Trade in Appliances and the Supply of Women's Labor:

Evidence from developing countries

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Abstract

This paper draws on a dataset of over 100 developing countries spanning a period of 20 years to estimate the causal impact of increased trade in appliances on the female labor supply. To investigate this relationship, I employ an instrumental variables strategy with two-way fixed effects, finding marginally statistically significant evidence of a strong positive effect. The results display substantial regional heterogeneity and vary greatly across development levels as well. The inter-regional differences align with previously observed variation in regional trends, while the income level variation underscores the importance of sectoral development for raising women's entry into the workforce. Together, these two results suggest that home appliances may work to increase women's labor force participation, in part, through an effect on female labor supply elasticity. As a robustness exercise, I test this relationship using a dynamic panel estimator in place of country-level fixed effects. The effect increases in statistical significance, though it decreases in magnitude compared to the two-way fixed effects model.

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1. Introduction

Since the end of the second World War, international trade has increased remarkably with the emergence of the liberal international economic order. Economic cooperation, expansive global supply chains, and rapid advancements in production technology have created an abundance of relatively inexpensive material goods, unmatched by any previous point in human history. The latter half of this period has coincided with a marked increase in trade liberalization across the developing world. For many developing countries, the embrace of free trade marks a departure from a period of import substitution policies designed to encourage domestic production and discourage foreign consumption. High tariff and non-tariff trade barriers generated massive distortions in the price of goods produced abroad, the removal of which has subsequently led to large declines in the relative price of such goods (Cubas, 2016).

Undoubtedly, increased trade has had profound effects on local labor markets in the United States and other wealthy nations (Autor, Dorn, and Hanson, 2013, Traiberman, 2019). The labor market effects of trade extend to developing economies as well. In much of the literature on this topic, there has been a persistent focus on how trade impacts labor markets through its effects on labor demand (e.g., Mansour, Medina, and Velasquez, 2022, Juhn, Ujhelyi, and Villegas-Sanchez, 2014). However, how trade impacts labor supply has received far less attention (Medina, Sotelo, and Velasquez, 2025).

Over this same period, most developing countries have undergone changes that should, theoretically, work to reshape the labor supply by encouraging women to enter the workforce: more widespread education of girls, lower average fertility rates, and strong economic growth (Klassen, 2019). Yet trends across developing economies have differed substantially by region, and clear explanations as to why remain elusive. Latin America and the Caribbean have seen

robust increases in female labor force participation (FLFP) while other regions have seen stagnant or even falling levels (Klassen, 2019). Gender equality broadly has been linked to a wide variety of desirable development outcomes, including greater long-run per capita income and human development (Ferrant, 2015). Further, gender equality and women's empowerment was identified as one of eight Millennium Development Goals by the United Nations at the turn of the century (United Nations, 2000). Understanding the factors that improve women's economic standing through greater labor force participation is thus a salient topic for global economic development.

Women's labor force participation may be connected to the observed rise in international trade through the latter's impact on access to domestic appliances. Specifically, increased trade in appliances lowers the relative price of goods that substitute for labor in home production. Subsequently, home production, which is performed overwhelmingly by women, becomes more efficient following the adoption of domestic appliances, thereby freeing up women's time to participate in market activities. The positive relationship between domestic appliance ownership and women's labor force participation is well documented for the U.S. and OECD countries (Greenwood, Seshadri, and Yorukoglu, (2005), Cavalcanti and Tavares, 2008, Coen-Pirani, Leon, and Lugauer 2010). However, evidence for this relationship in developing countries is limited.

This paper investigates the extent to which access to household appliances that substitute for domestic labor impacts women's decision to enter the workforce in developing countries. To assess the strength of this relationship, I build a panel of over 100 developing countries for the years 2000-2019 containing data on appliance trade volumes, women's labor force participation, and other covariates and estimate the effect of per capita appliance imports on FLFP. To handle the endogeneity of appliance imports, I construct a shift-share instrument to capture each country's exposure to increased trade in appliances. Country fixed effects are included to absorb time-

invariant determinants of the female labor supply, particularly unobserved factors such as cultural attitudes regarding women. To account for common shocks or potential systematic variation in the outcome variable, time fixed effects are used. Finally, cyclical and time-varying structural controls are included to isolate the effect of interest. To test the robustness of the findings to alternative identifying assumptions, I use a lagged dependent variable in place of country fixed effects.

I find that a one percent increase in appliance imports per capita leads to a roughly 0.04 percentage point increase in women's labor force participation. Interestingly, the size of this effect is comparable to that of a one percent increase in GDP per capita, which is thought to reduce FLFP through a strong household income effect (Goldin, 1995, Choudry and Elhorst, 2018, Klassen, 2019). Additionally, I examine this effect by region and income level, respectively, finding variation that aligns with observed trends and theoretical predictions from previous literature. The effect is strongest for Latin America, followed by the Middle East and North Africa (MENA), and then Eastern Europe. Regional effects are not statistically significant elsewhere. The size and significance of the effect shows an inverse relationship with country income level, and, by extension, the share of women employed in agriculture. When tested using the dynamic model, the relationship appears more significant but considerably smaller compared to the estimates produced by the static model. The significance under different assumptions strengthens the claim that a causal relationship exists, although its implications as to the actual effect size are less clear.

2. Literature Review

This section is organized into five components. First, I survey the broader debate regarding the feminization U hypothesis and discuss how it informs an evaluation of female labor supply impacts from labor saving technology. Second, I cover works analyzing regional trends in FLFP across the developing world, which show particularly strong inter-regional heterogeneity. Third, I

discuss differing results from rural electrification programs in South Africa and India and how these results suggest a relationship between time saving appliances and women's work. Fourth, I turn to evidence on this topic from OECD countries, which serve as a historical analogue. Finally, I return to the development literature for a discussion of two recent works analyzing the labor market impacts of home appliances in Latin America, both of which directly motivate the topic of this paper.

2.1 The Feminization U Hypothesis

A large body of the existing development literature aims to understand how women's labor is impacted by economic growth. Within this topic, there is considerable debate concerning the existence of a U-shaped relationship between economic development and FLFP. That is, as per capita income rises in the earliest stages of development, FLFP falls. Later, as further development causes structural changes, FLFP rises. The debate over the existence of a "feminization U" and its importance as an overarching development trend helps to inform how the female labor supply might respond to greater ownership of time saving appliances. The feminization U hypothesis, as outlined by Goldin (1995), can be understood as follows: In countries where incomes are low and agriculture is the dominant sector, most women combine home and agricultural labor in the same location. As a result, women's labor force participation is relatively high. As incomes rise, a strong income effect drives an initial decline in FLFP. This effect may also be complemented by technological improvements in agriculture as well as declines in the relative price of home goods, which lowers demand for women's labor. Eventually, however, further development spurs structural transformation such that the agriculture sector shrinks, and the service sector expands. In addition, girls' post-primary education rises, and the fertility rate declines. This causes the income effect from rising male wages to be dominated by a substitution effect, as work

opportunities in new sectors expand and the potential wage women can earn by entering the labor market rises.

