Trade in Appliances, Household Production, and Labor Force Participation

Pamela Medina
University of Toronto

Sebastian Sotelo
University of Michigan and NBER

Daniel Velasquez
University of Michigan*

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Abstract

We examine how trade influences female labor supply through reductions in the prices of household appliances that substitute for domestic labor. Using a comprehensive data set from 1981 to 2017, which includes four population censuses, household surveys, and customs records from Peru, we show that labor force participation rose at the same time that appliance import prices fell. We then develop and estimate a dynamic general equilibrium model of trade and household production, to quantitatively evaluate the aggregate impact of declining appliance prices. We find that the reduction in appliance prices during the sample period leads to an increase in female labor force participation that explains one-tenth of the total rise in female labor participation in Peru over the past 30 years. However, the gender wage gap widens by approximately 3 percentage points in response to these changes.

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1 Introduction

Globalization has increased rapidly during the past decades and the resulting competition from labor-abundant countries has transformed labor markets in rich and poor countries alike. This sweeping transformation has sparked a vast body of economic research, trying to understand globalization's effects across a wide range of outcomes, ranging from income inequality to health, and even death.[1]

An overarching principle in much of the existing literature is that trade competition affects labor markets primarily through its impact on labor demand. We propose a complementary view in which trade also reshapes labor supply. Specifically, increased trade reduces the prices of household appliances, such as refrigerators and washing machines, which substitute for labor in domestic production. Access to these appliances, in turn, allows individuals to shift their time from home production to market activities, driving higher labor force participation. Since women devote a larger share of their time to domestic tasks—twice as much as men, on average, in OECD countries (OECD, 2011)—this mechanism disproportionately affects female labor force participation.

To examine this new channel liking trade and labor markets, we focus on Peru, which like many developing countries, relies heavily on international trade to access modern appliances. We begin by presenting four empirical facts that document the transformation of labor markets in Peru and highlight the potential role of international trade in appliances in driving this transformation. To do so, we construct a comprehensive dataset comprising: (i) four population censuses from 1981, 1993, 2007, and 2017; (ii) detailed import and export records disaggregated at the 6-digit level, available from 1994 onward; (iii) a time-use survey from 2010; and (iv) household surveys spanning 1998 to 2017.

Fact 1 documents the macroeconomic and microeconomic dimensions of the transformation in Peruvian labor markets. At the macro level, we show that female labor force participation in Peru has risen by approximately 22 percentage points since 1993, while male participation has remained relatively stable, starting from a baseline of over 90 percent—a pattern consistent with trends in many other developing countries, where men were already highly engaged in the labor force. At the micro level, evidence from time-use surveys reveals large differences between households that own appliances and those that do not. Women in households with appliances dedicate less time to home production, are more likely to participate in the labor market, and spend more time working outside the household conditional on participating in the labor market.

[1] See, for example, Autor, Dorn, and Hanson (2016) and Harrison, McLaren, and McMillan (2011) for surveys.

Fact 2 documents the role of international trade in this transformation. Starting in the early 1990s, Peru engaged in a series of economic reforms that included opening up to international trade, after a period of import substitution policies. This opening allowed households to import modern appliances that were produced abroad and thus benefit from global productivity gains and the entry of East Asian countries to global markets towards the end of the period we analyze. As a result, there were two key developments: (i) the import prices of time-saving appliances, relative to average national income, dropped by 75 percent from 1994 to 2017, and (ii) total imports of these appliances grew tenfold. Throughout this period, appliance imports entirely replaced local production—virtually non-existent to begin—which makes the drop in prices act like an exogenous shock to the availability of appliances, and shows that international trade made the labor market transformation possible.

Fact 3 provides evidence that is consistent with a causal link running from appliance ownership to increased female labor force participation, by comparing regions that differ in their access to running water and electricity, which are preconditions for taking advantage of appliances. We begin by showing that in 1993, at the time of the shock, there was wide dispersion in access to utilities, with some regions having nearly complete coverage, whereas others were nearly completely uncovered. We find that in regions with better baseline access to services, both appliance ownership and female labor force participation grew faster, consistent with such regions being able to take advantage of cheaper appliances. The differential is particularly large among married women, who are more likely to bear greater responsibility for household chores and child-rearing.

In Fact 4, we analyze labor force participation and appliance ownership trends across different cohorts. After dividing regions into three categories based on access to utilities, we compare outcomes within each region for households of varying ages when appliance prices dropped. We find that the differences in appliance ownership and labor force participation between high- and low-access regions are more pronounced for younger households. For instance, appliance ownership among households aged 30-45 was 17 percentage points higher compared to households in their late 40s or older, when comparing high-access to low-access regions. These findings suggest that lower appliance prices had disparate effects across age groups, with younger households viewing appliances as long-term investments, whose costs they were more willing to spread over time.

Together, our four empirical facts document a profound transformation in Peru's labor markets since the 1990s. Female labor force participation surged, aided by the availability of time-saving appliances imported from abroad. This growth was particularly large in regions with high utility coverage, where households were better positioned to benefit from declining appliance prices. At the household level, appliance ownership enabled a reallocation of time, especially for women, who have traditionally borne a disproportionate share of home production responsibilities.

While these patterns strongly suggest that international trade and falling appliance prices played a key role, they do not allow us to quantify the aggregate magnitude of this channel. To provide such a quantitative assessment, the second part of our paper develops a dynamic, quantitative model of household production in a small open economy. In the model, we analyze the households' decisions to adopt appliances for home production in the face of a price shock. The new technology embodied in appliances entails a sunk investment cost and an increase in labor productivity at home. We show that, at the extensive margin, the sunk cost of ownership is traded off against the improved continuation value of having appliances in the rest of the lifecycle, inducing an adjustment that takes years to unfold. At the intensive margin, the productivity gain induced by appliances leads to increases in hours worked when market and home goods are complementary. The strength of these responses is governed by the dispersion of an unobserved heterogeneity shock to preferences.

