is 0.68. Column 2 repeats the

OLS exercise but including the regional dummies.[14] The R^2 increases to 0.83, but the female labor need of exports remains equally significant. Figure 1 displays the partial correlation between fertility and $FLNX$ from Column 2 of Table 5.

Column 3 implements the 2SLS procedure. The bottom panel displays the results of the first stage. As expected, the instrument is highly significant with a t-statistic of 7.7, and the F-statistic for the excluded instrument of 56.42 is comfortably within the range that allows us to conclude that the instrument is strong (Stock and Yogo, 2005). Figure 2 presents the partial correlation plot from the first stage regression between $FLNX$ and the instrument. There is a clear positive association between the two variables that does not appear to be driven by a few outliers. As expected, the variation in the instrument is much smaller than the variation in the actual $FLNX$. The instrument is predicting $FLNX$ while throwing out a great deal of country-specific information, and thus the instrument's predictions for the country-specific $FLNX$ vary much less across countries than do actual values.

In the second stage, the main variable of interest, $FLNX$, is statistically significant at the one percent level, with a coefficient substantially larger in absolute value than the OLS coefficient. Column 4 repeats the 2SLS exercise adding regional dummies. The second-stage coefficient of interest both increases in absolute value and becomes more statistically significant.

The OLS and 2SLS results described above constitute the main cross-sectional finding of the paper. Countries that have a comparative advantage in the female-intensive sectors exhibit lower fertility. The estimates are economically significant. Taking the coefficient in column 4 as our preferred estimate, a 10 percent change in $FLNX$ leads to a 5.9 percent lower fertility rate. In absolute terms, this implies that moving from the 25th to the 75th percentile in the distribution of the female labor needs of exports lowers fertility by as much as 20 percent, or about 0.36 standard deviations of average fertility across countries. Applied to the mean of 3.1 births per woman in this sample of countries, the movement from the 25th to the 75th percentile in $FLNX$ implies a reduction of 0.6 births per woman.

5.2 Panel Results

The cross-sectional 2SLS results are informative, and allow us to make the clearest case for the causal relationship between comparative advantage and fertility. However, because they do not allow the use of country fixed effects, the cross-sectional results may still suffer from omitted variables problems. As an alternative empirical strategy, we estimate the panel

[14] The regional dummies correspond to the official World Bank region definitions: East Asia and Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, North America, South Asia, and Sub-Saharan Africa.

specification (7) on non-overlapping 5-year and 10-year averages from 1962 to 2007. The gravity-based instrumentation strategy is not feasible in a panel setting with fixed effects. On the other hand, country effects allow us to control for a wide range of unobservable time-invariant country characteristics, and identify the coefficient of interest from the variation in $FLNX$ and fertility within a country over time.

The results are presented in Table 6. To control for autocorrelation in the error term, all standard errors are clustered at the country level. Column 1 reports the results for the pooled specification without any fixed effects. The coefficient is negative and strongly significant. Column 2 adds country fixed effects. The coefficient on $FLNX$ is nearly unchanged, and significant at the one percent level. Column 3 adds time effects to control for secular global trends, while column 4 adds female educational attainment. The results continue to be highly significant. Columns 5–8 repeat the exercise taking 10-year averages instead.[15] The coefficients are very similar in magnitude and equally significant.

5.3 Robustness

We now check the robustness of the cross-sectional result in a number of ways. The first set of checks is on how the instrument construction treats zero trade observations. As detailed in Section 3.1, the baseline instrument estimates the standard log-linear gravity specification that omits zeros in the trade matrix, and predicts trade only for those values in which observed trade is positive. We address the issue of zeros in two ways. The first is to predict trade values for the observations in which actual trade is zero based on the same log-linear regression. The second is to instead estimate a Poisson pseudo-maximum likelihood model on the levels of trade values, as suggested by Santos Silva and Tenreyro (2006). In this exercise, the zero trade observations are included in the estimation sample. The results of using those two alternative instruments are presented in columns 5 and 6 of Table 5. Very little is changed. The instruments continue to be strong, and the second-stage coefficients of interest are similar in magnitude and significant at the one percent level. We conclude from this exercise that the way zeros are treated in the construction of the instrument does not affect the main results.

Another concern is that the instrument is constructed based on variables – such as population – that do not satisfy the exclusion restriction. Note that the instrument relies on the *differential* impact of each gravity variable across sectors, as determined by the sectoral variation in non-country-specific gravity coefficients. To further probe into the importance of the country-specific gravity variables, column 7 of Table 5 implements the instrument

[15] To be precise, these are decadal averages for the 1960s, 1970s, and up to 2000s. Since our yearly data are for 1962-2007, the 1960s and the 2000s are averages over less than 10 years.

without the exporter population (the population of each particular trading partner is plausibly exogenous to the exporting country's fertility). The instrument remains strong, as evidenced by the first stage diagnostics. The coefficient drops by one-third, but the main result remains robust. Alternatively, column 8 controls for area and population directly. The coefficient of interest remains significant and of similar magnitude, while population and area are insignificant as a determinant of fertility in this specification.

Table 7 performs a number of additional specification checks. All columns report the 2SLS results controlling for openness, income, and regional dummies. First, it might be that what matters is the female labor needs of *net* exports. That is, perhaps a country imports a lot of the female-labor intensive goods, in which case its domestic demand for female labor will be lower. This is unlikely to be a major force on average, as import baskets tend to be more similar across countries than export baskets. Most countries specialize in a few sectors, but import a broad range of products. Indeed, in our data the standard deviation of the "female labor need of *imports*" ($FLNI$) is 4 times smaller than the standard deviation of $FLNX$. Nonetheless, to check the robustness of the results, we use the female labor need of net exports, $FLNX - FLNI$, as the independent variable. Since it can take negative values, we must use levels rather than logs. As the instrument, we use the level of predicted $FLNX$, rather than log. Column 1 of Table 7 reports the results, and shows that they are robust to using this alternative regressor of interest.

Next, we check whether the results are robust to including additional controls. Column 2 controls for female schooling, to account for the possible relationship between education and fertility. Female schooling is measured as the average number of years of schooling in the female population over 25, and is sourced from Barro and Lee (2000). While higher female schooling is indeed associated with lower fertility, the coefficient on $FLNX$ changes little and continues to be significant at the one percent level. Column 3 controls for the prevalence of child labor, since fertility is expected to be higher when children can contribute income to the household. Child labor is measured as the percentage of population aged 10-14 that is working, and comes from Edmonds and Pavcnik (2006). While the prevalence of child labor is indeed positively associated with fertility, the main coefficient of interest remains robust. Column 4 controls for infant mortality, sourced from the World Bank's World Development Indicators. Countries with higher infant mortality have higher fertility, but our coefficient of interest remains robust.

Next, column 5 controls for income inequality, using the Gini coefficient from the World Bank's World Development Indicators. Higher inequality is associated with higher fertility, but once again the main result is robust. Finally, column 6 controls for the extent of democracy, using the Polity2 index from the Polity IV database. The extent of democracy is not significantly associated with fertility, and $FLNX$ is still significant at the one percent level.

Table 8 checks whether the finding is driven by particular countries. Column 1 drops outliers: the top 5 and bottom 5 countries in the distribution of $FLNX$. Column 2 drops the OECD countries, to make sure that our results are not driven simply by the distinction between high-income countries and everyone else.[16] Column 3 drops Sub-Saharan Africa, and column 4 drops the Middle East and North Africa region. The results are fully robust to dropping outliers and these important country groups. The coefficients are similar to the baseline and the significance is at one percent throughout. Finally, column 5 drops mining exporters, defined as countries that have more than 60% of their exports in Mining and Quarrying, a sector that includes crude petroleum.[17] The results are unaffected by dropping these countries.

Table 9 looks at whether the effect of $FLNX$ on fertility is present in other time periods, by estimating the baseline 2SLS specification on every decade from the 1960s to the 1990s. The effect is present in all decades except the 1960s, consistent with the fact that in the 1960s trade globalization was in much earlier stages, so the effect of trade is expected to be more muted.

Finally, one may be worried that the US-based measures of FL_i may not be representative of the average country's experience. An earlier working paper version of our paper (Do et al., 2014) carried out the entire analysis using a measure of FL_i computed on a sample of 22 countries. This information comes from the UNIDO Industrial Statistics Database (INDSTAT4 2009), which records the total employment and female employment in each manufacturing sector for a large number of countries at the 3-digit ISIC Revision 3 classification (61 distinct sectors), starting in the mid-1990s. We compute FL_i as the mean share of female workers in total employment in sector i across the countries for which these data are available and relatively complete. This sample includes 11 countries in each of the developed and developing sub-samples: Austria, Cyprus, Ireland, Italy, Japan, Lithuania, Korea, Malta, New Zealand, Slovak Republic, United Kingdom; and Azerbaijan, Chile, Egypt, India, Indonesia, Jordan, Malaysia, Morocco, Philippines, Thailand, Turkey. The results are fully robust to this alternative way of measuring the female intensity of industries.

[16] OECD countries in the sample are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. We thus exclude the newer members of the OECD, such as Korea and Mexico.

[17] These countries are Algeria, Angola, Republic of Congo, Gabon, Islamic Republic of Iran, Kuwait, Nigeria, Oman, Saudi Arabia, and Syrian Arab Republic.

5.4 Mechanisms and Other Outcome Variables

The women's opportunity-cost-of-time hypothesis has a natural counterpart in another use of time, namely female labor force participation (FLFP). We should expect that an increase in comparative advantage in female-intensive sectors, as it lowers fertility, should also increase FLFP. Appendix B discusses this issue at length and estimates the relationship between comparative advantage in female-intensive sectors and FLFP. It appears that comparative advantage in female-intensive sectors increases FLFP, but only for countries with lower levels of income and female educational attainment and higher fertility. We argue that this type of conditional relationship should be expected, given that there is no simple relationship between fertility and FLFP, either in theory or in the data.[18] The results with respect to FLFP are nonetheless supportive of the main hypothesis in the paper.