Despite initial support for the feminization U hypothesis (e.g., Goldin 1995, Catagay and Ozler 1995), this evidence is limited by the fact many of these works test a within-country time series relationship using cross-sectional data. Improvements in panel data methods have since enabled more rigorous testing of this supposed relationship. Gaddis and Klasen (2014) find that the existence of a U-shape in the data is not robust to data revisions. Particularly, the shape is heavily affected by which version of the ILO estimate for FLFP is used. Further, they find that the U-shape vanishes under dynamic panel estimations. While Gaddis and Klasen (2014) conclude that the feminization U hypothesis has little support as a secular trend driving FLFP, their revised method is consistent with the sectoral perspective, where structural changes in the economy, namely the relative size of different employment sectors, initially lower but then later raise FLFP. The effect size, however, is small.

Choudry and Elhorst (2018), on the other hand, lend empirical support to the feminization U-hypothesis, investigating the strength of the U-shaped relationship across a panel of 40 countries from 1960-2005. These authors find that the income effect from rising male wages lowers women's participation in the workforce, absent improvements in women's wages. In addition, Choudry and Elhorst (2018) observe that the share of employment in agriculture is positively related to FLFP. As the economy develops and the employment share in agriculture declines, FLFP thus falls as well. As education levels improve and service sector employment eventually expands, FLFP begins to rise.[1] These findings are consistent with the explanation that women cannot as

[1] Choudry and Elhorst (2018) find that women's employment in agriculture declines as farm labor productivity increases. A portion of the declining employment share in agriculture is thus women whose labor has been replaced by technology. This helps to explain the lag between falling employment in agriculture and rising employment in

easily move across employment sectors absent structural changes that occur later in the development process. While there is still considerable debate as to the full explanatory power of the feminization U-hypothesis, it appears the sectoral element of the theory has some degree of salience in explaining how the female labor supply changes as countries develop. This suggests that FLFP gains from time savings are likely to differ, perhaps substantially, by development level.

2.2 Regional Trends in Women's Labor Force Participation

Klasen (2019) provides a comprehensive overview of trends in women's labor force participation across the developing world, finding that country fixed effects account for a far greater portion of the observed variation in FLFP than a country's position along the supposed feminization U. Despite strong, homogenous trends in expected covariates of the female labor supply—rapid fertility decline, expansion of education, and economic growth—there has been substantial heterogeneity in regional trends in FLFP over the past several decades (Klasen, 2019). While the rise in FLFP has been especially strong for Latin America, results differ across other regions. Conversely, in Central Asia, East Asia, and parts of South Asia, FLFP has trended downward. The Middle Eastern and North African (MENA) cluster exhibits a slow rise but from an incredibly low baseline. The relationship between FLFP and the fertility rate follows a similar pattern, with only Latin America and Bangladesh showing a strong negative relationship while the MENA and Sub-Saharan Africa regions show a considerably weaker negative relationship. All other regions either exhibit no relationship or a slight positive one. Finally, the absolute levels of women's labor participation also display substantial heterogeneity and have no discernable association with the suspected covariates. For instance, in Sub-Saharan Africa (SSA), where FLFP growth has been largely stagnant since the 2000s, the level of FLFP is still relatively high. This is

services—that many women formerly employed in agriculture exit the labor force rather than immediately shifting to a different sector.

attributable to the fact that a large proportion of women in SSA combine home production and agricultural work in the same location, although average market hours are still quite low despite high levels of participation (Dinkelman and Ngai, 2022). Altogether, these differing trends are inconsistent with the notion of an overarching theory that explains the behavior of women's labor force participation. Rather, these trends point to the importance of persistent cultural attitudes surrounding gender and other country-level fixed effects in evaluating changes to the female labor supply in developing economies.

Despite a robust expansion of the female labor supply in Latin America, there has been a marked deceleration in FLFP since the early 2000s. Gasparini and Marchionni (2017) investigate this deceleration, finding that a combination of lower unemployment, higher male earnings, and a more robust social safety net may have reduced the need for women to enter the workforce. Moreover, it appears that women's attachment to the labor force can be quite weak depending on the type of employment available. That is, when work opportunities are predominantly hard manual labor in agriculture or low-end services, women leave these jobs when it becomes affordable to do so (Klasen, 2019). These explanations are especially relevant to poorer women, who often occupy these lower quality, more physically demanding jobs. These findings speak to the persistence of both a household income effect and sectoral development as factors determining women's labor force participation.

2.3 Electrification and Women's Labor

Expanded infrastructure access is another source of structural transformation with potential for strong labor market impacts. Infrastructural improvements should, in theory, support women's entry into the workforce through substantial alterations to the time devoted to household tasks. However, results in the literature have been mixed. Dinkelman (2011) finds that the rollout of a

rural household electrification program in South Africa raised FLFP, with its effects on home production identified as one of several possible channels through which electricity affects rural labor markets. Two particular details from this paper suggest domestic appliance ownership as a causal mechanism behind the observed FLFP increase. First, the use of electricity in cooking increased considerably, while wood fueled cooking decreased by an almost identical amount following electrification. This indicates an electrification driven substitution from more to less time intensive cooking methods. Second, newly electrified households in the study area reported a large increase in ownership of domestic appliances. Together, these suggest that domestic appliance ownership acted as a driving force that frees up women's time and thus facilitates greater labor participation. Van de Walle et al (2017), however do not find the same significant labor supply impacts for women following India's national electrification program. Burlig and Preonas (2021) employ a regression discontinuity design to evaluate this same program, likewise finding no significant positive labor supply impact for women. Unlike Dinkelman (2011), these authors observe no changes to the share of households using non-traditional fuels in cooking following electrification. This finding suggests that differences in the uptake of time saving home appliances following electrification could explain a considerable portion of the differing results.

2.4 The Liberation Hypothesis and Supporting Evidence

Assembling microdata from a set of time use surveys in four SSA countries of varying development levels, Dinkelman and Ngai (2022) show that the allocation of time across different home production activities bears a close resemblance to women's time use patterns in the U.S. during the 1920s and 1960s.[2] Hence, studying the diffusion of home appliances and its impact on

[2] Dinkelman and Ngai (2022) show that present day Ghanaian and Moroccan women spend, on average, upwards of 20 hours per week cooking, as did married women in the US during the 1920s. In present day South Africa, laundry is roughly as time intensive as it was in the 1960s US. In Ghana, hours spent caring for children and other family members closely resembles the 1960s US.

the female labor supply over this period provides a historical parallel from which to draw. A set of literature directly investigates the role of time saving appliances in women's entry into the workforce in the U.S. and other OECD countries during the 20th century. Central to this body of works is Greenwood, Seshadri, and Yorukoglu (2005) (GSY), who argue that the proliferation of time-saving appliances was a major cause of the mass shift from the home to the labor market seen in the U.S. and other industrialized economies; an explanation commonly referred to as the "liberation hypothesis." This effect takes place through two mechanisms: first, a direct effect on the time allocated to home production, and second, an interaction effect with female labor supply elasticity. That is, as household appliances are introduced, the responsiveness of the female labor supply to a narrowing of the gender gap in wages increases. In one version of their model, GSY posit that improvements in household technology can explain over half of the observed rise in the increase in FLFP among married women between 1900 and 1980.