We calibrate the model and simulate the effects of the shock in general equilibrium. Our strategy combines indirect inference with standard model-inversion methods. In short, we calibrate the household's heterogeneity across occupation-appliance choices by targeting reduced-form impacts of a price reduction, together with observed shares of households across cells, as well as other informative moments. We recover fundamentals by inverting our model to match census data from 1993, roughly around the time the price drop starts. Using the calibrated model, we assess how the reduced-form effects translate to aggregates, taking into account the substitution between men and women in market production and the differential responses across the age distribution.

In our main quantitative exercise, we study a counterfactual scenario in which there is a permanent and unexpected drop in appliance prices (relative to average national income) of 75 percent, similar to what we observe in the data. We find that appliance ownership increases in aggregate by 10 percentage points, whereas female labor force participation increases by 4 percentage points. This correspond to about one tenth of the total change in female labor force participation observed in the data between 1993 and 2017, which demonstrates the importance of the labor supply channel of trade. Given that our simulation keeps all other fundamentals constant, the increase in female labor supply increases the wage gap between men and women increases by 3 percentage points. All these effects take several years to unfold, as they require substantial adjustments across households of different ages.

We contribute to three main strands of literature. First, we contribute to a large literature documenting empirically the impacts of international trade on local labor markets. Early work includes Topalova (2010), who documents the distributional impacts of trade liberalization in India, as well as Autor, Dorn, and Hanson (2013) and Pierce and Schott (2016), who study the distributional impacts of Chinese import competition on US local labor markets. Subsequent work has documented these distributional impacts to be similar in developing and developed countries (e.g. Pierce and Schott, 2020, Traiberman, 2019, Hummels, Jorgensen, Munch, and Xiang, 2014, Costa, Garred, and Pessoa (2016), Greenland and Lopresti, 2016, Greenland, Lopresti, and McHenry, 2019). In addition, the adjustment to trade shocks has been shown to be persistent and its consequences long-lived (e.g. Dix-Carneiro, 2014, Dix-Carneiro and Kovak, 2017, Caliendo, Dvorkin, and Parro, 2019). More recently, attention has turned to gendered impacts, with Autor, Dorn, and Hanson (2019) showing that job losses in the U.S. from Chinese imports primarily affected men, while Juhn, Ujhelyi, and Villegas-Sanchez (2014) find that Mexican exporters reduced gender gaps through labor-saving technologies. Conversely, Gaddis and Pieters (2017) find no improvements for women in Brazil due to male-dominated sectoral expansion, and Mansour, Medina, and Velasquez (2022) document adverse and persistent effects of Chinese imports on women's labor market outcomes in Peru. Much of this literature focuses on how trade influences labor demand, often emphasizing gendered employment impacts across sectors. Our work complements this view by examining how trade shapes women's labor supply by shifting the relative prices of goods and time within the household.

Second, our study also connects to the literature on electrification, household appliance adoption, and women's employment. Theoretically, we build on Greenwood, Seshadri, and Yorukoglu (2005), who examine how the introduction of household appliances increased female labor force participation in the United States during the past century, as well as on Gertler, Shelef, Wolfram, and Fuchs (2016) who characterize the acquisition of energy-using assets in the household problem. Empirically, we align with studies that establish causal links between electrification and women employment such as Dinkelman (2011), as well as causal links between appliance ownership and labor force participation, such as Hackett and Marquez-Padilla (2022) and Coen-Pirani, Leon, and Lugauer (2010). We contribute to this literature by providing a global perspective, showing how household and market time allocation responded to the recent wave of globalization. Our work offers new evidence for this mechanism and evaluates its equilibrium and aggregate impacts in a developing country context.

Finally, our paper also relates to the literature that studies how household production and the allocation of time, vary over time and demographic groups (e.g Aguiar and Hurst, 2005, 2007a,b). Our contribution is to highlight that trade can also lead to changes in the productive structure of the economy through changes in the demographic composition of the labor supply. In addition, we focus on the role that such changes can play in developing countries, where female labor force participation is relatively lower.

2 Data

We compile a micro-level dataset using two primary sources from Peru. First, we draw from four population censuses conducted in 1981, 1993, 2007, and 2017. These censuses provide detailed data on labor force participation, employment status, demographic characteristics, and household appliance ownership, all at a fine geographic level (districts). To mitigate potential confounding effects related to college attendance and early retirement, our main sample comprises individuals aged 25-50.[2] An individual is classified as part of the labor force if he or she reports being employed or actively seeking employment.

Second, we use customs records from 1994 to 2017. These records provide detailed data on appliance imports and exports at the product level, including value, quantities, and unit prices. Our focus is on time-saving household appliances, specifically refrigerators and washing machines (including combined washing and drying machines, see Appendix Table D.1).

We supplement this main data set with two other sources of information. First, we use the Peruvian Time Use Survey of 2010 to document the allocation of time by gender between labor market and household work. Second, we also use the National Household Surveys (Encuesta Nacional de Hogares - ENAHO), which covers the period from 1998 to 2017 and contains detailed information on demographics, employment dynamics, and earnings. We use these data to calibrate some moments of the model related to earnings.

3 Stylized Facts

In this section, we describe four main stylized facts about the relationship between international trade in appliances and female labor force participation in Peru, since 1993. Our analysis reveals that (i) there was a large, simultaneous transformation of labor markets and household production during the period, as ownership of modern, time-saving appliances surged and female labor force participation rose by 22 percentage points; (ii) high adoption of appliances was enabled by international trade, (iii) households in areas with access to those services required to take advantage of time-saving technologies, such as electricity and running water, increase appliance ownership and female labor force participation, particu-

[2] In Peru, the *Régimen Especial de Jubilación Anticipada* (REJA) was established in 2002, allowing for early retirement under certain conditions. The qualifying age has varied over time, ranging between 50 and 55 years. Until 2021, the retirement age criteria under REJA were different for women and men.