Similarly, one may expect to see a lower gender wage gap in countries with a comparative advantage in female-intensive industries. Unfortunately, testing this hypothesis is even more challenging than for FLFP. First and foremost, there are no reliable and comprehensive data on the gender wage gaps for a large enough cross-section (much less a panel) of countries. Second, even if data on the gender wage gaps were available, actual wage outcomes are affected by worker heterogeneity in a number of ways that would be challenging to account for in estimation. Across countries, there are large differences in the age, work experience, and education distributions of both the male and female labor force. Within countries, wages are only observed conditional on working, which introduces sample selection problem. Controlling convincingly for these major confounding factors would be infeasible in our cross-country context.

6 Conclusion

Fertility is an economic decision, and like all economic decisions has long been considered an appropriate – and important – subject of analysis by economists. As trade integration increased in recent decades, there is growing recognition that the impacts of globalization are being felt well beyond the traditional market outcomes such as average wages, skill premia, and (un)employment. This paper makes the case that international trade, or more precisely

[18] Indeed, in the data there is no simple negative relationship between fertility and FLFP. For instance, Ahn and Mira (2002) show that it is not stable even in the cross-section of OECD countries: FLFP was was negatively correlated with fertility until the 1970s and 1980s, and but since then the correlation changed sign, and fertility is now positively correlated with FLFP. Furthermore, Hazan and Zoabi (2014) show that among US households the income-fertility relationship has gone from negative up until the 1990s to U-shaped in the 2000s. Hazan and Zoabi (2014)'s explanation is that at the very high levels of income, women buy childcare services, which enables them to both work longer hours and have more children.

comparative advantage, matters for one key non-market outcome: the fertility decision.

Our results thus emphasize the heterogeneity of the effects of trade on countries' industrial structures and gender outcomes. At a more conjectural level, to the extent that comparative advantage impacts fertility, it may also impact women's human capital investments, occupational choice, and bargaining power within the household. From a policy perspective, our results suggest that it will be more difficult for countries with technologically-based comparative advantage in male-intensive goods to undertake policy measures to reduce the gender gap, potentially leading to a slower pace of women's empowerment. In an increasingly integrated global market, the road to female empowerment is paradoxically very specific to each country's productive structure and exposure to international trade. At the same time, since our paper points to comparative advantage as a determinant of women's opportunities, a potential policy lever to affect the gender gap could be through industrial policy promoting female-intensive sectors.

Appendix A Theory: Formal Derivation

It will be convenient to express all the equilibrium outcomes of the economy (prices and quantities) as functions of $\theta^c \equiv \frac{K_F^c}{K_M^c}$ instead of K_F^c.

A.1 Production and Trade Equilibrium

We first characterize the production and trade equilibrium under a fixed female labor supply $L_F^c = 1 - \lambda N^c$, for a given $N^c \in \left[0, \frac{1}{\lambda}\right]$.

Firms' optimization In each of the two sectors $i \in \{M, F\}$, firms rent capital and hire labor to maximize profits:

$$\max_{K,L} p_i i^c K^\alpha L^{1-\alpha} - r^c K - w_i^c L.$$

The necessary and sufficient first-order conditions with respect to K_i^c yield the following expression for the return to capital: $\frac{r^c}{p_i} = \alpha i^c \left(\frac{L_i^c}{K_i^c}\right)^{1-\alpha}$. Equalizing the returns to capital across sectors and assuming that labor markets clear pins down relative prices of the two goods: $\frac{p_F}{p_M} = \frac{M^c}{F^c}\left(\frac{\theta^c}{1-\lambda N^c}\right)^{1-\alpha}$. Under the choice of numeraire (4), prices are equal to

$$\begin{cases} p_F & = \frac{1}{F^c}\left(\frac{\theta^c}{1-\lambda N^c}\right)^{(1-\alpha)(1-\eta)} \\ p_M & = \frac{1}{M^c}\left(\frac{1-\lambda N^c}{\theta^c}\right)^{(1-\alpha)\eta} \end{cases}, \tag{A.1}$$

which yields the following expression for the return to capital:

$$r^c = \alpha \left[(1+\theta^c) \left(\frac{1-\lambda N^c}{\theta^c} \right)^{\eta} \right]^{1-\alpha}. \quad \text{(A.2)}$$

Finally, the necessary and sufficient first-order conditions with respect to L_i^c yield $\frac{w_i^c}{p_i} = (1-\alpha)\, i^c \left(\frac{K_i^c}{L_i^c} \right)^{\alpha}$, which pins down equilibrium wages of women and men:

$$w_F^c = (1-\alpha) \left(\frac{1}{1+\theta^c} \right)^{\alpha} \left(\frac{\theta^c}{1-\lambda N^c} \right)^{1-\eta(1-\alpha)} \quad \text{(A.3)}$$

$$w_M^c = (1-\alpha) \left(\frac{1}{1+\theta^c} \right)^{\alpha} \left(\frac{\theta^c}{1-\lambda N^c} \right)^{-\eta(1-\alpha)} \quad \text{(A.4)}$$

Consumers' optimization, market clearing conditions, and the law of one price The Cobb-Douglas specification of the consumption bundle implies $p_F C_F^c = \eta E^c$ and $p_M C_M^c = (1-\eta)\, E^c$, where expenditure is equal to income derived from wages paid to labor and rental of capital: $E^c = r^c + w_F^c (1-\lambda N^c) + w_M^c$. Aggregate consumption of good F equalizes aggregate production, so that $\sum_c p_F F^c (1-K_M^c)^{\alpha} (1-\lambda N^c)^{1-\alpha} = \eta \left[\sum_c r^c + (1-\lambda N^c)\, w_F^c + w_M^c \right]$, which can be rewritten

$$\sum_c M^c \left(\frac{1}{1+\theta^c} \right)^{\alpha} \left[\eta - (1-\eta)\, \theta^c \right] = 0. \quad \text{(A.5)}$$

Since the law of one price holds, equalizing the right-hand sides of equation (A.1) in the two countries for sector F leads to the following condition:

$$\frac{M^c}{F^c} \left(\frac{\theta^c}{1-\lambda N^c} \right)^{1-\alpha} = \frac{M^{-c}}{F^{-c}} \left(\frac{\theta^{-c}}{1-\lambda N^{-c}} \right)^{1-\alpha}, \quad \text{(A.6)}$$

where the notation "$-c$" denotes "not country c."

Characterization of production equilibrium We define $\gamma^c = \left(\frac{F^c}{M^c} \frac{M^{-c}}{F^{-c}} \right)^{\frac{1}{1-\alpha}}$, and $\rho^c = \gamma^c \frac{1-\lambda N^c}{1-\lambda N^{-c}}$. A value $\rho^c > 1$ indicates that country c has a comparative advantage in the female-intensive good F. The comparative advantage can be decomposed into a *technological* or Ricardian component γ^c and an *occupational* or "factor-proportions" component $\frac{1-\lambda N^c}{1-\lambda N^{-c}}$, which can exacerbate or attenuate technological differences. We rewrite the two equations (A.5) and (A.6) as a system of two equations with two unknowns $\{\theta^c, \theta^{-c}\}$ given exogenous model parameters and "pre-determined" values $\{N^c, N^{-c}\}$:

$$\frac{\eta - (1-\eta)\, \theta^c}{(1+\theta^c)^{\alpha}} + (\gamma^c)^{\eta(1-\alpha)} \frac{\eta - (1-\eta)\, \theta^{-c}}{(1+\theta^{-c})^{\alpha}} = 0 \quad \text{(A.7)}$$

$$\rho^c \frac{\theta^{-c}}{\theta^c} = 1 \quad \text{(A.8)}$$

Equation (A.7) implicitly defines a downward-sloping "goods market-clearing curve" in the space $(\theta^{-c}, \theta^{c})$ and is just a rearrangement of equation (A.5), keeping in mind that normalization (2) implies that $\frac{M^{-c}}{M^{c}} = \left(\frac{F^{c}M^{-c}}{M^{c}F^{-c}}\right)^{\eta} = (\gamma^{c})^{\eta(1-\alpha)}$. Since goods produced by the two countries are perfect substitutes, market clearing implies a negative relationship between the size θ^{c} of the F-sector in country c and its size θ^{-c} in country $-c$. On the other hand, the upward-sloping "factor market-clearing curve" in the space $(\theta^{-c}, \theta^{c})$, defined by (A.8), implies that F-sectors have to be of comparable size in the two countries (i.e. the larger sector F gets in country c, the larger it needs to be in country $-c$ as well), otherwise the return to capital will diverge across the F- and M-sectors in each country. Thus, allocations of capital between two sectors in the two countries $\{\theta^{c}\}^{c\in\{X,Y\}}$ are uniquely determined by the system of two equations (A.7) and (A.8).

Proposition A1: Production and trade equilibrium Consider the endowment structure $\left\{\bar{K}^{c}, \bar{L}_{M}^{c}, L_{F}^{c}\right\}^{c\in\{X,Y\}} = \left\{1, 1, 1-\lambda N^{c}\right\}^{c\in\{X,Y\}}$. The unique production and consumption equilibrium is characterized by the vector of prices $\{p_i, r^{c}, w_i^{c}\}_{i\in\{M,F\}}^{c\in\{X,Y\}}$ defined by (A.1)-(A.4), and capital allocations $\{\theta^{c}\}^{c\in\{X,Y\}}$ that solve (A.7)-(A.8).■

Proof of Proposition A1 The "goods market-clearing curve" and "factor market-clearing curve" have opposite slopes. We therefore need to show that they intersect at least once, since if they do, such intersection is unique. A necessary and sufficient condition for the two curves to intersect is that the "goods market-clearing curve" be above the "factor market-clearing curve" for low values of f^{c} and below for larger values of θ^{c}.