A closer look at the theoretical basis for the GSY hypothesis is warranted here since it underlies the proposition that appliance ownership facilitates women's entry into the workforce. GSY construct their model by applying the theory of household time allocation developed by Becker (1965)[3] to a dynamic general equilibrium in which appliance prices decline and the ratio of female to male wages rises over time. Specifically, households in the model are faced with two decisions: whether to adopt time saving appliances and whether women in the family should enter the labor market. The exogenous price decline in labor saving technology substantially alters this first decision in favor of adoption. Adoption in turn impacts the decision to work by lowering the relative cost of home goods through greater efficiency. However, whether the reduced cost of home production translates to increased labor market activity and not greater consumption of home

[3] Becker (1965) treats households as both producers and consumers who combine inputs of goods and time following basic utility maximization and cost minimization principles.

goods in most cases is not certain. Rather, this outcome depends on the elasticity of substitution between home and market goods in terms of household utility (Jones, Maneulli, and McGrattan, 2015).[4] This raises the question as to whether the results produced by the GSY model replicate in different settings or using different methods.

Two papers provide credible empirical support for this hypothesis. Coen-Pirani, Leon, and Lugauer (2010) test the GSY hypothesis using micro level data on FLFP and household appliance ownership in the U.S. during the 1960s, finding that increased ownership accounts for an estimated 40 percent of the increase in married women's labor participation over the decade.[5] Cavalcanti and Tavares (2008) assess how female labor supply responds to changes in the relative price of appliances, using aggregate level data for a set of OECD countries, finding a robust, significant, negative relationship. Further, their IV strategy yields estimates that are greater in magnitude than their OLS estimates, providing strong evidence for causality.

2.5 Evidence from Latin America

Returning to the development literature, two papers suggest the GSY hypothesis helps to explain a substantial portion of the strong rise in FLFP seen in Latin America since the 1990s. Latin American countries are a particularly interesting setting to study the labor supply impacts of appliance ownership, as the rapid trade liberalization that took place following a period of price-distortive import substitution (ISI) policies[6] has dramatically lowered the relative price of

[4] If home and market goods are substitutes in terms of household utility, an increase in household productivity increases consumption of home goods whereas labor market hours increase if home and market goods are complements.

[5] Full ownership of an appliance bundle (freezer, washer, dryer) raised the likelihood of married women's LFP by 27 percentage points. Given the 17 percentage point increase in the U.S. over this period, this estimate implies increased appliance ownership accounts for as much as a 4.6 percentage point increase in FLFP, or an average of nearly 0.5 percentage points per year.

[6] Import substitution industrialization (ISI) aimed to promote domestic manufacturing and discourage reliance on foreign production through high import tariffs and nontariff trade barriers.

appliances (Cubas, 2016). Cubas (2016) finds that both trade-driven declines in appliance prices and expanded access to appliance supporting infrastructure (i.e., electricity, running water) substantially drive increases in FLFP, based on a predictive model for Brazil and Mexico, respectively.[7] Medina, Sotelo, and Velasquez (2025) similarly link trade liberalization to growth in the female labor supply in Peru, identifying home appliance ownership as the mechanism through which FLFP increases. Since domestic appliance production is weak in Peru, as is the case in most developing countries, appliance imports serve as a proxy for aggregate level ownership (Medina, Sotelo, and Velasquez, 2025). Following the same behavioral model put forth in GSY, steep relative price declines induce greater appliance ownership, causing a substantial reallocation of time from home production to the labor market, thereby increasing labor force participation. Specifically, these authors document a 75 percent decline in the relative price of home appliances from 1994 to 2017, during which total appliance import levels grew by a factor of ten. This in turn caused quite a notable rise in FLFP, enough to explain one tenth of the variation over the period.[8]

The discussed transition from ISI to more liberal trade policy has also occurred alongside technological innovations in appliance manufacturing as well as increased involvement of East Asian economies in global trade (Medina, Sotelo, and Velasquez, 2025). Taken together, these facts imply that a large portion of the world's developing economies have thus been exposed to a strong, positive supply shift in appliances. This establishes the effects of expanded appliance access as a topic warranting further investigation and also serves as the basis for the IV strategy used in this paper to assess the appliance trade expansion's relationship to the female labor supply.

[7] For Brazil, the model accounts for almost all the observed rise in FLFP. For Mexico, however, the model overpredicts levels of FLFP.

[8] To assess causality, Medina, Sotelo, and Velasquez use variation in electricity and water coverage across localities to instrument for exposure to relative price declines. These authors find that owning an appliance increases the probability of a woman participating in the labor market by 59 percentage points. Note that while large, this is a local average treatment effect, not the aggregate effect from the price change.

While some credible evidence has emerged that greater appliance adoption and rising FLFP are interlinked, evidence on this topic is still quite limited. As stated directly by Klasen (2019), "Clearly, more research in this important area is required". Moreover, a cross-country analysis with panel data similar to that of Cavalcanti and Tavares (2008) has yet to be conducted for a set of developing countries. It is in this gap in the literature that this paper intends to contribute. Whether the measured effect follows the same regional heterogeneity discussed above and how this relationship differs across development status are also points of interest.

3. Data

The panel used in this paper features trade, economic, and demographic data for 116 countries spanning the years 2000 to 2019. The data is drawn from two sources. First, appliance trade data is drawn from the U.N. Comtrade database. This includes import levels, recorded annually in US dollars, for the Standard International Trade Classification code corresponding to appliances for home use (SITC 775). In addition to total import levels, export levels to individual trading partners from each available country are used to construct the instrument. All other data is sourced from the World Bank, specifically the World Development Indicators (WDI) database. The data on women's labor force participation from the World Bank WDI database is based on the International Labor Organization (ILO) modeled estimate. This estimate involves using a series of models to add observations and make projections where data from labor force surveys or population censuses is missing. The labor force participation rate is defined as, "the proportion of the population ages 15-64 economically active: all people who supply labor for the production of goods and services during a specified period." (World Bank, 2025).