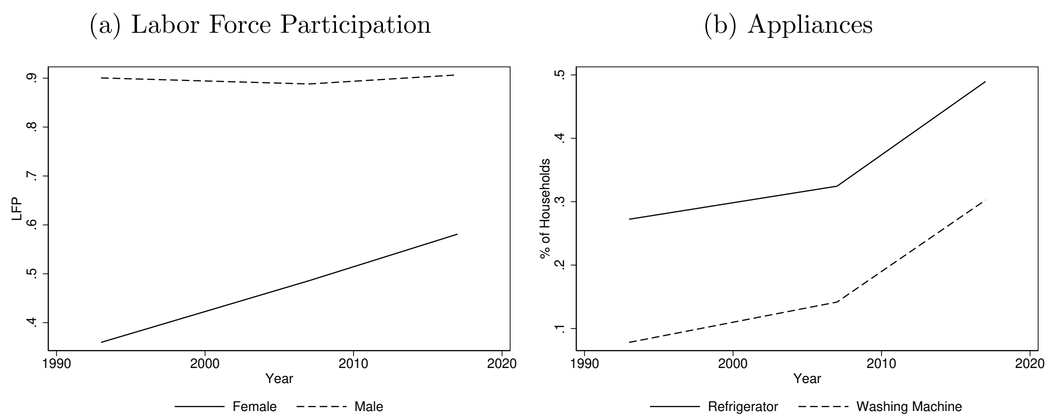
larly those households with married women, and (iv) there were larger shifts in ownership and participation in younger cohorts.

3.1 Fact 1: The Use of Appliances and the Transformation of Household Production and Female Labor Force Participation

Over the past few decades, labor markets across both developed and developing countries have experienced substantial growth in female labor force participation, while male labor force participation has remained relatively stable or declined. In Latin America and the Caribbean, for instance, female labor force participation among women aged 15 and older increased from 44 percent to 51 percent between 1993 and 2017, according to the International Labor Organization (ILO). At the same time, ownership of appliances such as washing machines and refrigerators increased globally by approximately 25 percentage points, marking a substantial shift in household technology adoption.[3]

In Peru, these global trends are mirrored by striking local patterns. Female labor force participation among women aged 25 to 50 rose dramatically from 36 percent in 1993 to 58 percent in 2017, according to our population census data. By contrast, male labor force participation remained steady at around 90 percent during the same period (Figure 1a). At the same time, household ownership of time-saving appliances increased significantly, with ownership of washing machines growing from 8 to 30 percent and that of refrigerators from 27 to 49 percent (Figure 1b).

Figure 1: The Evolution of Labor Force Participation and Appliance Ownership in Peru



Notes: Panel (a) shows labor force participation rates for women and men. Panel (b) shows the share of Peruvian households that own refrigerators and washing machines. Both panels are based on data from the Peruvian censuses of 1993, 2007, and 2017.

[3] Appendix A documents these trends.

Increased availability of these household technologies has substantial implications for the allocation of time in the household and, by extension, for labor markets. Our time-use data show that this is particularly true for women, who disproportionately bear the burden of household chores. Table 1 shows the median hours per day allocated by women and men to household chores and labor markets according to the Peruvian Time Use Survey of 2010.[4] The median woman aged 25 to 50 spends four times more time on household chores than her male counterpart. The ownership of time-saving appliances, however, alleviates this burden. Women in households with such appliances spend 23 percent less time on daily chores, reducing their median from 6.7 to 5.1 hours per day. Appliance ownership is also associated with a 5 percentage point increase in female labor force participation and an 11 percent increase in hours worked in the labor market, conditional on employment. In contrast, across all these measures, the time allocation of men is virtually unchanged with ownership of time-saving appliances.

Table 1: Time Use, by Ownership of Appliance and Sex

	Female		Male	
Variable	With Appl.	W/o Appl.	With Appl.	W/o Appl.
HH Chores (hrs/day, median)	5.1	6.7	1.3	1.6
	(0.32)	(0.10)	(0.10)	(0.05)
Labor Force Participation (%)	65.1	60.3	93.8	94.2
	(0.02)	(0.01)	(0.01)	(0.01)
Labor Market (hrs/day, median)	5.0	4.2	9.8	9.6
	(0.30)	(0.25)	(0.15)	(0.05)
Labor Market (hrs/day, med., cond. work)	8.0	7.2	10.0	9.8
	(0.27)	(0.15)	(0.25)	(0.10)

Notes: Household chores include cooking, cleaning, washing clothing, managing the household, shopping for the household, childrearing, and caring for a disabled, sick, or elderly household member. Labor market hours refer to the total time spent on both primary and secondary jobs for each individual. Appliance ownership indicates a refrigerator and a washing machine in the household. Standard errors are in parenthesis.

The data show, therefore, that starting in the 1990s there was a substantial change in Peruvian households pertaining to the way household production is done and to the decisions of women to participate in the labor market. Our 2010 snapshot also suggests that appliances play a pivotal role in reducing the domestic workload for women, enabling them to reallocate

[4]Unfortunately, Peru's time use survey was only conducted in 2010, in which the transformation of labor markets was well underway. Data availability prevents us from exploiting time series variation for the analysis. We present medians to avoid the influence of outliers and measurement error.

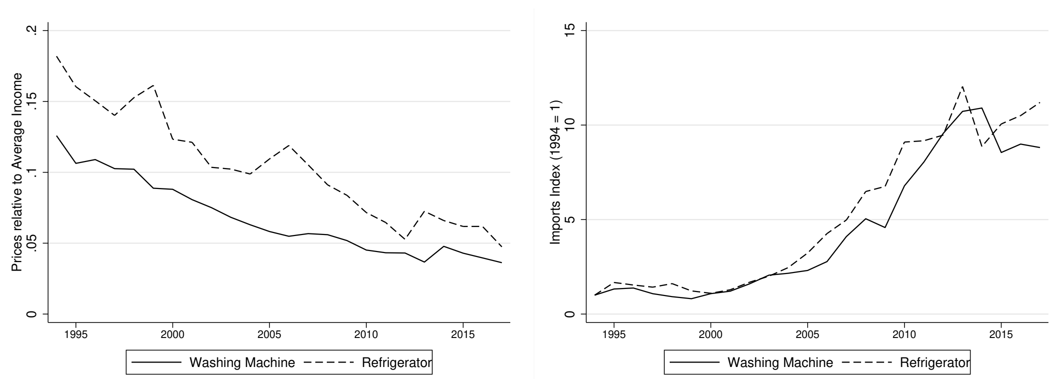
time toward paid labor outside the home, whereas for men the differences are much smaller. We next turn to show that international trade enabled that change.