- As θ^{c} gets arbitrarily close to 0, equality (A.7) implies that the "goods market-clearing" curve is bounded below by $\frac{1}{1-\eta}$, while (A.8) indicates that the "factor market-clearing" curve converges to $1 < \frac{1}{1-\eta}$, and therefore lies below the "goods market-clearing" curve.
- On the other hand, when θ^{c} grows arbitrarily large, the "goods market-clearing" curve converges to $\frac{1}{1-\eta}$, while the "factor market-clearing" diverges, and hence lies above the "goods market-clearing" curve.

Thus, the "goods market-clearing" curve is above the "factor market-clearing" curve in the neighborhood of 1, while the opposite holds for large values of θ^{c}. Continuity of the two curves implies existence of an intersection.■

The proof of Proposition A1 establishes existence of an intersection of the two "factor market-clearing" and "goods market-clearing" curves, which is therefore unique since the two curves have opposite slopes.

A.2 Fertility Decisions

The analysis above is carried out under an exogenously fixed fertility rate or, equivalently, an exogenously fixed level of female labor force participation. We now turn to endogenizing households' fertility decisions. To pin down equilibrium fertility N^{c}, we proceed in two steps. First, for a given N^{-c}, w_F^{c} and N^{c} are jointly determined by labor supply and demand. Thus, we must ensure that labor supply is upward-sloping and the female labor market equilibrium is well defined. Second, fertility in the other country affects the labor market equilibrium by shifting female labor demand and hence fertility in country c. We therefore look for a fixed point in $\{N^c, N^{-c}\}$ such that the female labor markets are in equilibrium in both countries simultaneously.

Fertility choices and female labor supply Taking N^{-c} as given and anticipating the production equilibrium prices and quantities, households make fertility decisions accordingly. Namely, they take prices as given and choose N^c to maximize their indirect utility:

$$V^c(N) = r^c + w_F^c(1 - \lambda N) + w_M^c + v(N). \tag{A.9}$$

The first-order condition for the representative household's fertility decision is necessary and sufficient and given by

$$\begin{cases} w_F^c = \frac{v'(N^c)}{\lambda} & \text{if } N^c < \frac{1}{\lambda} \\ w_F^c \leq \frac{v'(N^c)}{\lambda} & \text{if } N^c = \frac{1}{\lambda} \end{cases}. \tag{A.10}$$

Since $v(.)$ is concave, female labor market supply implicit in (A.10) is upward-sloping: a rise in women's wages reduces fertility and hence increases female labor supply.

Female labor demand For a given set of parameters $\left\{F^X, M^X, F^Y, M^Y, N^{-c}\right\}$, equation (A.3) defines a downward-sloping female market labor demand curve. To see this, we rewrite labor demand using (A.8):

$$w_F^c = (1-\alpha)\left(\frac{1}{1+\theta^c}\right)^{\alpha}\left(\gamma^c \frac{\theta^{-c}-1}{1-\lambda N^{-c}}\right)^{1-\eta(1-\alpha)}. \tag{A.11}$$

Thus, for a given female labor force supply $1 - \lambda N^{-c}$ in country $-c$, w_F^c decreases with θ^c and increases with θ^{-c}. To sign the slope of the female labor demand curve, we first establish the following result:

Lemma A1: Comparative statics in partial equilibrium If comparative advantage of country $c \in \{X, Y\}$ in the female-labor intensive sector becomes stronger (ρ^c increases), then country c has a larger female-labor intensive sector: $\frac{d\theta^c}{d\rho^c}(\rho^c) > 0.$■

Proof of Lemma A1 From equation (A.7), let's try to characterize the behavior of θ^c when the patterns of comparative advantage ρ are changing.

Dropping the country reference and substituting for θ^{-c}, f is implicitly defined for every ρ by:

$$\left(\frac{\theta}{\rho}+1\right)^{\alpha}[\eta - (1-\eta)\theta] + (\gamma^c)^{\eta(1-\alpha)}(1+\theta)^{\alpha}\left[\eta - \frac{\theta}{\rho}(1-\eta)\right] = 0$$

that is denoted $x(\theta,\rho)=0$. On the one hand,

$$\frac{\partial x(\theta,\rho)}{\partial\rho} = -\frac{\alpha\theta}{\rho^2}\left(\frac{\theta}{\rho}+1\right)^{\alpha-1}[\eta-(1-\eta)\theta]+(\gamma^c)^{\eta(1-\alpha)}(1+\theta)^{\alpha}\frac{(1-\eta)\theta}{\rho^2}$$

and since $x(\theta,\rho)=0$, we can rewrite

$$\frac{\partial x(\theta,\rho)}{\partial\rho} = (\gamma^c)^{\eta(1-\alpha)}\frac{(1+\theta)^{\alpha}}{\rho}\frac{\theta}{\rho+\theta}\left[\alpha\eta+(1-\eta)+(1-\alpha)(1-\eta)\frac{\theta}{\rho}\right]$$

On the other hand, similar derivation yields

$$\frac{\partial x(\theta,\rho)}{\partial\theta} = (\gamma^c)^{\eta(1-\alpha)}(1+\theta)^{\alpha}\left(\frac{\rho-1}{\rho}\right)\left\{\frac{\alpha[\eta\rho-\theta(1-\eta)]}{(1+\theta)(\theta+\rho)}+\frac{\eta(1-\eta)}{[\eta-(1-\eta)\theta]}\right\}$$

The implicit function theorem indicates that $\theta(\rho)$ is well defined and continuously differentiable around ρ such that $x(\theta(\rho),\rho)=0$; we can now compute the derivative of θ with respect to ρ :

$$\theta'(\rho) = \frac{(1-\eta)\theta-\eta}{\rho-1}\frac{\theta(1+\theta)\left[\alpha\eta+(1-\eta)+(1-\alpha)(1-\eta)\frac{\theta}{\rho}\right]}{\eta\rho[\alpha+(1-\alpha)(1-\eta)(1+\theta)]+\theta(1-\eta)[\alpha\theta+(1-\alpha)\eta(1+\theta)]}$$

The second term of the equation is always positive; by virtue of (A.7) and (A.8), the first term $\frac{(1-\eta)\theta-\eta}{\rho-1}>0$. We thus have

$$\theta'(\rho)>0.$$

■

Lemma A2: Fertility in partial equilibrium For a given level of the other country's fertility level N^{-c}, there exists a unique N^c satisfying both (A.10) and (A.11).■

Proof of Lemma A2 Having established that the female labor demand curve is downward sloping for every level of country $-c$'s female labor force participation and that the female labor supply curve is upward sloping, we have shown uniqueness of an intersection. We now need to show existence of an intersection.

- As N^c goes to zero (i.e. female labor supply goes to 1), the labor supply curve defined by (A.10) diverges given that $\lim_0 v'(.)=+\infty$, by assumption. The labor demand curve is on the other hand bounded above since it is downward sloping; it therefore lies below the labor supply curve.

- Let's now let N^c get arbitrarily close to $\frac{1}{\lambda}$, so that ρ^c converges to zero. Equation (A.8) implies that θ^c will converge to 0, so that, by virtue of (A.7), θ^{-c} will converge to some $\bar{\theta}^{-c}>0$ such that $\eta+(\gamma^c)^{\eta(1-\alpha)}\left(\bar{\theta}^{-c}+1\right)^{-\alpha}\left[\eta-(1-\eta)\bar{\theta}^{-c}\right]=0$. Thus, the labor demand curve converges to some positive wage $\bar{w}_F^c$. Two cases arise:

– if $\frac{v'\left(\frac{1}{\lambda}\right)}{\lambda} < \bar{w}_F^c$, then the labor supply curve is below the labor demand curve at $N^c \to \frac{1}{\lambda}$; the labor supply curve is thus above the labor demand curve in the neighborhood of $N^c = 0$, while below in the neighborhood of $N^c = \frac{1}{\lambda}$. Continuity of the two curves implies existence of an intersection, and thus existence of a well-defined fertility decision equilibrium.

– if $\frac{v'\left(\frac{1}{\lambda}\right)}{\lambda} \geq \bar{w}_F^c$, then the two curves intersect in $\left(1, \bar{w}_F^c\right)$.

The two possibilities are depicted in Figure A1.■

In the proof of Lemma A2, we establish that the female labor supply and demand curves either intersect at the corner, i.e. $N^c = \frac{1}{\lambda}$, or in the interior and the solution is also unique since labor supply and demand curves have opposite slopes.

Equilibrium fertility Lemma A2 and the labor demand equation (A.11) imply that the female labor demand curve in country c shifts down when female labor supply in country $-c$ goes up. Thus $N^c\left(N^{-c}\right)$, the equilibrium fertility rate in country c when that rate in country $-c$ is N^{-c}, is decreasing; so is $N^{-c}\left(N^c\right)$. The following proposition formally establishes that these two "reaction functions" intersect and therefore defines the complete equilibrium of the economy.

Proposition A2: Full characterization of the equilibrium Equations (A.1) to (A.4), (A.8), and (A.10) define a vector of prices $\{p_i, r^c, w_i^c\}_{c\in\{X,Y\}}^{i\in\{M,F\}}$, capital allocations $\{\theta^c\}^{c\in\{X,Y\}}$ and fertility decisions $\{N^c\}^{c\in\{X,Y\}}$ that form the unique equilibrium of the economy.■

Proof of Proposition A2 We need to prove that the two "reaction" functions $N^c\left(N^{-c}\right)$ and $N^{-c}\left(N^c\right)$ intersect at least once. We have argued that these two curves are decreasing. Furthermore, we note that the two curves are continuous. We next investigate the behavior of $N^c\left(N\right)$ as N gets arbitrarily close to 0 and $\frac{1}{\lambda}$, respectively.