While most data from the World Bank WDI database is present for each year since 1990, trade data for the 1990s are missing with far greater frequency. Ideally, data used in this paper

would cover the 1990s considering that this decade saw a rapid increase in trade liberalization for much of the developing world. However, selecting 2000 as the base year ultimately minimizes the number of missing observations. As will be discussed in section 4, the instrument construction involves the use of a trade share for a selected base year. Developing countries that would otherwise be appropriate to include in the set but are missing trade data for the year 2000 are thus excluded. Summary statistics and average changes over the period are presented below.

Summary Statistics

Variables	Observations	Mean	Std. Dev.	Min	Max
FLFP	2119	52.83	17.561	5.269	88.523
Appliance Imports (in millions USD)	2119	163	405	.03189	4,600
Appliance Imports per capita	2119	14.205	31.83	.022	352.19
GDP growth rate	2104	4.129	4.284	-36.392	34.5
GDP per capita	2079	12765.873	18754.283	471.967	181000
Urban-rural population ratio	2066	2.89	24.861	.09	1085.95
Unemployment (Female)	2119	9.844	7.769	.15	42.485
Unemployment (male)	2119	7.493	6.11	.045	36.969

Average changes 2000-2019

Variables	Mean	Std. Dev.	Min	Max	25^{th}	75^{th}
ΔFLFP	1.95	8.98	-22.05	20.84	-2.06	8.03
% Δ Appliance imports (in USD)	5.83	7.08	-.64	39.28	1.69	6.63
% Δ Appliance imports per capita	4.39	6.63	-.80	40.30	.87	4.87
Δ log of appliance imports per capita	1.21	0.93	-1.60	3.72	.63	1.77

4. Methodology

4.1 Model Summary

To investigate the impact of domestic appliance ownership on the female labor supply, the following model is estimated.

$$y_{it} = \alpha_i + \lambda_t + \delta I_{it-1} + \beta X_{it} + \epsilon_{it} \,,$$

where y_{it} is women's labor force participation, I_{it-1} is country level appliance imports with a one-year time lag, α_i and λ_t, are country and time fixed effects, respectively, and X_{it} is a set of controls. Country and year are denoted by subscripts *i* and *t*.

Domestic appliance manufacturing is weak in most developing countries, a fact that has been observed previously (Medina, Sotelo, and Velasquez, 2025). Appliance imports thus serve as a proxy for aggregate level appliance purchases. For measuring appliance imports, simply using the raw dollar values would be problematic, as this measure fails to account for variation in population size. Further, measurement error of the same relative amount between countries with substantially different import levels would introduce considerable heteroskedasticity.[9] Instead, appliance imports are scaled by population size and logged such that the variable of interest is the log of per capita imports. The per capita feature allows for cross-country comparability while taking logs compresses the effect of outliers and helps to reduce heteroskedasticity. To better capture the causal impact, a one-year time lag is added to the imports variable. Women's labor force participation decisions likely do not adjust immediately to greater appliance availability. First, it likely takes time for changes in household production efficiency to alter labor market decisions. Second, there may be a considerable lag between when appliances are imported and adopted. As a secondary point of analysis, the explanatory variable is interacted with regional dummies to

[9] For instance, the same level of percent error for a country that imports $1 million versus $10 million in appliances annually would be entirely different dollar amounts, thus leading to nonconstant variance in the residuals.

gauge inter-regional differences in effect size and significance. Likewise, this strategy is employed to investigate variation between countries of differing development status.

4.2 IV Strategy

A standard ordinary least squares estimation is insufficient to assess the causal nature of this relationship given that appliance imports are endogenous. One particular source of endogeneity is that increased demand for women's labor may drive greater purchases of appliances that substitute for home production. To isolate the causal effect, I construct a shift-share style instrument[10] to capture exposure to the exogenous rise in global appliance production.

For a number of countries in the data set, particularly those in Latin America and SSA, trade policy for much of the latter half of the 20th century was oriented such that domestic production would substitute for imports from abroad. In the decades since, there has been a marked shift in these countries away from ISI toward more liberal trade policy, especially following the structural adjustment programs of the 1980s and 1990s, of which trade liberalization was an essential component (Edwards, 1997). As discussed in Section 2, two key developments in global appliance production have occurred alongside this trade liberalization. First, technological advancements have generated substantial improvements in appliance manufacturing productivity. Second, whereas numerous developing countries during the mid-20th century adopted ISI policies, various East Asian economies such as South Korea and Japan pursued export-oriented industrial policy in what came to be known as the "East Asian Miracle" and have since emerged as major exporters of manufactured goods, including home appliances (World Bank, 1993). Together, these developments have led to a large-scale global supply increase in home appliances. Cubas (2016)

[10] This style of instrument can be generally described as measuring an exogenous common shock (the "shift" component), weighted by some measure of a base-level of exposure (the "share" component).

and Medina, Sotelo, and Velasquez (2025) provide strong evidence that these technology and trade driven relative price declines have spurred the adoption of home appliances in developing countries. These facts provide a basis for the construction of an instrument to capture each country's exposure to increased trade in appliances. Imports are thus treated as endogenous and instrumented by z_{it}. The instrument z_{it} is defined as follows.[11]

$$z_{it} = \sum_{j}^{J} (x_{jwt} - m_{ijt}) * (\frac{m_{ijt_0}}{x_{jwt_0}}),$$

where x and m represent appliance exports and imports, respectively, and subscripts signify country, trade partner, and year. Thus, x_{jwt} represents the level of appliance exports by country j to the world (w) in year t and m_{ijt} is the amount country i imports from exporter j in year t. Their difference captures changes in appliance output for country j that are exogenous to demand shifts in country i. The base year is denoted by t_0 such that $\frac{m_{ijt_0}}{x_{jwt_0}}$ represents country i 's trade share in j for the base year, 2000. The product of the base year share for i in j and the exogenous export term therefore captures country i's exposure to supply shifts for a given exporter j. This value is summed across all exporters j ∈ J.

The instrument is, by construction, exogenous to within-country demand shocks, as the "shift" component of the instrument excludes country i imports. Appliance production in exporting countries is assumed to affect FLFP solely through its impact on appliance ownership within importing countries. With the causal variable of interest identified as the sole mechanism linking the IV to the outcome variable, the instrument is assumed to satisfy the exclusion restriction.

4.3 Controls

The controls used can be classified into three groups: fixed effects, cyclical controls, and time-varying structural controls. The model employs two-way fixed effects to account for unobserved factors that influence the female labor supply. Country fixed effects are included to

[11] The IV is adjusted in the same manner as imports, which are scaled by population and logged.

control for unobserved time-invariant heterogeneity across countries, while time fixed effects are included to account for shocks or trends over time that all countries in the panel are similarly exposed to.