3.2 Fact 2: Ownership of Appliances Boosted by International Trade

Between 1994 and 2017, Peru saw a sharp increase in the imports of time-saving appliances. This surge can be traced back to economic reforms in the early 1990s, when the country shifted from import substitution policies to greater integration into international trade. These reforms enabled Peru to access modern appliances produced abroad, benefiting from global productivity gains and the integration of East Asian countries into global markets. Two key developments characterize this transformation. First, as shown in Figure 2a, the import prices of appliances—relative to national income per worker—declined significantly between 1994 and 2017, with refrigerator prices falling by approximately 74 percent and washing machine prices by 71 percent.[5] Second, as illustrated in Figure 2b, imports of refrigerators and washing machines surged during this period, each growing tenfold (against population growth of only about thirty percent).

Figure 2: Relative Price and Imports

(a) Relative Price (b) Imports



Notes: Panel (a) shows the relative price of appliances, defined as the ratio of the nominal import price to the national income per worker in Peru. Panel (b) shows an index of total imports of these appliances during the same time period (1994=1). Prices and imports are derived from customs data, while the average national income per worker is obtained from the World Bank.

This increase in imports of appliances was instrumental in expanding access to time-saving technologies for Peruvian households. Throughout this period, appliance imports entirely replace local production, which was virtually non-existent to begin with. According to the Peruvian Statistical Institute (INEI) and our own calculations using customs data, in 1994,

[5]The early years of our imports data contain a few records in which quantities are measured with error and, therefore, unit values are mismeasured as well. We present median import prices for each appliance.

the quantity imported of washing machines was approximately 15 times greater than the number of domestically produced washing machines. This number is 2.2 for refrigerators.[6] Furthermore, the Peruvian Ministry of Production reports a 62.5 percent decline in the physical volume of production in the appliance manufacturing sector from 1994 to 2002. Coupled with the large increase we see in imports, these numbers suggest the vast majority of the supply into the country comes from abroad (Proexport-Colombia, 2003). This near absence of domestic manufacturing means that the large drop in import prices effectively acted as an exogenous shock that gave international trade a critical role in facilitating the adoption of time-saving technologies.

3.3 Fact 3: Ownership and Labor Force Participation

This fact provides evidence supporting a causal relationship between appliance ownership and the rise in female labor force participation. We demonstrate this by examining how the transformation of Peruvian labor markets was shaped by access to water and electricity—essential prerequisites for a household to benefit from declining appliance prices. In other words, the data suggest that the adoption of appliances, only possible with access to utilities, seems to have played a key role in reducing the time required for household production tasks, thereby enabling more women to participate in the labor market.

We begin with Figures 3a and 3b, which illustrate the large baseline variation in utility coverage across districts. In 1993, at the time of the shock, electricity and water coverage ranged from nearly universal access in coastal and urban areas to almost complete absence in the interior regions. In aggregate, only 36 percent of households had access to electricity and running water at that time. This regional disparity naturally separates households into those that could take advantage of lower appliance prices and those that could not.

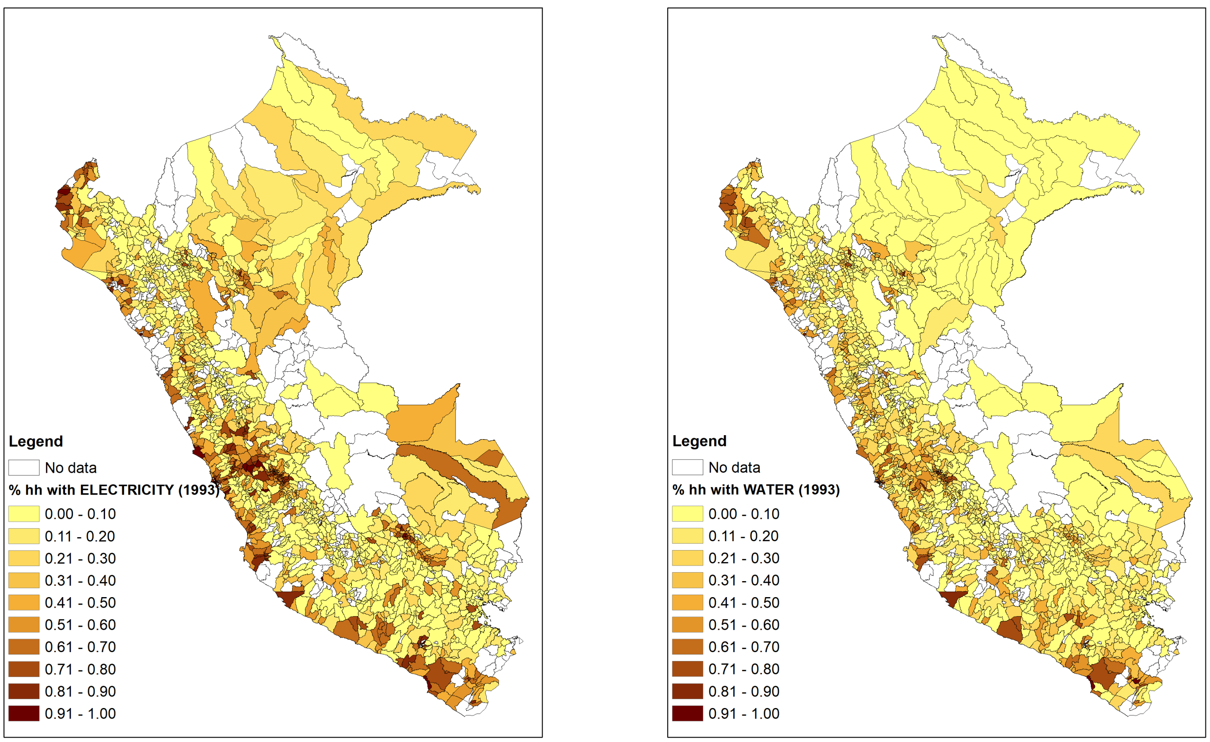
The timing of the shock suggests that we should observe a differential pattern of appliance ownership and labor force participation across regions with different access, starting in 1993. We turn to investigate that pattern now. To do so, we construct a variable that interacts the average baseline share of access to services at the district level, $Access_{d,1993}$, with a linear time trend. Then, we run the following regression in our main sample of individuals aged 25-50:

[6] In addition, it was a relatively unimportant industry within Peruvian manufacturing. According to the results of the 1994 Annual Manufacturing Statistical Survey, the household appliance industry in Peru accounted for just 0.76 percent of the country's total manufacturing output. It also represented only 0.99 percent of manufacturing employment and 0.56 percent of the total number of manufacturing establishments.