Existence First, since prices in country c are continuous in $N^{-c} = 0$, and $\lim_0 v'\left(.\right) = +\infty$, $N^c\left(0\right)$ is well defined and interior: there exists $\varepsilon^c > 0$, such that $N^c\left(0\right) = \frac{1}{\lambda} - \varepsilon^c$. Next, and given that $N^c\left(.\right)$ is decreasing, we have $N^c\left(N\right) \in \left[0, 1 - \varepsilon^c\right]$, a compact set. Suppose now that N^{-c} is set arbitrarily close to $\frac{1}{\lambda}$. Then, (A.8) implies that θ^{-c} converges to 0, uniformly with respect to N^c; (A.7) in turn implies that θ^c converges towards some $\bar{\theta}^c < \infty$ such that $\eta + \left(\gamma^c\right)^{\eta(1-\alpha)}\left(\bar{\theta}^c + 1\right)^{-\alpha}\left[\eta - \left(1-\eta\right)\bar{\theta}^c\right] = 0$. Equation (A.3) indicates that female wages in country c remain bounded above, so that $\lim_{\frac{1}{\lambda}} N^c\left(.\right) > 0$. Thus, the curve $N^{-c}\left(.\right)$ cuts $N^c\left(.\right)$ at least once, and "from above," as shown in Figure A2 below. This establishes the existence of an equilibrium $\left(N^X, N^Y\right)$.

Uniqueness To show uniqueness, we look at the labor market equilibrium. For an interior solution, we note that $\{(\theta^c, N^c)\}^{c\in\{X,Y\}}$ are implicitly defined by the intersection of labor supply and demand, i.e.

$$\frac{v'\left(N^c\right)}{\lambda} = \left(1-\alpha\right)\left(\frac{1}{1+\theta^c}\right)^{\alpha}\left(\frac{\theta^c}{1-\lambda N^c}\right)^{1-\eta(1-\alpha)}. \tag{A.12}$$

N^c can thus be expressed as a function $N(.)$ of θ^c and exogenous parameters only such that $N(.)$ is continuously differentiable and simple algebra yields for an interior solution:

$$\frac{dN(\theta)}{d\theta} = \frac{1-\lambda N(\theta)}{\theta} \frac{1 - \frac{1}{1-\eta(1-\alpha)} \alpha \frac{\theta}{1+\theta}}{\lambda - \frac{v"[N(\theta)]}{v'[N(\theta)]} \frac{1-\lambda N(\theta)}{1-\eta(1-\alpha)}} \geq 0 \tag{A.13}$$

We now turn to the system of equilibrium conditions (A.7) and (A.8) that are conditional on labor endowments $\left(1-\lambda N^X, 1-\lambda N^Y\right)$. On the one hand, (A.7) defines a negative *unconditional* relationship between θ^c and θ^{-c}; on the other hand, we rewrite (A.8) as

$$\frac{\theta^c}{1-\lambda N^c} = \gamma^c \frac{\theta^{-c}}{1-\lambda N^{-c}} \tag{A.14}$$

that can be written $u^c(\theta^c) = \gamma^c u^{-c}(\theta^{-c})$, where $u^c(\theta) = \frac{\theta}{1-\lambda N(\theta)}$. Inequality (A.13) implies that $u^c(.)$ is increasing, so that (A.14) defines a positive *unconditional* relationship between θ^c and θ^{-c}. Thus, the two equilibrium conditions for capital define two curves with opposite slope, implying a unique intersection, given that existence was established above. Uniqueness of capital allocation across sectors implies uniqueness of fertility decisions.■

Comparative statics and cross-sectional comparisons We now consider (θ^c, N^c) and $(\tilde{\theta}^c, \tilde{N}^c)$, two equilibrium capital allocations and fertility decisions of the economy when the Ricardian comparative advantage of country c takes values γ^c and $\tilde{\gamma}^c$, respectively. The objective of this section is to compare fertility and the allocation of capital across sectors in these two parameter configurations.

Lemma A3: Comparative statics in general equilibrium An increase in comparative advantage exacerbates fertility differences: if $\gamma^c \geq \tilde{\gamma}^c$, then $N^c \leq \tilde{N}^c$ and $N^{-c} \geq \tilde{N}^{-c}$.■

Proof of Lemma A3 The ratio of female wages in the two countries and use (A.8) to obtain the following equality:

$$\frac{v'(N^c)}{v'(N^{-c})} \left(\frac{1+\theta^c}{1+\theta^{-c}}\right)^{\alpha} = (\gamma^c)^{1-\eta(1-\alpha)}. \tag{A.15}$$

Equality (A.15) implies that if $\gamma^c \geq \tilde{\gamma}^c$ then either $\frac{v'(N^c)}{v'(N^{-c})} \geq \frac{v'\left(\tilde{N}^c\right)}{v'\left(\tilde{N}^{-c}\right)}$ or $\frac{1+\theta^c}{1+\theta^{-c}} \geq \frac{1+\tilde{\theta}^c}{1+\tilde{\theta}^{-c}}$, or both. In other words, a change in comparative advantage triggers either a change in fertility choices in either or both countries ($N^c \leq \tilde{N}^c$ and/or $N^{-c} \geq \tilde{N}^{-c}$), or a reallocation of capital across sectors in either or both countries ($\theta^c \geq \tilde{\theta}^c$ and/or $\theta^{-c} \leq \tilde{\theta}^{-c}$). However, since $\gamma^c = 1/\gamma^{-c}$, a stronger comparative advantage in the F-good in country c is associated with a weaker comparative advantage in country $-c$, vice and versa. Therefore, if a change in comparative advantage positively (resp. negatively) affects fertility in country c, it will simultaneously negatively (resp. positively) affect fertility in country $-c$. The same holds for capital allocation. Thus, we can state the following:

$$\gamma^c \geq \tilde{\gamma}^c \Longrightarrow \left(N^c \leq \tilde{N}^c \text{ and } N^{-c} \geq \tilde{N}^{-c}\right) \textbf{ or } \left(\theta^c \geq \tilde{\theta}^c \text{ and } \theta^{-c} \leq \tilde{\theta}^{-c}\right) \tag{A.16}$$

Finally, to see that *both* fertility and capital allocation respond to an exogenous change in comparative advantage, we note that the right-hand side of (A.12) is increasing in θ^c, while the left-hand side is decreasing in N^c. The following equivalence therefore holds:

$$\theta^c \geq \tilde{\theta}^c \Longleftrightarrow N^c \leq \tilde{N}^c. \tag{A.17}$$

That is, a higher inflow of capital in the F-sector is associated with higher female labor force participation and hence lower fertility in equilibrium. Equivalence (A.17) implies that the last term in (A.16) is therefore redundant and we can simply write

$$\gamma^c \geq \tilde{\gamma}^c \Longrightarrow \left(N^c \leq \tilde{N}^c \text{ and } N^{-c} \geq \tilde{N}^{-c}\right). \tag{A.18}$$

■

From Lemma A3, the main result of the paper is stated in the theorem below:

Proof of Theorem 1 To move from comparative statics to cross-sectional comparisons, we set $\tilde{\gamma}^c = 1$.

Interior solutions Equilibrium conditions (A.7) and (A.8) and labor market clearing equations (A.12) are thus symmetric in both (N^c, N^{-c}) and (θ^c, θ^{-c}), implying $\tilde{N}^c = \tilde{N}^{-c} = N^0$, where N^0 satisfies (A.12) with $\tilde{\theta}^c = \tilde{\theta}^{-c} = \frac{1}{1-\eta}$. Implication (A.18) becomes for $\tilde{\gamma}^c = 1$:

$$\gamma^c \geq 1 \Longrightarrow N^c \leq N^0 \leq N^{-c}.$$

Corner solutions Finally, since the arguments leading to Proposition 4 assume interior solutions for equilibrium fertility in both countries, we now address the cases in which the labor market equilibrium is at a corner (i.e. $N^c = \frac{1}{\lambda}$ or $N^{-c} = \frac{1}{\lambda}$). Without loss of generality, suppose that $\gamma^c \geq 1$.

- If $N^{-c} = \frac{1}{\lambda}$, i.e. the F-sector in country $-c$ disappears, then $N^c < \frac{1}{\lambda}$ (since $N^c = \frac{1}{\lambda}$ implies that $\theta^c = 0$, and (A.7) does not hold for $\theta^c = \theta^{-c} = 0$), and the proposition trivially holds. Indeed, if $c's$ comparative advantage in the F-sector is large enough, then c will end up producing all the F-goods in the economy.

- Alternatively, suppose that $N^c = \frac{1}{\lambda}$ and $N^{-c} < \frac{1}{\lambda}$. Female wages are given by

$$w_F^c = (1-\alpha)\left(\gamma^c \frac{\theta^{-c}}{1-\lambda N^{-c}}\right)^{1-\eta(1-\alpha)} \leq \frac{1}{\lambda} v'\left(\frac{1}{\lambda}\right)$$

$$w_F^{-c} = (1-\alpha)\left(\frac{\theta^{-c}}{1-\lambda N^{-c}}\right)^{1-\eta(1-\alpha)} = \frac{1}{\lambda} v'\left(N^{-c}\right)$$

and since $N^{-c} < \frac{1}{\lambda}$, and $v'(.)$ is decreasing, we have $v'(N^{-c}) > v\left(\frac{1}{\lambda}\right)$ so that $w_F^{-c} > w_F^c$. This implies

$$\gamma^c < 1,$$

a contradiction.

- Finally, $N^c = N^{-c} = \frac{1}{\lambda}$ cannot be an equilibrium since no production would take place, thus pushing female wages in both countries to infinity.