The male and female unemployment rates and GDP growth are included as cyclical controls. Unemployment is included to absorb the effects of short-run labor market conditions while GDP growth is included to control for movements along the business cycle. Generally, high unemployment is expected to discourage entry into the workforce by signaling poor labor market conditions and low job prospects. Unemployment is separated into male and female unemployment to account for gender-specific changes to employment and their impact on FLFP. The model is tested with the unemployment controls excluded, included separately, and included jointly. High collinearity between male and female unemployment may reduce the precision of these two estimates for the specification where they are jointly included. Nonetheless, this specification is still reported, as controlling for gendered aspects of the labor market better isolates the relationship of interest. As for GDP growth, the sign is expected to be positive, as short-run economic expansion is associated theoretically with higher labor demand. However, it is possible for this effect to display a negative sign through a supply side effect where more women enter the workforce during periods of economic downturn to provide support for weaker family incomes. GDP growth and unemployment for both genders display a very weak negative correlation, which eliminates any collinearity concern.[12]

Two structural controls are included. First, logged per capita GDP is included to absorb the labor-supply impacts of rising incomes. As discussed in section two, there is ongoing debate as to whether the income effect or substitution effect from rising incomes dominates at various stages

[12] The correlations between annual GDP growth and male and female unemployment are roughly -0.08 and -0.07, respectively.

of development. Rising incomes could lower the need for women, particularly vulnerable women to work (Gasparini and Marchionni, 2017), while rising wages could raise the opportunity cost of not working. Given the repeated findings in the literature of a strong household income effect (Choudry and Elhorst, 2018, Klassen, 2019), the sign on this coefficient is expected to be negative. Second, the urban-rural population ratio is added as a control to account for how shifts in where the population works and lives could impact FLFP. Generally, urban populations are associated with factors thought to increase FLFP, namely reduced fertility and less rigid cultural norms. However, population migration from rural to urban areas could also result in a lower rate of FLFP by altering the distance between home production and market work, considering that many rural women conduct these activities in the same location (Dinkelman and Ngai, 2022). While much of the urban-rural population ratio may be absorbed by country fixed effects, there is still a substantial time-varying component.[13] Further, Cavalcanti and Tavares (2008) similarly include the urban population level as a control for FLFP while simultaneously including country fixed effects. The results from these estimations are described in the next section.

5. Results

5.1 Main results

The results in Table 1 show a statistically significant effect for five of the six specifications in the table. For columns (5)-(6), where male unemployment is included, the estimates are significant only at the 10% level, just narrowly missing the 5% threshold.[14] For these two specifications, the coefficients signify that a one percent increase in appliance imports per capita

[13] Appendix Table 2 shows that roughly 40 percent of the variation in the urban-rural population ratio remains unaccounted for by country and time fixed effects.
[14] Exact p-values are reported in Appendix Table 3.

Table 1. Effect of changes in appliance imports on FLFP. Two stage least squares results.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Log of appliance imports per capita	0.015***	0.009	0.047**	0.048**	0.040*	0.039*
	(0.002)	(0.012)	(0.022)	(0.022)	(0.021)	(0.020)
GDP growth rate			0.037	0.037	0.026	0.025
			(0.032)	(0.032)	(0.030)	(0.029)
GDP per capita (logged)			-0.053**	-0.054***	-0.047**	-0.047**
			(0.021)	(0.021)	(0.020)	(0.019)
Urban-rural population ratio			0.002***	0.001***	0.001***	0.001***
			(0.000)	(0.000)	(0.000)	(0.000)
Unemployment (female)				-0.039		0.014
				(0.037)		(0.042)
Unemployment (male)					-0.121***	-0.132**
					(0.042)	(0.053)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	Yes	Yes	Yes	Yes	Yes
Observations	1,925	1,925	1,838	1,838	1,838	1,838
R^2	0.97	0.97	0.96	0.96	0.96	0.96
First-stage F-statistic	586.32***	31.335***	12.21***	12.29***	12.22***	12.75***

Robust standard errors in parentheses. Constants not reported.
*** p<0.01, ** p<0.05, * p<0.1

causes an approximate 0.04 percentage point increase in women's labor force participation. Given the relatively slow rate at which FLFP changes, the size of this effect is considerable. Of the countries that saw an increase in FLFP from 2000 to 2019, the average total increase was 6.82 percentage points or 0.36 percentage points per year, on average. Using average changes in per capita appliance imports and FLFP over the study period, a simple calculation of the form

$$\%\ of\ Total\ Variation = \frac{\beta * \Delta appliances}{\Delta FLFP} * 100\ ,$$

where Δ appliances is the difference over time in the log of per capita appliance imports.

implies that the rise in appliance imports explains roughly 2.4-3.0 percent of the observed increase in FLFP between 2000 and 2019.[15] While this is a rather crude measurement, it serves as a simple

[15] 0.039 * 1.21 / 1.95 * 100 = 2.4% ; 0.048 * 1.21 / 1.95 * 100 = 3.0%

point of comparison to the aforementioned case of the U.S. during the 1960s. Coen-Pirani, Leon, and Lugauer (2010), use the same simple calculation for their estimate that greater appliance ownership accounts for 40 percent of the rise in FLFP among married women in the U.S. over the decade.[16]

Per capita GDP, the urban-rural population ratio, and male unemployment are statistically significant in each specification. GDP growth, though not significant, and the urban-rural population ratio are positively related to FLFP while per capita GDP and male unemployment exhibit a negative relationship. Female unemployment also exhibits a negative relationship for column (4), where it is included on its own, although it is not significant. The signs for these coefficients align with the theoretical predictions discussed in section 4.3 as well as previous results from OECD countries. Cavalcanti and Tavares (2008) use a similar set of controls for the female labor supply, finding a positive relationship between FLFP and each of real GDP growth and the share of urban population, and a negative relationship with average male income. The signs on the coefficients from Cavalcanti and Tavares (2008) match the signs on their counterparts for this paper—real GDP growth, the urban-rural population ratio, and per capita GDP. Per capita GDP, male unemployment, and the urban-rural population are each statistically significant at the 5% level, whereas the variable of interest is significant only at the 10% level. Compared by magnitude, the coefficient for appliance imports is roughly one third the size of male unemployment, slightly smaller than that of per capita GDP, and larger than the remaining controls. The size of this effect compared to GDP per capita provides evidence that the relationship between appliance imports and the female labor supply is quite meaningful. Although the debate

[16] While Coen-Pirani, Leon, and Lugauer (2010) measure this effect specifically for married women, their IV strategy draws on the fact that FLFP among single women did not increase over this period. Hence a comparison of the 6.5% and 40% figures is still reasonable.

regarding the extent of the feminization U hypothesis' explanatory power remains unsettled, the existence of a strong household income effect is validated by proponents and skeptics alike (Choudry and Elhorst, 2018, Klassen, 2019). That the impact of increased appliance ownership on FLFP is comparable to a well-established female labor supply determinant speaks to the strength of this effect. While these results are indicative of a considerable causal impact, the strength of this effect varies substantially by region and income level. These variations are consistent with key aspects of the literature.