Figure 3: Household Access to Basic Services in 1993

(a) Electricity

(b) Running Water



Notes: Panel (a) and Panel (b) display district-level access to electricity and running water, respectively, as recorded by the 1993 Peruvian population census.

$$y_{idg,t} = \beta_1 \left(Access_{d,1993} \times t\right) + \gamma_d + \gamma_t + \delta' X_{i,t} + \tau' \text{Trade}_{gd,t} + \alpha' \left(W_{gd,1981} \times t\right) + \epsilon^o_{idg,t}, \quad (1)$$

where an observation is denoted by individual i of gender g in district d in census year t, $y_{idg,t}$ represents either (i) appliance ownership (an indicator that equals one if the individual owns a refrigerator, washing machine, or both) or (ii) labor force participation (an indicator that equals one if the individual participates in the labor market and zero otherwise). We focus on the coefficient β_1 in equation (1), which allows us to compare the differential evolution of the dependent variable between individuals residing in districts with full access to electricity and running water against those in districts with no access to these services. To aid the interpretation of this coefficient, below we discuss the accumulated differences implied by it in a period of 24 years, i.e., the difference between the baseline year 1993 and 2017, the last year of our sample.[7]

In both specifications, we include an increasingly stringent set of controls to ensure the differences we measure are due to initial access to services. First, we include district and year fixed effects, denoted by γ_d and γ_t. Second, $X_{i,t}$ represents a set of individual-level characteristics, including age and age squared, as well as indicators for urban residence, access to electricity and running water at the dwelling, and indicators for different education levels. Our third set of controls, denoted by $\text{Trade}_{gd,t}$, accounts for gender-specific shifts in labor demand induced by trade. Specifically, we construct two controls for each gender, one capturing changes in labor demand due to increased exports and one due to increased imports.[8] Fourth, $W_{gd,1981} \times t$ represents the interaction of linear time trends with district-level covariates for individuals of gender g in 1981, including average labor force participation and income.

Table 2 presents our results when using appliance ownership as the dependent variable, while Table 3 presents the findings for labor force participation, both for the women sub-sample. In each table, Columns (1) through (6) report the the coefficients for β_1 in equation (1) across specifications that progressively add controls. The progression begins with district

[7]While the variation in our main regressor, $Access_{d,1993} \times t$, is at the district-time level, our regression is at the individual level. We choose this specification to be able to exploit the richness of the individual level controls that the census affords us.

[8]We follow Autor, Dorn, and Hanson (2019) and calculate the weighted average of changes in imports and exports per worker for each district,where weights are the district's industrial employment shares for gender g. The first control is defined as: $\Delta \text{Import exposure}_{g,d,t} = \sum_j \frac{l_{j,g,d,93}}{l_{gd93}} \frac{\Delta \text{Impors}_{j,t}}{L_{j,t}}$, where $\Delta \text{Imports}_{j,t}$ denotes the change in total imports of Peru in 2-digit industry j, between time t and 1993, and $l_{j,g,d,93}$ is total employment in that sector for gender g, district d in 1993. The second control is defined analogously, but for exports: $\Delta \text{Export exposure}_{g,d,t} = \sum_j \frac{l_{j,g,d,93}}{l_{g,d,93}} \frac{\Delta \text{Exports}_{j,t}}{L_{j,t}}$.

Table 2: Changes in Appliance Ownership in Regions with Different Access, Women

	(1)	(2)	(3)	(4)	(5)	(6)
Access Trend	0.0138	0.0060	0.0124	0.0116	0.0132	0.0119
	(0.0008)***	(0.0010)***	(0.0010)***	(0.0012)***	(0.0011)***	(0.0012)***
Mean Dependent	0.359	0.359	0.367	0.373	0.381	0.382
District FE	X	X	X	X	X	X
District + Year FE		X	X	X	X	X
Ind. Controls			X	X	X	X
Trade Controls				X	X	X
LFP_{81} x t					X	X
$Income_{81}$ x t						X
N.Districts	1,622	1,622	1,622	1,535	1,064	1,055
N.Obs.	13,843,651	13,843,651	13,101,622	12,851,231	9,940,680	9,855,634

Notes: Appliances bundle is defined as a dummy variable that takes value of 1 if the household owns a refrigerator or a washing machine. The unit of observation is women aged between 25 and 50. Column (1) includes district fixed effects (γ_d), Column (2) adds year fixed effects (γ_t) , Column (3) includes individual controls ($X_{i,t}$), Column (4) adds trade exposure controls ($Trade_{gd,t}$), and Columns (5) and (6) account for pre-trends in labor force participation and income ($t.W_{gd,1981}$).Standard errors shown in parentheses and clustered at the district level.

fixed effects (γ_d) in Column (1), then adds year fixed effects (γ_t) in Column (2). Columns (3) and (4) incorporate individual control variables ($X_{i,t}$) and controls for trade exposure effects ($\text{Trade}_{gd,t}$), respectively. Finally, Columns (5) and (6) account for pre-trends by including interactions of 1981 labor force participation and income levels with time ($W_{gd,1981} \times t$).