This concludes the proof.■

Appendix B Female Labor Force Participation

The theoretical model in Section 2 connects comparative advantage to fertility through the opportunity cost of women's time. This mechanism is related to female labor force participation (FLFP). This section presents a set of empirical results on how comparative advantage affects FLFP. To clarify the connections between these and the baseline results, we preface the empirics with a theoretical discussion of the relationship between fertility and FLFP.

B.1 Theoretical Discussion

In the simple model of Section 2, fertility is perfectly negatively correlated with FLFP, which, if taken literally, conveys the impression that comparative advantage affects fertility "through" FLFP. However, the notion that fertility is affected by the opportunity cost of women's time is distinct from women's labor supply for a series of reasons.

First, the elasticity of FLFP with respect to women's wage is not simply the negative of the elasticity of fertility with respect to the wage. Suppressing the country superscripts, let N, as before, be the number of children, and denote FLFP by $L_F = 1 - \lambda N$. Denote the elasticity of a variable x with respect to the female wage by $\varepsilon_x \equiv \frac{\partial x}{w_F} \frac{w_F}{x}$. It is immediate that $\varepsilon_{L_F} = -\varepsilon_N \frac{\lambda N}{1-\lambda N}$. Thus, for a finite ε_N, the elasticity of FLFP with respect to the wage approaches zero as childrearing time goes to zero, either because of low λ or low N. This suggests that in countries with already low fertility, or in countries with low λ (for instance, due to easily accessible childcare facilities, as in many developed countries) the impact of (log) opportunity cost of women's time on (log) FLFP may not be detectable.[19]

Second, even in levels the negative linear relationship between fertility and labor supply is an artifact of the assumption that working in the market economy and childrearing are the only uses of women's time. More generally, suppose that there is another use of women's time, Q, which can stand for leisure, investments in quality of the children (as opposed to quantity N), or non-market housework. Suppose further that the indirect utility, instead of (A.9), is now represented by:

$$V(N, Q) = r + w_F(1 - \lambda N - \mu Q) + w_M + v(N) + z(Q), \tag{B.1}$$

where μ is number of units of a woman's time required to produce one unit of Q.

On the one hand, this addition leaves unchanged the first-order condition with respect to fertility, (A.10), embodying the notion that fertility is affected by the opportunity cost of women's time.

On the other hand, there is now another first-order condition that relates women's opportunity cost of time to Q:

$$w_F = \frac{z'(Q)}{\mu}. \tag{B.2}$$

Thus, the relationship between FLFP and w_F is now

[19] To give a stark example, suppose that $v(.)$ is CES: $v(N) = N^{1-1/\zeta}/(1-1/\zeta)$, so that the elasticity of fertility with respect to the wage is simply constant: $\varepsilon_N = -\zeta$. In this case, we will always be able to detect the effect of (log) wage on (log) fertility at all levels of fertility or income, whereas the impact of (log) wage on (log) FLFP will go to zero as income rises/fertility falls.

$$L_F = 1 - \lambda(v')^{-1}(\lambda w_F) - \mu(z')^{-1}(\mu w_F),$$

and the elasticity of FLFP with respect to the wage is

$$\varepsilon_{L_F} = -\varepsilon_N \frac{\lambda N}{1 - \lambda N - \mu Q} - \varepsilon_Q \frac{\mu Q}{1 - \lambda N - \mu Q}.$$

It is immediate that FLFP and fertility are no longer inversely related one-for-one. Depending on the curvatures of $v(.)$ and $z(.)$, FLFP could be more or less concave in w_F than N, even as (A.10) continues to hold and the wage-fertility relationship is unaffected. When ε_Q is different from ε_N, and μQ is high relative to λN, ε_{L_F} can look very different from negative ε_N even when women's labor supply is far away from 1.[20]

Third, the simple model above assumes that the marginal utility of income is always constant at 1. Departing from that assumption and introducing diminishing marginal utility of income will make the relationship between FLFP and w_F^c even more complex, and possibly non-monotonic, due to income effects. While in all of the cases above, FLFP and fertility were still negatively correlated, with income effects it is possible to generate a positive relationship between FLFP and fertility at high enough levels of income, for instance through satiation in goods consumption.

Finally, when it comes to measurement of FLFP, an additional challenge is that the model is written in terms of the intensive margin (i.e. hours), whereas the FLFP data are recorded at the extensive margin (binary participation decision). This implies that, especially for countries with already high FLFP, in which in response to fertility women adjust hours worked rather than labor market participation, our data will not be able to accurately capture the interrelationships between FLFP and fertility.[21]

To summarize, the insight that fertility is determined by the opportunity cost of women's time does not have a one-to-one relationship to FLFP. One can easily construct examples in which the wage elasticities with respect to fertility and FLFP are very different. In addition, even the simple baseline model above implies that the elasticity of female labor supply with respect to the opportunity cost of women's time is not constant, and approaches zero as time spent on childrearing falls. This suggests that the impact of comparative advantage in female-intensive goods on FLFP will be attenuated, and potentially difficult to detect in countries with high income and low fertility.

B.2 Empirical Results

With those observations in mind, Table A3 explores the relationship between $FLNX$ and FLFP. FLFP data come from the ILO's KILM database, and are available 1990-2007. All shown specifications include controls for per capita income and openness, and regional dummies. Column 1 presents the OLS regression. The coefficient on FLFP is positive but not significant. Column 2 reports the 2SLS results. The coefficient becomes larger, but not sig-

[20] As an example, when $v(.)$ and $z(.)$ are CES: $v(N) = N^{1-1/\zeta}/(1-1/\zeta)$ and $z(Q) = Q^{1-1/\xi}/(1-1/\xi)$, ε_Q and ε_N are simply constants, and $\varepsilon_{L_F} = \zeta \frac{\lambda N}{1-\lambda N-\mu Q} + \xi \frac{\mu Q}{1-\lambda N-\mu Q}$, which can obviously be very different from ζ.

[21] Unfortunately, data on hours worked are not available for a large sample of countries.

nificant at conventional levels. However, as argued above the elasticity of FLFP with respect to $FLNX$ should not be expected to be constant across a wide range of countries. Thus, in columns 3 and 4 we re-estimate these regressions while letting the impact of $FLNX$ vary by income. The difference is striking. Both the main effect and the interaction with income are highly significant, and the impact of $FLNX$ is clearly less pronounced for higher-income countries. Column 5 reports the 2SLS results in which $FLNX$ is interacted with fertility, and column 6 with female educational attainment. In both cases, all of the coefficients of interest are highly significant.[22]

Of course, the main effect of the $FLNX$ is now not interpretable as the impact of $FLNX$ on FLFP. To better illustrate how the impact of $FLNX$ on FLFP varies through the distribution of income, fertility, and educational attainment, we re-estimate the specification with quartile-specific $FLNX$ coefficients, rather than the interaction terms (that is, we discretize income, fertility, or female educational attainment into quartiles, and allow the $FLNX$ coefficient to differ by quartile). Figure A3 reports the quartile-specific coefficient estimates, with the bars depicting 95% confidence intervals. The top panel presents the results by quartile of income. There is a statistically significant positive effect of $FLNX$ on FLFP in the bottom quartile of countries, with the coefficient estimate of 1.16. In the other quartiles, the coefficient estimates are close to zero and not significant.

The second panel presents the same result with respect to fertility. As expected, the impact of $FLNX$ on FLFP is most pronounced at high levels of fertility. The top quartile estimate is statistically significant at the 1% level. Finally, the bottom panel presents the results with respect to female educational attainment quintiles. The impact of $FLNX$ is strongly positive in the bottom quartile, and close to zero elsewhere.

To summarize, the results with respect to FLFP are suggestive that the impact of comparative advantage on fertility is concomitant with a female labor supply response, but only in some countries. As argued above, this is should be expected, given that the relationship between FLFP and fertility is not straightforward.

[22] In order to conserve space, Table A3 does not report the first-stage coefficients and diagnostics. With the income, fertility and educational attainment interactions, two variables are being instrumented, which would require reporting multiple coefficients and F-statistics. All of the F-statistics in these specifications are above 15.

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Table 1. Share of Female Workers in Total Employment, Highest to Lowest

Sector Name	FL_i
Cut and sew apparel manufacturing	0.66
Footwear; Leather; Textile and apparel, n.e.c.	0.56
Textile product mills, except carpet and rug	0.55
Soap, cleaning compound, and cosmetics manufacturing	0.51
Sugar and confectionery products	0.48
Pharmaceutical and medicine manufacturing	0.46
Medical equipment and supplies manufacturing	0.44
Fabric mills, except knitting mills	0.43
Carpet and rug mills	0.41
Seafood and other miscellaneous foods, n.e.c.	0.40
Miscellaneous manufacturing, n.e.c.	0.39
Not specified food industries	0.38
Fruit and vegetable preserving and specialty food manufacturing	0.37
Sporting and athletic goods, and doll, toy and game manufacturing	0.37
Not specified manufacturing industries	0.37
Bakeries, except retail	0.37
Animal slaughtering and processing	0.36
Household appliance manufacturing	0.36
Printing and related support activities	0.35
Electronic component and product manufacturing, n.e.c.	0.35
Agricultural chemical manufacturing	0.35
Miscellaneous paper and pulp products	0.35
Navigational, measuring, electromedical, and control instruments manufacturing	0.32
Communications, and audio and video equipment manufacturing	0.32
Rubber product, except tire, manufacturing	0.32
Forestry, except logging	0.31
Electrical lighting and electrical equipment and other electrical component manufacturing, n.e.c.	0.31
Computer and peripheral equipment manufacturing	0.30
Plastics product manufacturing	0.30
Cutlery and hand tool manufacturing	0.29
Commercial and service industry machinery manufacturing	0.28
Resin, synthetic rubber and fibers, and filaments manufacturing	0.28
Glass and glass product manufacturing	0.28
Tobacco manufacturing	0.27
Furniture and fixtures manufacturing	0.27
Dairy product manufacturing	0.26
Beverage manufacturing	0.26
Animal food, grain, and oilseed milling	0.26
Paperboard containers and boxes	0.25