5.2 Regional results

Table 2. Effect of changes in appliance imports on FLFP. Regional comparison.

Region	Effect (1)	FLFP (percent level) (2)	Δ FLFP (percentage points) (3)
Sub-Saharan Africa	0.078	60.96	-2.48
	(0.071)		
South Asia	0.116	36.19	3.59
	(0.077)		
East Asia	0.0692	60.75	-1.71
	(0.045)		
Middle East and North Africa	0.064*	27.12	4.12
	(0.033)		
Eastern Europe	0.039*	60.65	3.84
	(0.022)		
Latin America	0.202*	54.65	8.52
	(0.120)		
Non-interacted coefficient	0.123		
	(0.118)		

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Among the regional interactions that are statistically significant (only at the 10% level), the largest effect size can be seen for Latin America, followed by MENA, and Eastern Europe, as can be seen from table 2 below. The magnitude of the coefficients themselves, however, should

be interpreted with caution. While the effects appear large compared to the initial overall estimate, they are considerably less precise.[17] Consequently, these region-specific estimates are not intended to serve as precise measurements of each intra-regional effect, but rather as a basis for inter-regional comparison. Recall that Klasen (2019) observes high regional variation in the responsiveness to trends that should positively impact the female labor supply, with the greatest increases occurring in Latin America. The strong effect seen in Latin America in particular matches this behavior. Further, the more modest appliance driven increases seen for MENA appears to match the region's slow rise from low levels of FLFP. The increase seen in Eastern Europe aligns with the observation that many Eastern European nations should, theoretically, be positioned along the ascending portion of the feminization U (Klassen, 2019). South Asia, East Asia, and Sub-Saharan Africa, which have not seen the same consistent rise in participation, do not show a statistically significant effect. South Asia displays the highest variance, which matches the inconsistent behavior of FLFP between countries in the region. India and Bangladesh, for instance, are two South Asian countries with vastly different trends in FLFP over time. Bangladesh has seen a rise in FLFP of roughly twelve and a half percentage points from 2000-2019, while India has seen a decline of nearly eight percentage points.

Recall that GSY (2005) find that appliance ownership has a secondary effect on the female labor supply by increasing women's responsiveness to changes in the gender wage gap. In this setting, an effect on female labor supply elasticity[18] could likewise be a channel through which appliance ownership increases FLFP. That is, aside from a first order effect where time savings

[17] Reduced precision likely stems from several factors: noise introduced by the several regional interaction terms, lower statistical power from dividing the sample size across regions, and potential instrument strength variation by region.

[18] Defined generally as the responsiveness of the female labor supply to changes in determinants of women's labor participation.

from home appliances are directly reallocated to the labor market, this newly freed up time could alter the extent to which women respond to changes in co-determinants of FLFP. In this sense, the causal mechanism through which appliances impact women's labor is not strictly time reallocation, but an interaction between time savings and contemporaneous changes in gender norms, macroeconomic conditions, and other cultural and labor market factors. That appliances may impact female labor supply elasticity provides a plausible explanation for the regional heterogeneity observed in the results. Essentially, if appliance ownership increases women's responsiveness to the factors underlying differing regional trends, this would help to account for why regional variation in the female labor supply impact of appliances matches regional variation in the behavior of FLFP over time.

5.3 Income level results

Table 3. Effect of changes in appliance imports on FLFP. Income level comparison.

Income level	Effect (1)	FLFP (2)	Δ FLFP (percentage points) (3)	Agricultural Employment, Female (4)
Low income	-0.006	61.35	-7.10	66.91
	(0.023)			
Lower-middle income	0.031*	51.14	-0.44	41.58
	(0.018)			
Upper-middle income	0.053***	51.50	5.92	17.92
	(0.020)			
High income developing	0.086***	54.07	7.93	1.62
	(0.023)			

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The income group decomposition shows coefficients that increase considerably in size and significance moving from lowest to highest levels of development. The lowest income group exhibits no statistically significant relationship between appliance imports and FLFP. The lower-

middle income group estimate is significant only at a 10% level and is considerably smaller than that of the two higher income groups, both of which are significant at the 5% level. The high-income group[19] coefficient is especially large. Per column (4), the share of female employment in agriculture is highest for the least developed countries and decreases as countries develop. The average rate of women's labor force participation is highest for the low-income group, where the share of women's employment in agriculture is also highest, although the difference between the non low-income groups is quite modest. Taken together, columns (1) and (4) show that effect size and significance are inversely related to the share of female employment in the agriculture sector. These results are consistent with the sectoral explanation where FLFP is high when agriculture is the dominant economic activity, but that further entry of women into the labor force does not take place absent an expansion of non-agricultural sectors. Further, per the discussion in Section 2, women's attachment to the labor market tends to be weaker when the available work options are lower quality. Thus, in lower income countries, where such employment options are generally more widespread, appliance driven time savings likely have a more muted impact on women's decision to enter the labor force. Relating these results to the discussion of female labor supply elasticity in Section 5.2, the effect is strongest for those countries that should theoretically be on the ascending portion of the feminization U. That is, in countries that have undergone or are actively undergoing structural changes that should pull women into the labor force. Increasing women's responsiveness to those changes can thus be considered as a complementary mechanism through which greater appliance ownership impacts the supply of women's labor.

5.4 Limitations

While these results provide evidence of a sizable causal relationship between appliance

[19] This group includes countries that are classified as "high income" by the World Bank, but still classified as an emerging market or developing economy by the IMF.

ownership and female labor force participation, several important questions remain unanswered due to data limitations. Finding answers to these questions would help to elucidate key aspects of this relationship. First, labor force participation is recorded as a strict binary of whether each individual in the population does or does not work. This leaves open the possibility that appliance ownership has caused a substantial yet unrecorded increase in hours dedicated to market work among women who combine home and market work in the same location. Alternatively, it could be the case that work hours are simply unaffected. The present results provide no clear-cut evidence in favor of or against either hypothesis. Uncovering this relationship would be especially beneficial in understanding the female labor supply effects in parts of the developing world where women's labor participation is high, but market hours remain low, such as Sub-Saharan Africa.

Second, the results do not differentiate between the effect for married and unmarried women. Changes in appliance ownership are almost certain to impact these two groups differently, with this difference possibly varying by region and development level as well. Understanding how greater appliance ownership impacts married women would help to better evaluate the strength of the relationship between appliances and women's labor, as time savings are likely to impact this group to a greater degree. Further, uncovering any regional or development level differences in the impacts to married versus unmarried women could provide insight into factors that account for the differing trends seen in FLFP.