The coefficient in Column (1) of Table 2 implies that ownership of appliances increases by 33 percentage points between 1993 and 2017, for women who live in districts that had full utility coverage in 1993, compared to those without any utilities. This comparison is quite stable across specifications. It decreases to about 30 percentage points as we move to Column (3) and control for district and year fixed effects as well as individual characteristics. To guard against the possibility that regions with better access to utilities in the baseline year might have also experienced larger export or import shocks, Column (4) controls for labor demand changes due to trade openness, which leaves the comparison almost unchanged at 28 percentage points.[9] Finally, another concern is that these results may reflect that regions with better access to utilities in the baseline year experienced differential, exogenous participation growth in labor markets. Columns (5) and (6), therefore, controls for pre-trends in labor force participation and income, interacting linear trends with measures of labor force participation and individual income from the 1981 census. In both cases, the

[9] One concern with including this set of controls is that they may capture income effects arising from trade that are not specific to an individual but rather impact household income as a whole. The fact that the main coefficient barely changes mitigates these concerns.

Table 3: Changes in Labor Force Participation in Regions with Different Access, Women

	(1)	(2)	(3)	(4)	(5)	(6)
Access Trend	0.0142	0.0069	0.0069	0.0067	0.0071	0.0071
	(0.0003)***	(0.0004)***	(0.0004)***	(0.0005)***	(0.0006)***	(0.0006)***
Mean Dependent	0.360	0.360	0.357	0.360	0.364	0.363
District FE	X	X	X	X	X	X
District + Year FE		X	X	X	X	X
Ind. Controls			X	X	X	X
Trade Controls				X	X	X
LFP_{81} x t					X	X
$Income_{81}$ x t						X
N.Districts	1,622	1,622	1,622	1,535	1,064	1,055
N.Obs.	13,843,651	13,843,651	13,101,622	12,851,231	9,940,680	9,855,634

Notes: Labor force participation is defined as a dummy variable that takes value of 1 if the individual participates from the labor market and 0 if they do not. The unit of observation is women aged between 25 and 50. Column (1) includes district fixed effects (γ_d), Column (2) adds year fixed effects (γ_t) , Column (3) includes individual controls ($X_{i,t}$), Column (4) adds trade exposure controls ($Trade_{gd,t}$), and Columns (5) and (6) account for pre-trends in labor force participation and income ($t.W_{gd,1981}$). Standard errors shown in parentheses and clustered at the district level.

results remain unchanged.[10] Column (6) in particular, implies a difference of 29 percentage points.

The results in Table 3 further suggest an impact of appliance ownership on labor force participation, which is the mechanism we are after. Starting with Column (2), we measure a stable coefficient across specifications including our growing set of controls. The coefficient implies that labor force participation grew by about 17 percentage points, between 1993 and 2017, in regions that had full access to utilities at baseline, compared to those without.

The main takeaway of these tables is that in regions where access to water and electricity was prevalent in 1993, ownership of appliances grew substantially more than in regions lacking utilities. Further, female labor force participation also grew substantially. This comparison is consistent with households taking advantage of the large reduction in appliance prices that started in 1993 and with them using these appliances to reallocate labor that had been previously tied up in home production to the market.

The differential behavior between men and women reinforces this interpretation. As shown in Appendix Tables D.2 and D.3, the evolution of ownership is quantitatively similar for men and women. These results, however, are significantly different for labor force participation, where the relative growth for men is half that for women, at about 8 percentage points.

[10]Note that the number of observations drops substantially starting in Column (5). The reason is that the data in the 1981 Census are incomplete and do not include about one-third of the districts.

To provide further evidence that appliances released labor previously used in home production and allowed for increased female labor force participation, we examine how our comparisons vary for single versus married individuals. This distinction is important, as married women typically shoulder a larger share of household responsibilities, so we expect to see larger changes in behavior for them. Table 4 reports the results for appliance ownership, comparing single and married individuals, while Table 5 focuses on labor force participation. Each column estimates equation (1) on a different sample, including all controls. As shown in Columns (1) and (2) of Table 5, both single and married individuals experience a similar evolution of time-saving appliance ownership. This large change in ownership only translates to large increases in labor force participation for married women, as shown in Table 5. In fact, the increase in labor force participation for married women is almost three times that of their male counterparts and three times that of single women.

Table 4: Changes in Appliance Ownership in Regions with Different Access, by Marital Status

	Women		Men	
	(1)	(2)	(3)	(4)
	Single	Married	Single	Married
Access Trend	0.0117	0.0123	0.0133	0.0137
	(0.0013)***	(0.0011)***	(0.0012)***	(0.0012)***
Mean Dependent	0.469	0.352	0.425	0.318
District FE	X	X	X	X
District + Year FE	X	X	X	X
Ind. Controls	X	X	X	X
Trade Controls	X	X	X	X
LFP_{81} x t	X	X	X	X
$Income_{81}$ x t	X	X	X	X
N.Districts	1,055	1,055	1,055	1,055
N.Obs.	2,921,160	6,934,474	2,728,322	6,352,609

Notes: Appliances bundle is defined as a dummy variable that takes value of 1 if the household owns a refrigerator or a washing machine. Columns (1) and (2) of the table examine the impact on appliance ownership for single and married woman, respectively, while Columns (3) and (4) replicate this analysis for men. All specifications include district and time fixed effects, $\gamma_d + \gamma_t$, individual controls $X_{i,t}$, as well as controls for gender-specific exposure to exports and imports and for pre-trends $(W_{gd,1981} \times t)$. Standard errors shown in parentheses and clustered at the district level.

Table 5: Changes in Labor Force Participation in Regions with Different Access, by Marital Status

	Women		Men	
	(1)	(2)	(3)	(4)
	Single	Married	Single	Married
Access Trend	0.0029	0.0085	0.0051	0.0032
	(0.0007)***	(0.0006)***	(0.0005)***	(0.0005)***
Mean Dependent	0.579	0.289	0.828	0.921
District FE	X	X	X	X
District + Year FE	X	X	X	X
Ind. Controls	X	X	X	X
Trade Controls	X	X	X	X
LFP_{81} x t	X	X	X	X
$Income_{81}$ x t	X	X	X	X
N.Districts	1,055	1,055	1,055	1,055
N.Obs.	2,921,160	6,934,474	2,728,322	6,352,609

Notes: Labor force participation is defined as a dummy variable that takes value of 1 if the individual participates from the labor market and 0 if they do not.Columns (1) and (2) of the table examine the impact on labor force participation for single and married woman, respectively, while Columns (3) and (4) replicate this analysis for men. All specifications include district and time fixed effects, $\gamma_d + \gamma_t$, individual controls $X_{i,t}$, as well as controls for gender-specific exposure to exports and imports and for pre-trends ($W_{gd,1981} \times t$) . Standard errors shown in parentheses and clustered at the district level.