Table 1 (cont'd). Share of Female Workers in Total Employment, Highest to Lowest

Sector name	FL_i
Animal production	0.25
Miscellaneous fabricated metal products manufacturing	0.25
Motor vehicles and motor vehicle equipment manufacturing	0.25
Railroad rolling stock; Other transportation equipment	0.24
Crop production	0.23
Paint, coating, and adhesive manufacturing	0.23
Aircraft and parts manufacturing	0.23
Miscellaneous wood products	0.22
Machinery manufacturing, n.e.c.	0.22
Veneer, plywood, and engineered wood products	0.22
Not specified machinery manufacturing	0.22
Electric power generation, transmission, and distribution	0.22
Industrial and miscellaneous chemicals	0.22
Engines, turbines, and power transmission equipment manufacturing	0.21
Agricultural implement manufacturing	0.21
Miscellaneous petroleum and coal products	0.21
Nonferrous metal (except aluminum) production and processing	0.20
Petroleum refining	0.20
Oil and gas extraction	0.20
Pulp, paper, and paperboard mills	0.19
Pottery, ceramics, structural clay, and plumbing fixtures	0.19
Ordnance; Not specified metal industries	0.18
Prefabricated wood buildings and mobile homes	0.17
Ship and boat building	0.17
Structural metals, and boiler, tank, and shipping container manufacturing	0.17
Miscellaneous nonmetallic mineral product manufacturing	0.17
Metalworking machinery manufacturing	0.17
Aluminum production and processing	0.16
Tire manufacturing	0.16
Construction, and mining and oil and gas field machinery manufacturing	0.15
Fishing, hunting, and trapping	0.15
Machine shops; turned product; screw, nut, and bolt manufacturing	0.14
Iron and steel mills and steel product manufacturing	0.13
Foundries	0.13
Metal ore and nonspecified type of mining	0.13
Nonmetallic mineral mining and quarrying	0.11
Sawmills and wood preservation	0.11
Cement, concrete, lime, and gypsum product manufacturing	0.10
Coal mining	0.06
Logging	0.05
Mean	0.27

Notes: This table reports the share of female workers in total employment by sector in the US. Source: BLS.

Table 2. Summary Statistics for Female Labor Need of Exports and Fertility

	OECD			NON-OECD		
	Panel A: Female Labor Need of Exports					
	Mean	St. Dev.	Countries	Mean	St. Dev.	Countries
1960s	0.272	0.036	21	0.255	0.055	100
1970s	0.274	0.034	21	0.260	0.061	101
1980s	0.273	0.037	21	0.265	0.068	101
1990s	0.280	0.036	21	0.288	0.080	121
2000s	0.279	0.030	21	0.291	0.094	125
	Panel B: Fertility Rates					
	Mean	St. Dev.	Countries	Mean	St. Dev.	Countries
1960s	2.784	0.452	21	6.165	1.380	100
1970s	2.120	0.449	21	5.748	1.607	101
1980s	1.735	0.257	21	5.109	1.768	101
1990s	1.634	0.249	21	3.951	1.829	121
2000s	1.641	0.255	21	3.341	1.664	125

Notes: This table reports the summary statistics for $FLNX$ and fertility, by country group and decade.

Table 3. $FLNX$: Top 10 and Bottom 10 Countries, 2000-2007

Highest $FLNX$		*Lowest $FLNX$*	
Lesotho	0.612	Mauritania	0.152
Cambodia	0.609	Gabon	0.175
Bangladesh	0.595	Papua New Guinea	0.181
Haiti	0.593	Mozambique	0.184
Mauritius	0.512	Kazakhstan	0.189
El Salvador	0.490	Guinea	0.190
Sri Lanka	0.485	Congo, Rep.	0.193
Honduras	0.482	Venezuela, RB	0.196
Pakistan	0.474	Libya	0.198
Madagascar	0.440	Iraq	0.198

Notes: This table reports the 10 countries with the highest, and 10 countries with the lowest $FLNX$.

Table 4. $FLNX$: Top 10 and Bottom 10 Changers since 1960s

Largest Increase in $FLNX$		*Largest Decrease in $FLNX$*	
Cambodia	0.342	Sudan	-0.040
Haiti	0.298	Uruguay	-0.044
Honduras	0.252	Papua New Guinea	-0.056
El Salvador	0.221	Central African Republic	-0.058
Albania	0.209	Australia	-0.060
Tunisia	0.192	Angola	-0.063
Nicaragua	0.165	Hong Kong, China	-0.064
Jordan	0.161	Mozambique	-0.102
Morocco	0.158	Tanzania	-0.109
Guatemala	0.141	Cuba	-0.113

Notes: This table reports the 10 countries with the largest increases and the largest decreases in $FLNX$. Change is calculated as the difference between the $FLNX$ in the 2000s and that in the 1960s.

Table 5. Cross-Sectional Results, 2000-2007

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Dependent Variable: (Log) Fertility Rate								
(Log) Female Labor	-0.34***	-0.24***	-0.73***	-0.59***	-0.65***	-0.60***	-0.41***	-0.46***
Need of Exports	(0.08)	(0.08)	(0.18)	(0.15)	(0.19)	(0.18)	(0.14)	(0.18)
(Log) Openness	-0.04	0.01	-0.02	0.03	0.03	0.03	0.02	0.02
	(0.04)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
(Log) GDP per capita	-0.35***	-0.22***	-0.35***	-0.23***	-0.23***	-0.23***	-0.22***	-0.22***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)
Log (Area)								0.01
								(0.02)
Log (Population)								-0.02
								(0.02)
Constant	5.34***	3.62***	6.57***	5.09***	5.31***	5.14***	4.42***	4.62***
	(0.32)	(0.42)	(0.59)	(0.59)	(0.75)	(0.73)	(0.55)	(0.89)
R^2	0.678	0.831						
			First Stage					
Dependent Var. (Log) FLNX								
(Log) Predicted FLNX			1.84***	1.68***				3.00***
			(0.24)	(0.25)				(0.66)
(Log) Predicted FLNX					1.25***			
(out of sample)					(0.25)			
(Log) Predicted FLNX						0.96***		
(Poisson)						(0.18)		
(Log) Predicted FLNX							4.30***	
(No Population)							(0.61)	
F-test			56.42	44.01	24.16	27.00	49.81	20.39
First Stage Partial R^2			0.290	0.277	0.165	0.193	0.307	0.174
Region Dummies	no	yes	no	yes	yes	yes	yes	yes
Observations	146	146	146	146	146	146	146	146

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. All variables are averages over the period 2000-2007 and in natural logs. Variable definitions and sources are described in detail in the text.

Table 6. Panel Results, 1962-2007

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Five-Year Averages				Ten-Year Averages			
Dependent Variable: (Log) Fertility Rate								
(Log) Female Labor	-0.60***	-0.54***	-0.24***	-0.20**	-0.61***	-0.58***	-0.27***	-0.23**
Need of Exports	(0.09)	(0.10)	(0.09)	(0.09)	(0.10)	(0.12)	(0.10)	(0.11)
(Log) Openness	-0.01	-0.15***	-0.01	0.00	-0.01	-0.15***	-0.01	0.01
	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.05)	(0.04)	(0.04)
(Log) GDP per capita	-0.35***	-0.35***	-0.19***	-0.18***	-0.35***	-0.37***	-0.20***	-0.20***
	(0.02)	(0.05)	(0.04)	(0.05)	(0.02)	(0.06)	(0.05)	(0.05)
(Log) Female				0.01				0.00
Educational Attainment				(0.04)				(0.04)
Country FE	no	yes	yes	yes	no	yes	yes	yes
Year FE	no	no	yes	yes	no	no	yes	yes
R^2	0.594	0.889	0.936	0.934	0.602	0.899	0.942	0.940
Observations	1,254	1,254	1,254	1,109	630	630	630	557

Notes: Standard errors clustered at the country level in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. All of the variables are 5-year averages (left panel) or 10-year averages (right panel) over the time periods spanning 1962-2007, and in natural logs. Variable definitions and sources are described in detail in the text.

Table 7. Alternative Specifications and Controls: Cross-Sectional 2SLS Results, 2000-2007

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable: (Log) Fertility Rate						
(Log) $FLNX$		-0.51***	-0.58***	-0.42***	-0.37***	-0.54***
		(0.13)	(0.14)	(0.15)	(0.14)	(0.14)
$FLNX - FLNI$	-0.02***					
	(0.01)					
(Log) Openness	0.05	0.04	0.04	0.02	-0.03	0.04
	(0.04)	(0.05)	(0.05)	(0.03)	(0.05)	(0.03)
(Log) GDP per capita	-0.24***	-0.20***	-0.23***	-0.14***	-0.24***	-0.22***
	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)	(0.03)
(Log) Female		-0.13**				
Educational Attainment		(0.06)				
Child Labor Indicator			0.01***			
			(0.00)			
(log) Infant Mortality				0.12***		
				(0.04)		
Gini Coeff					0.62**	
					(0.30)	
Polity 2 Indicator						0.00
						(0.00)
Constant	3.31***	4.55***	4.85***	3.18***	4.34***	4.53***
	(0.28)	(0.61)	(0.78)	(0.76)	(0.60)	(0.59)
(Log) Predicted $FLNX$		1.77***	1.69***	1.70***	1.77***	1.68***
		(0.26)	(0.33)	(0.30)	(0.33)	(0.27)
Predicted $FLNX$	1.62***					
	(0.31)					
F-test	26.59	48.14	25.92	31.81	29.38	38.88
First Stage Partial R^2	0.205	0.319	0.275	0.254	0.291	0.271
Region Dummies	yes	yes	yes	yes	yes	yes
Observations	146	126	103	145	103	145

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. All variables are averages over the period 2000-2007. Variable definitions and sources are described in detail in the text.