Third, the measure of appliance imports used is an imperfect proxy for appliance ownership in that it lacks specificity as to the nature of the appliances imported. Since import values are recorded in US dollars, a given increase could be comprised of a greater volume of less costly items or, alternatively, of a lesser volume of more costly items. For instance, the same dollar

amount in imported tea kettles versus refrigerators would represent entirely different changes to actual appliance ownership for a given country. Moreover, different appliances yield different amounts of time savings. The data used here could thus mask important differences in the actual within-country changes to appliance ownership and, subsequently, time usage, which could in turn yield different FLFP responses. For each of these limitations, an analysis drawing on more comprehensive microdata would provide the level of granularity required to uncover these key relationships.

6. Robustness Check

I test the robustness of the primary estimates by using a lagged dependent variable (LDV) in place of country fixed effects (FE), a technique which relies on a weaker identifying assumption. The assumption that underlies the use of country FE, shown below, is that the unobserved determinants of country-level variation in FLFP are time-invariant.

$$E[\epsilon_{it}|\alpha_i, \lambda_t, X'_{it}] = 0\,,$$

where ϵ_{it} is the error term, α_i, λ_t , are fixed effects, and X'_{it} represents all other variables.

Essentially, the unobserved determinants are assumed to be either time-invariant or time-varying but common to all countries. The model therefore does not account for unobserved determinants that simultaneously vary across time and within countries. However, the idea that the most important unobserved sources of variation are time invariant is a rather strong assumption. Alternatively, the causal effect of interest can be estimated by including a dynamic estimator to capture how past values of the outcome variable influence future values, such as in the following model.

$$y_{it} = \theta y_{it-1} + \lambda_t + \delta I_{it-1} + \beta X_{it} + \epsilon_{it}\,,$$

where y_{it-1} is the value of FLFP for country *i* in the previous period.

The identifying assumption for this model, shown below, is conceptually weaker. Compared to a two-way FE model, this model assumes that past outcomes better account for the unobservable characteristics that influence future outcomes. However, the estimates for this model will be biased if there is autocorrelation in the residuals.

$$E[\epsilon_{it}|y_{it-1}, \lambda_t, X'_{it}] = 0$$

Per Angrist and Pischke (2009), separate use of these estimations provides a useful bracketing property. If the assumption motivating the use of unit fixed effects is incorrect, but a static model is used to estimate the coefficient of interest, the coefficient will likely overstate the causal effect (Angrist and Pischke, 2009). By failing to account for the impact of past outcomes on future outcomes, the FE model attributes too much explanatory power to the variable of interest. Conversely, if the fixed effects assumption holds but an LDV is mistakenly used to estimate a positive relationship, the estimates will exhibit attenuative bias (Angrist and Pischke, 2009). Since fixed effects are, by definition, persistent over time, the error terms for each period contain fixed effects and are thus serially correlated. If an LDV is used in the presence of residual autocorrelation, the coefficient for the explanatory variable will be biased downward (Keele and Kelly, 2006). Taken together, these properties therefore serve as a means of bounding the estimated causal impact. The results produced by the dynamic model are presented in Table 4.

Compared to the primary estimates, the estimates for the short-run effect produced by the dynamic model are considerably smaller in magnitude but far greater in significance. While the estimates shown in columns (5)-(6) of Table 1 (section 5.1) are significant at the 10% level, the estimates, shown in columns (3)-(4) of Table 4 are significant at the 1% level. Interestingly, the significance of the coefficient for per capita income vanishes compared to the static model. Moreover, the estimated effect of male unemployment is significant only at the 10% level in the

Table 4. Effect of changes in appliance imports on FLFP using lagged DV.

VARIABLES	(1)	(2)	(3)	(4)
Log of appliance imports	0.0020***	0.0019***	0.0019***	0.0019***
per capita	(0.0006)	(0.0006)	(0.0006)	(0.0006)
GDP growth rate	-0.001	-0.002	-0.003	-0.003
	(0.007)	(0.007)	(0.007)	(0.007)
GDP per capita	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Urban-rural	0.000	0.000	0.000	0.000
population ratio	(0.000)	(0.000)	(0.000)	(0.000)
Unemployment		-0.006		0.007
(female)		(0.004)		(0.008)
Unemployment			-0.010**	-0.017*
(male)			(0.005)	(0.010)
FLFP, lagged	0.995***	0.994***	0.995***	0.995***
	(0.001)	(0.001)	(0.001)	(0.002)
Country FE	No	No	No	No
Time FE	Yes	Yes	Yes	Yes
Observations	1,838	1,838	1,838	1,838
R-squared	0.99	0.99	0.99	0.99

Robust standard errors in parentheses. Constants not reported.
Coefficient of interest rounded to four decimal places.
*** p<0.01, ** p<0.05, * p<0.1

most complete specification. While the immediate effect is quite small, the long-run effect appears to be somewhat large at an estimated 0.38 percentage points.[20]

Altogether, these results substantiate the existence of a positive, causal relationship, but render the estimated size of the effect less certain. That is, these results strengthen the case that the true short-run effect of appliance imports on the female labor supply is greater than zero, however the true effect could in fact be much smaller than what is suggested by the two-way FE results. Two competing possibilities could explain this behavior. First, the LDV captures important variation ignored by FEs and the true effect is thus much smaller than the estimate produced by

[20] Long run effect calculated as ß/(1-θ) or 0.0019/(1-0.995) = 0.38

the primary model. Alternatively, the considerable decrease in effect size could be interpreted as attenuative bias, which would thus validate the use of two-way FE by showing that the model is behaving as expected if the first assumption was identified correctly. Whichever possibility is the case, the significance of the effect under a weaker assumption helps to substantiate the existence of a relationship between appliance imports and the female labor supply.

7. Conclusion

This paper finds evidence to support the existence of a causal relationship between home appliance imports and the supply of women's labor in developing countries. Greater international trade paired with vast improvements in production technology has led to a significant decline in the relative price of goods that substitute for domestic labor across much of the developing world. Expanded access to labor-saving technology affects women's decision to work by freeing up time, which can in turn be reallocated to the labor market. Specifically, I find that a one percent increase in appliance imports per capita causes a roughly 0.04 percentage point increase in women's labor force participation. The magnitude of this relationship is comparable to the income effect from a one percent increase in per capita GDP, an effect which has been observed repeatedly in the literature.

While the main result tells a clear, plausible story of appliance induced time savings increasing FLFP, the effect is not uniform across all settings. Differing effect sizes by region and income level suggest that greater home production efficiency may encourage participation in the workforce, but itself be insufficient in causing a reallocation of time from the home to the labor market. In the income level analysis, the results are consistent with the explanation that the relative development of different employment sectors greatly affects the level of women's labor force participation. For the regional analysis, effect sizes follow regional variations in FLFP over time.