Robustness Checks. Our results are robust across several checks. First, our findings remain when use alternative definitions of region and when we increase the age range of individuals in the sample. Appendix Table D.4 addresses concerns that district-level regressions may not fully capture the scope of local labor markets, by showing our results are virtually unchanged when we use provinces as the unit of observation. The results also hold when considering a broader sample of women and men aged 25–65, as shown in Appendix Table D.5, which addresses the concern that behavior is substantially different at the end of people's work life.

Second, one might worry that cheaper appliances may have fostered the migration of working age households, or those with a high propensity to work more generally, to regions with high access to utilities. If this were the case, our observed effects could reflect changes in population composition rather than shifts in household decisions. As shown in Appendix Table D.6, however, we find no evidence that access trends drives migration from low-access districts to areas with better access. In fact, it does not significantly influence migration overall, either from low-access districts or from high-access ones.

3.4 Fact 4: The Evolution of Ownership and Labor Force Participation across Cohorts

To complement the evidence we have presented so far, Fact 4 compares the evolution of appliance ownership and labor force participation for women of two different age groups—30 to 45 and 50 to 65—across different cohorts. This analysis allows us to assess whether the choices of younger cohorts, who experienced the decline in appliance prices earlier in their lives, differ from those of older cohorts, when compared at two different points of the lifecycle. As before, in this exercise we also leverage variation in access to running water and electricity, comparing regions with higher utility access to those with limited access.

For the remainder of this section, we narrow our sample to male-breadwinner households, defined as couples where the male spouse participates in the labor market. We thus focus on a common type of household, and one where our previous findings suggest the relation between appliance ownership and female labor force participation is most concentrated. Since men in these households are already highly likely to be employed and their labor force participation is less likely to shift, we only discuss results for female labor force participation.

Women aged 30 to 45. We begin our analysis with women aged 30 to 45, estimating the following model using data aggregated at the province-by-cohort level:[11]

$$y_{c,p} = \beta\left[\text{Access Bin}_p \times \text{Cohort}_c\right] + \text{Cohort}_c + \text{Province}_p + \phi' X_{c,p} + \varepsilon_{c,p} \tag{2}$$

where c stands for cohort, and p for province. We divide the sample into terciles of access to water and electricity, and denote them by Access Bin_p. Cohort_c denote groups of eight consecutive cohorts (those born in 1947-51, 1952-56, ..., 1982-86), and Province_p refers to province fixed effects. $X_{c,p}$ is a set of controls at the cell c, p level, including the share of urban population, the share of married women, gender-specific exposure to imports and exports, $\text{Trade}_{g,p,t}$, as well as the number of households and the number of people in the cell.[12] Finally, $y_{c,p}$ is the cell share of either (i) appliance ownership (washing machine, refrigerator, or both) or (ii) labor force participation.

Our results so far points to an effect of cheaper appliances on ownership and, in turn,

[11] In this section, we increase the level of regional aggregation in the analysis. The reason is that, despite working with our full Census data, the number of observations in our age-region cells reduces power in our analysis. The robustness analysis in Appendix Table D.4 shows that our main results remain unchanged when looking at provinces, which is reassuring.

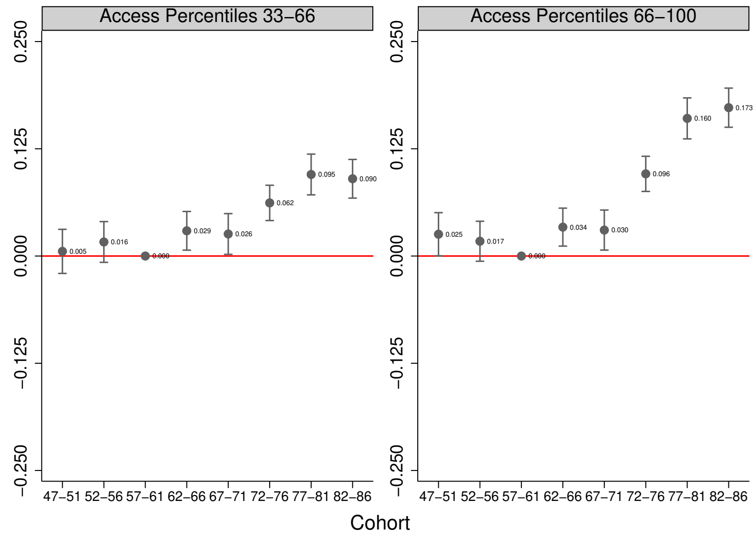
[12] In this case, the variable set $\text{Trade}_{g,p,t}$ is defined as the employment weighted average of the original set at the district level.

female labor force participation. Therefore, in this exercise, we think of individuals aged 30-45 in the 1993 census as not exposed to the shock, and of those the same age in the 2007 and 2017 censuses as exposed. As we show next, the results of this comparison are consistent with a larger impact of appliance prices on labor force participation for cohorts that were exposed to these changes during their prime working years.

To aid understanding of our specification, Appendix Table D.7 explains how we construct our cohort comparisons, distinguishing those who were exposed to imported appliance price changes from those who were not. Individuals born between 1947 and 1961—specifically those in the cohorts of 1947-51, 1952-56, and 1957-61—were aged 30-45 in 1993, before the decrease in appliance prices occurred. These cohorts, therefore, serve as the control group for our analysis. Within this group, we define the cohort 1957-61 as the omitted category. We use the preceding, 1947-56 cohorts, to assess if trends were parallel. In turn, cohorts with women born from 1962 to 1986 were 30-45 years old in the census years 2007 or 2017, years during which appliances were considerably cheaper (and had been for some time). We regard these cohorts as our treatment group.