Table 8. Subsamples: Cross-Sectional 2SLS Results, 2000-2007

	(1)	(2)	(3)	(4)	(5)
Sample:	no outliers	no OECD	no Sub-Saharan Africa	no Middle East & North Africa	No mining exporters
Dependent Variable: (Log) Fertility Rate					
(Log) Female Labor	-0.78***	-0.59***	-0.76***	-0.52***	-0.55***
Need of Exports	(0.24)	(0.16)	(0.20)	(0.14)	(0.15)
(Log) Openness	0.03	0.07*	0.05	0.01	0.02
	(0.04)	(0.04)	(0.06)	(0.03)	(0.03)
(Log) GDP per capita	-0.20***	-0.29***	-0.23***	-0.23***	-0.23***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Constant	5.18***	5.41***	5.71***	4.71***	4.75***
	(0.90)	(0.64)	(0.87)	(0.58)	(0.57)
First Stage					
(Log) Predicted FLNX	1.20***	1.77***	1.74***	1.73***	1.79***
	(0.21)	(0.30)	(0.28)	(0.29)	(0.30)
F-test	31.69	34.79	39.15	36.17	36.33
First Stage Partial R^2	0.167	0.269	0.28	0.282	0.268
Region Dummies	yes	yes	yes	yes	yes
Observations	136	125	105	130	136

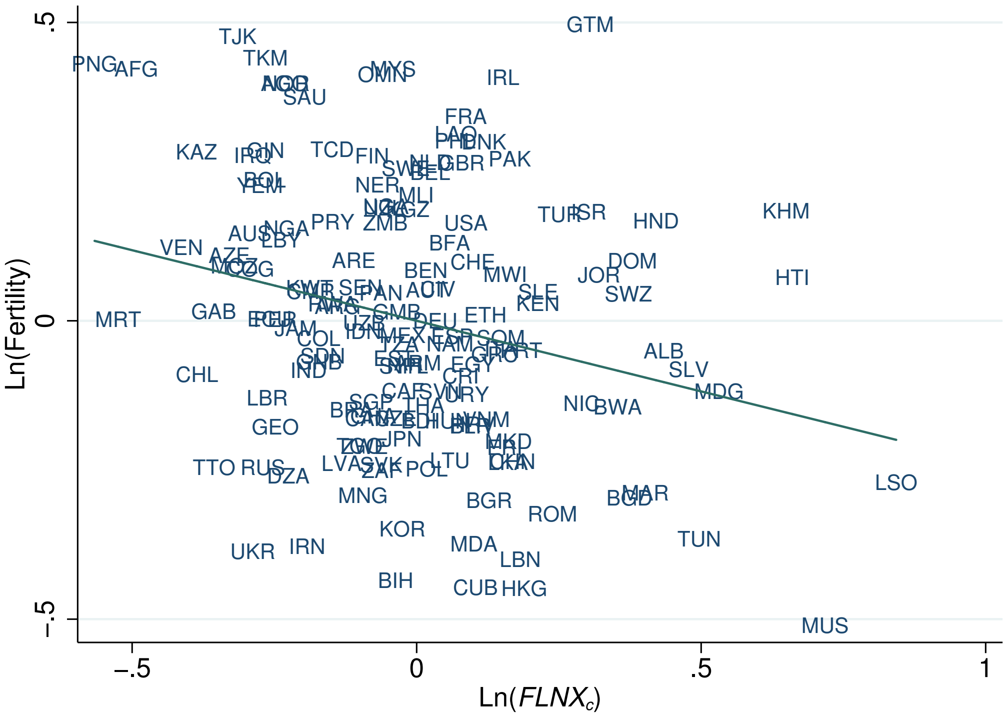
Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. All variables are averages over the period 2000-2007. Variable definitions and sources are described in detail in the text.

Table 9. Other Decades: Cross-Sectional 2SLS Results

	(1) 1960s	(2) 1970s	(3) 1980s	(4) 1990s
Dependent Variable: (Log) Fertility Rate				
(Log) Female Labor	0.05	-0.63***	-0.86***	-0.68***
Need of Exports	(0.14)	(0.24)	(0.22)	(0.14)
(Log) Openness	0.07**	-0.02	-0.02	0.04
	(0.03)	(0.03)	(0.03)	(0.03)
(Log) GDP per capita	-0.18***	-0.19***	-0.26***	-0.24***
	(0.04)	(0.03)	(0.03)	(0.02)
Constant	2.54***	4.58***	5.97***	5.20***
	(0.62)	(0.86)	(0.76)	(0.54)
		First Stage		
(Log) Predicted FLNX	1.30***	1.23***	1.33***	1.64***
	(0.32)	(0.28)	(0.28)	(0.23)
F-test	16.95	20.12	22.43	53.07
First Stage Partial R^2	0.276	0.263	0.284	0.336
Region Dummies	yes	yes	yes	yes
Observations	96	119	120	142

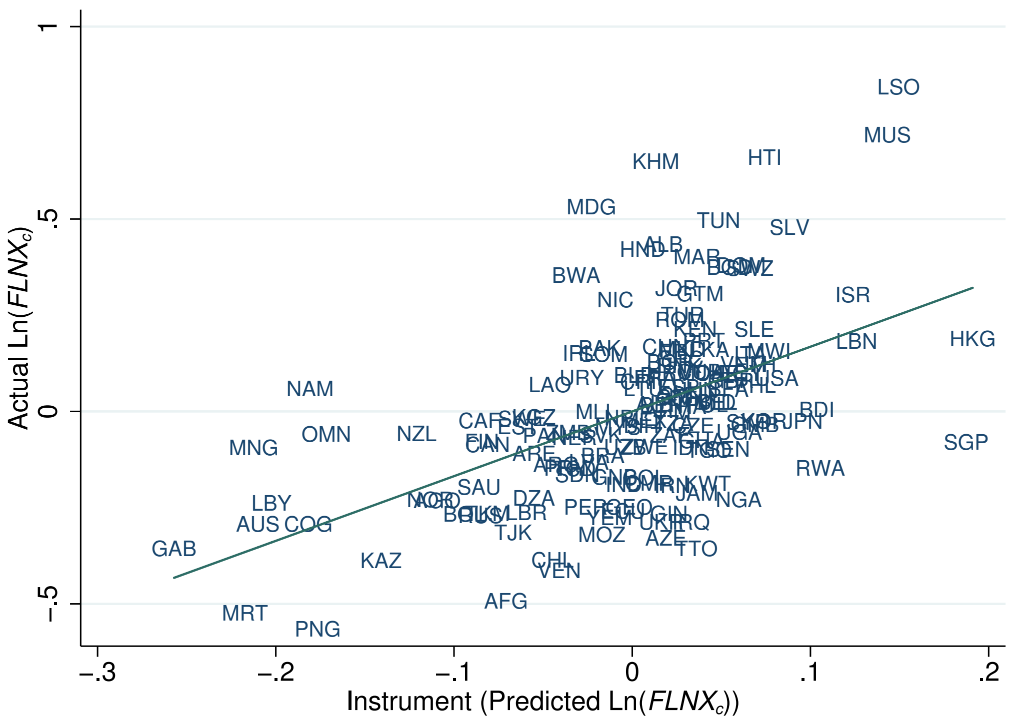
Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. All variables are decadal averages. Variable definitions and sources are described in detail in the text.

Figure 1. Partial Correlation Between Fertility and $FLNX$



Notes: This figure displays the partial correlation between $FLNX$ and fertility, in logs, after controlling for openness, per capita income, and regional dummies (see Column 2 of Table 5).

Figure 2. First Stage: Partial Correlation between $FLNX_c$ and $\widehat{FLNX}_c$



Notes: This figure presents the partial correlation plot from the first stage regression between the actual value of $FLNX_c$ and the instrument.

Table A1. An Illustration of the Instrumentation Strategy

Sector	Exporter	Destination	Distance	Exports	FL_i
Apparel	Canada	EU	1000	2500	0.66
Apparel	Canada	US	1000	4500	0.66
Apparel	Australia	EU	10000	850	0.66
Apparel	Australia	US	10000	415	0.66
Metals	Canada	EU	1000	25000	0.12
Metals	Canada	US	1000	15000	0.12
Metals	Australia	EU	10000	1000	0.12
Metals	Australia	US	10000	1150	0.12

Table A2. Variation in Gravity Coefficients Across Sectors

Coefficient	Mean	Std. Dev.	Min	Max
$Ln(Distance_{cd})$	-1.152	0.308	-2.419	-0.102
$Ln(Pop_c)$	-0.136	0.450	-1.780	0.514
$Ln(Area_c)$	-0.110	0.272	-0.486	0.927
$Ln(Pop_d)$	0.672	0.276	0.132	1.769
$Ln(Area_d)$	-0.113	0.139	-0.720	0.151
$Landlocked_{cd}$	-0.619	0.518	-2.526	2.218
$Border_{cd}$	0.655	3.678	-13.116	6.507
$Border_{cd} \times Ln(Distance_{cd})$	0.178	0.258	-0.396	1.294
$Border_{cd} \times Ln(Pop_c)$	0.315	0.234	-0.280	1.221
$Border_{cd} \times Ln(Area_c)$	-0.227	0.194	-1.146	0.492
$Border_{cd} \times Ln(Pop_d)$	-0.189	0.204	-0.649	0.797
$Border_{cd} \times Ln(Area_d)$	0.003	0.131	-0.525	0.319
$Border_{cd} \times Landlocked_{cd}$	0.416	0.419	-1.394	1.687

Table A3. FLFP: Cross-Sectional Results, 2000-2007

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	2SLS	OLS	2SLS	2SLS	2SLS
Dependent Variable: (Log) FLFP						
(Log) $FLNX$	0.08	0.19	2.13***	4.13**	-1.07***	1.79**
	(0.11)	(0.19)	(0.80)	(1.66)	(0.41)	(0.76)
(Log) $FLNX$*(log) GDP per capita			-0.25**	-0.45**		
			(0.10)	(0.18)		
(Log) $FLNX$ * (log) Fertility					1.24***	
					(0.41)	
(Log) Fertility					-4.07***	
					(1.39)	
(Log) $FLNX$ * (ln) Fem. Educ. Attainment						-0.88**
						(0.40)
(Log) Fem. Educ. Attainment						2.90**
						(1.28)
(Log) Openness	0.04	0.04	0.85***	1.52**	0.05	0.02
	(0.03)	(0.03)	(0.32)	(0.60)	(0.04)	(0.05)
(Log) GDP per capita	-0.01	-0.02	-0.01	-0.02	0.00	-0.05
	(0.06)	(0.06)	(0.05)	(0.06)	(0.06)	(0.05)
Constant	-0.96*	-1.98**	-7.77***	-15.23***	1.98	-6.31**
	(0.54)	(0.86)	(2.72)	(5.65)	(1.48)	(2.49)
R^2	0.567		0.588			
Region Dummies	yes	yes	yes	yes	yes	yes
Observations	146	146	146	146	146	126

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. All variables are averages over the period 2000-2007. Variable definitions and sources are described in detail in the text.