Together these results indicate the presence of an interaction effect between appliance adoption and female labor supply elasticity, much like the relationship observed by GSY (2005) where appliance ownership increases the amount by which FLFP responds to changes in the gender wage gap. In this case, the time savings provided by home appliances may increase women's responsiveness to contemporaneous changes in factors that influence their decision to work.

To better grasp the nature of this relationship, more research is required. In particular, understanding how appliance ownership impacts women's work hours and what the size of the effect is for married women specifically would clarify key questions that remain unanswered. Another important dimension to consider is how these results might differ when controlling for changes in women's wages. Finally, measuring the interaction between appliance adoption and changes in women's wages would provide an empirical test of the hypothesis that the effect of labor-saving technology on female labor supply elasticity functions as a secondary mechanism in this relationship.

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Appendix

Appendix Table 1. **Instrument relevance.**
LM test for under identification, first-stage F-statistic, Stock-Yogo critical values for % maximal IV size.

	(1)	(2)	(3)	(4)	(5)	(6)
LM test	294.39***	31.34***	13.58***	13.62***	13.18***	13.57***
F-statistic	586.32***	31.335***	12.21***	12.29***	12.22***	12.75***
Stock-Yogo weak ID test:						
10%	16.38	16.38	16.38	16.38	16.38	16.38
15%	8.96	8.96	8.96	8.96	8.96	8.96
20%	6.66	6.66	6.66	6.66	6.66	6.66
25%	5.53	5.53	5.53	5.53	5.53	5.53

*** p<0.01, ** p<0.05, * p<0.1

Based on the reported Stock-Yogo critical values, the instrument can be described as moderately strong. The first-stage F statistic for columns (3)-(6) exceeds the critical value for 15% maximal IV size but falls short of the 10% threshold. This implies that the bias of the 2SLS estimates could be more than 10% as large as the OLS bias, but less than 15%. While instruments must of course have a nonzero first stage for valid causal inference, weak-instrument bias is less of a concern in "just-identified" models, where the instruments and endogenous regressors are equal in number (Angrist and Pischke, 2009). In fact, in the just-identified case, 2SLS is "approximately unbiased" (Angrist and Pischke p. 209, 2009). Further, the direction of 2SLS bias in the presence of weak instruments is toward the OLS estimate. In this case, the OLS estimates (see Appendix Table 5) show a negative sign for the coefficient of interest, whereas the 2SLS results are positive, which reduces concern that weak instruments are causing the size of the effect to be overstated.

Appendix Table 2.

Urban-rural population ratio and fertility rate regressed on fixed effects.

	Urban-rural population ratio		Fertility rate	
	(1)	(2)	(3)	(4)
VARIABLES				
Observations	2,240	2,240	2,298	2,298
R-squared	0.61	0.61	0.96	0.98
Country FE	Yes	Yes	Yes	Yes
Time FE	No	Yes	No	Yes

Constants not reported.

Appendix Table 2 shows two suspected controls, the urban-rural population ratio and fertility rate, each regressed on country and time fixed effects. This is done to assess each variable's relevance as a control on FLFP, independent of the fixed effects. As indicated by the R-squared for columns (1) and (2), roughly 40% of the variation in the urban-rural population ratio is not accounted for by country or time fixed effects. This is a substantial amount of variation, so it is thus included as a control. On the other hand, per columns (3) and (4), 95-98% of the variation in the fertility rate is accounted for by the fixed effects. Further, from a theoretical standpoint, while a higher fertility rate works to lower women's participation in the workforce, the two are jointly determined (Cavalcanti and Tavares, 2008). Hence this variable is excluded from the model.

Appendix Table 3. Two stage least squares z-statistics and p-values (for Table 1, section 5).

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Log of appliance	6.92***	.393	0.034**	0.032**	0.053*	0.051*
imports per capita	(0.000)	(0.85)	(2.11)	(2.15)	(1.94)	(1.95)
GDP growth rate			0.240	0.241	0.383	0.391
			(1.17)	(1.17)	(0.87)	(0.86)
GDP per capita			-0.053**	0.009***	0.015**	0.014**
			(-2.52)	(-2.60)	(-2.43)	(-2.45)
Urban-rural			0.000***	0.000***	0.000***	0.000***
population ratio			(7.89)	(7.66)	(8.20)	(8.22)
Unemployment				0.303		0.742
(female)				(-1.03)		(0.33)
Unemployment					0.004***	0.013**
(male)					(-2.91)	(-2.49)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	Yes	Yes	Yes	Yes	Yes
Observations	1,925	1,925	1,838	1,838	1,838	1,838
R^2	0.97	0.97	0.96	0.96	0.96	0.96

P-values reported first, z-statistics in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Appendix Table 4. Robustness test z-statistics and p-values (for Table 4, section 6)

VARIABLES	(1)	(2)	(3)	(4)
Log of appliance	0.001***	0.001***	0.001***	0.001***
imports per capita	(3.28)	(3.29)	(3.28)	(3.27)
GDP growth rate	0.870	0.773	0.700	0.699
	(–0.16)	(–0.29)	(–0.39)	(-0.39)
GDP per capita	0.551	0.619	0.627	0.582
	(–0.60)	(–0.50)	(–0.49)	(-0.55)
Urban-rural	0.645	0.830	0.930	0.881
population ratio	(0.46)	(0.21)	(0.09)	(0.15)
Unemployment		0.151		0.386
(female)		(–1.44)		(0.87)
Unemployment			0.046**	0.094*
(male)			(–2.00)	(-1.67)
FLFP, lagged	0.000***	0.000***	0.000***	0.000***
	(726.71)	(674.82)	(713.98)	(656.39)
Country FE	No	No	No	No
Time FE	Yes	Yes	Yes	Yes
Observations	1,838	1,838	1,838	1,838
R-squared	0.99	0.99	0.99	0.99

P-values reported first, z-statistics in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

Appendix Table 5. Ordinary least squares results.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Log of appliance	0.006***	-.0007***	-0.008***	-0.008***	-0.008***	-0.008***
imports per capita	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
GDP growth rate			-0.025	-0.026	-0.030	-0.029
			(0.018)	(0.018)	(0.018)	(0.018)
GDP per capita			-0.004	-0.006	-0.005	-0.006
			(0.006)	(0.006)	(0.006)	(0.006)
Urban-rural			0.000	0.000	0.000	0.000
population ratio			(0.000)	(0.000)	(0.000)	(0.000)
Unemployment				-0.072**		-0.033
(female)				(0.029)		(0.036)
Unemployment					-0.113***	-0.086**
(male)					(0.032)	(0.042)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time fixed effects	No	Yes	Yes	Yes	Yes	Yes
Observations	2,119	2,119	2,005	2,005	2,005	2,005
R^2	0.97	0.97	0.97	0.97	0.97	0.97

Robust standard errors in parentheses. Constants not reported.

*** p<0.01, ** p<0.05, * p<0.1