Figure A1. Female Formal Labor Market Equilibrium

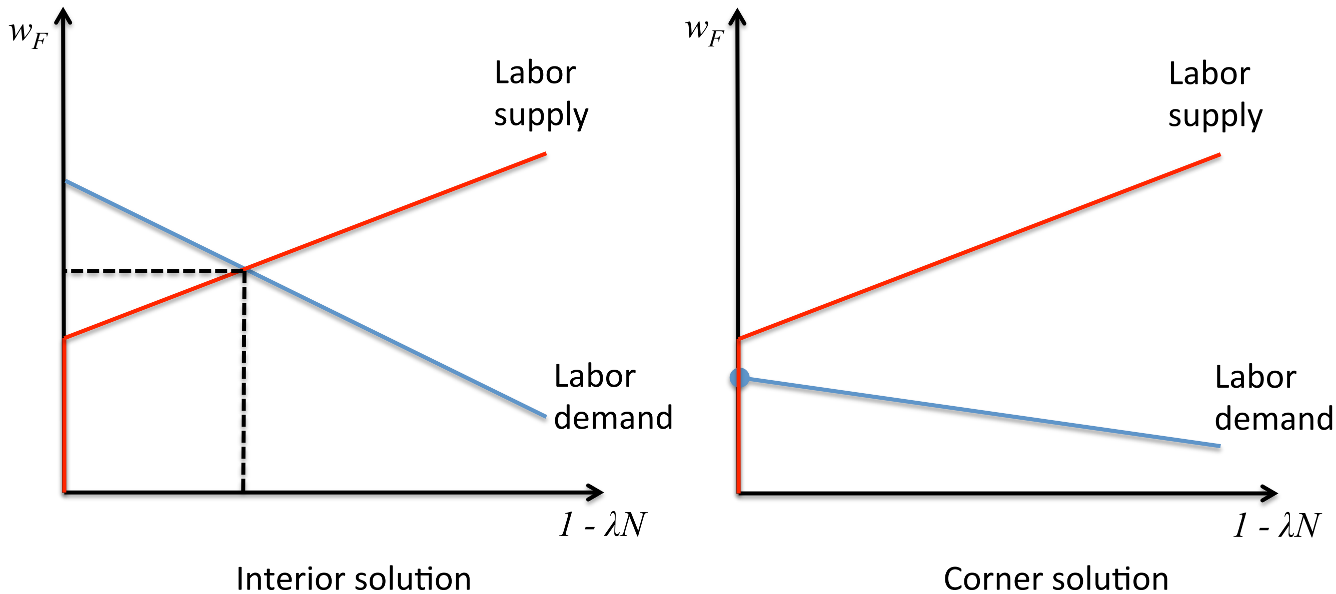


Figure A2. Equilibrium Female Labor Force Participation

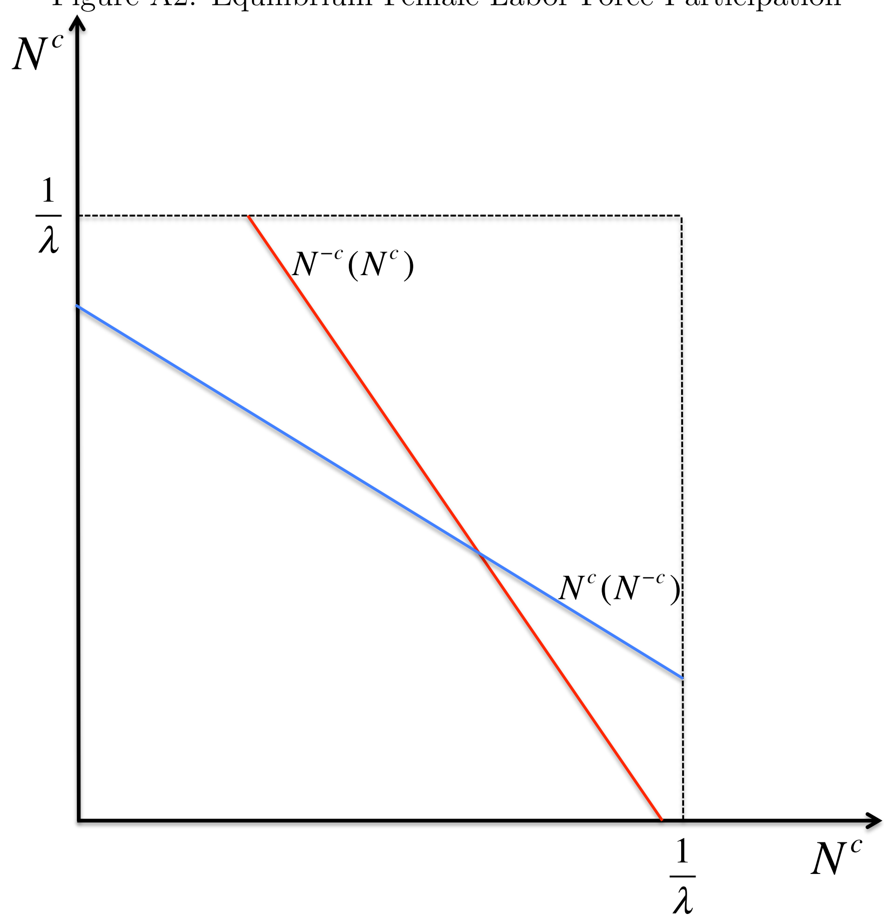
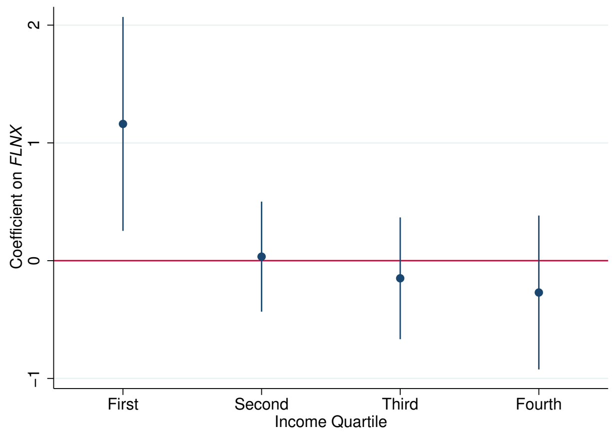
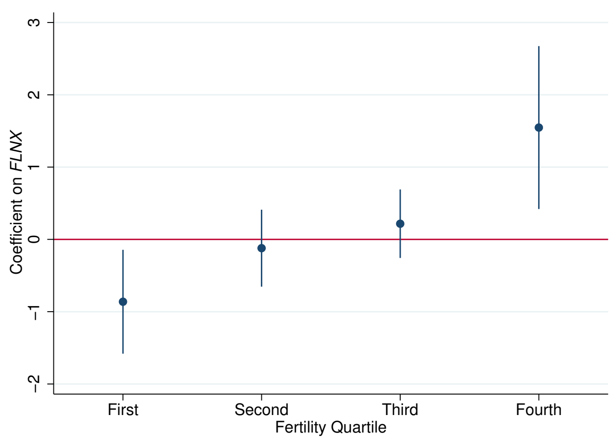


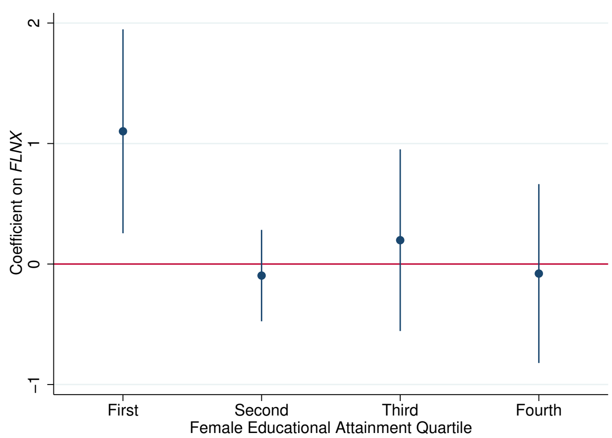
Figure A3. Impact of $FLNX$ on FLFP by Quartile



(a) By Income



(b) By Fertility



(c) By Educational Attainment

Notes: This figure displays the quartile-specific coefficients on $FLNX$ in the 2SLS regressions with log FLFP as the dependent variable, and the controls/regional dummies as in Table A3. Panel (a) displays the coefficients by income quartile, panel (b) by fertility quartile, and panel (c) by female educational attainment quartile.