Figure 4 shows the results of estimating equation (2) using ownership as the dependent variable. The figure illustrates the differential rate of appliance ownership for each cohort (vertical axis), relative to our omitted category, the 1957-61 cohort, and the provinces with low access to services. The main result is that the younger the cohort, the larger the differential in ownership rates, with results particularly large in provinces belonging in the highest access tercile. For example, appliance ownership is 17 percentage points larger for women in the 30-45 age group, observed in 2017 in high-access provinces, relative to those observed in 1993 in low-access provinces.

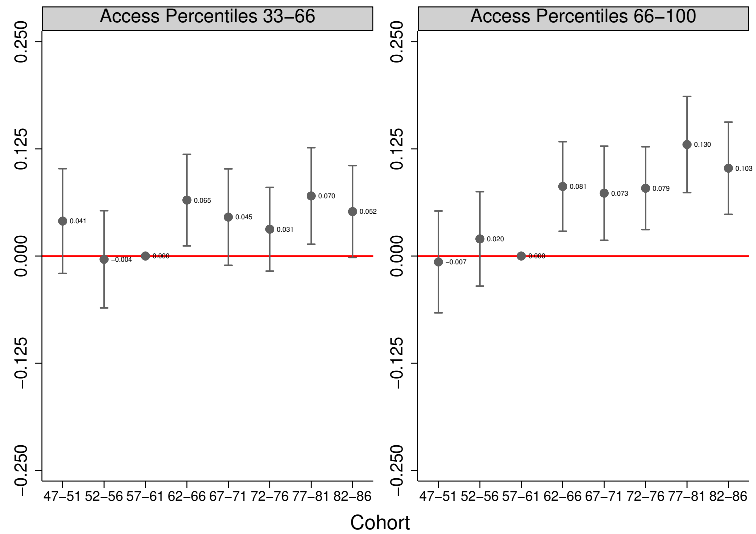
Figure 4: Cohort Analysis - Appliance Ownership 30-45 year olds



Notes: This figure shows the results of the estimation of equation (2) where the dependend variable is ownership of appliances (refrigerator or washing machine). The x-axis denotes the cohort (birth year) while the y-axis refers to the estimated effect. The panels are divided by percentiles of electrification at the district level. All the effects are evaluated for individuals within 30-45 years old.

Figure 5 repeats our analysis, but considering female labor force participation as the dependent variable. The differential in female labor force participation, relative to the 1957-61 cohort in low access regions, mirrors the trends in ownership. The differential is particularly large for cohorts residing in areas with good access to services, where labor force participation was up to 13 percentage points larger.

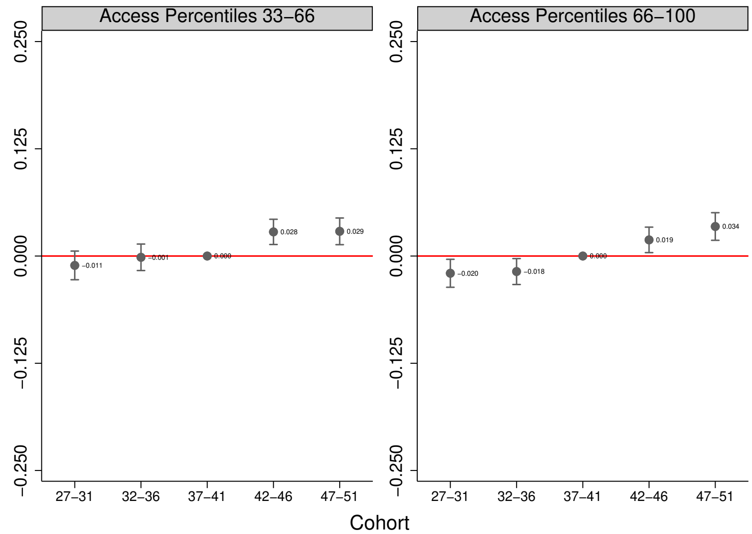
Figure 5: Cohort Analysis - Female Labor Force Participation 30-45 year olds



Notes: This figure shows the results of the estimation of equation (2) where the dependent variable is labor force participation. The x-axis denotes the cohort (birth year) while the y-axis refers to the estimated effect.The panels are divided by percentiles of electrification at the district level. All the effects are evaluated for individuals within 30-45 years old. The effect for males is zero as the sample is restricted to households where males are already in the labor force.

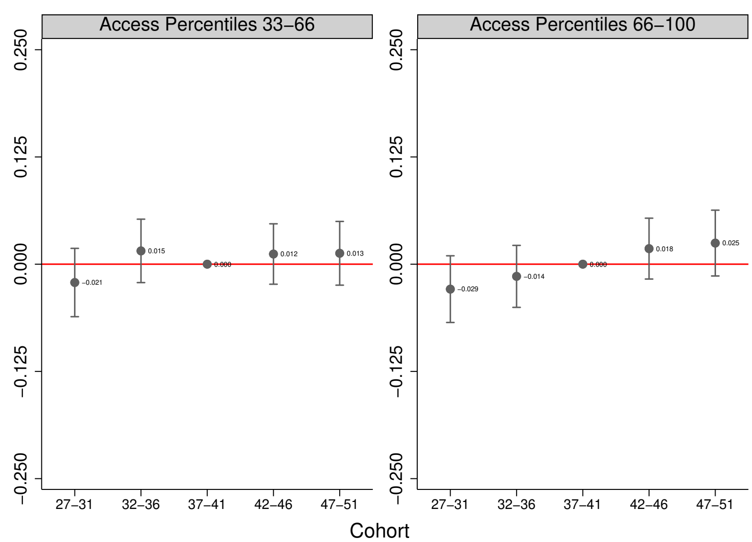
Women aged 50 to 65. Second, we investigate whether these patterns differ by age (and not only by cohort). We use a similar specification as before, comparing ownership and labor force participation rates among women aged 50-65, who are nearing retirement. In this analysis, the control cohorts comprise women born between 1927 and 1941, while the treated cohorts include those born between 1942 and 1951. Figures 6 and 7 present the results. While we observe a small differential on ownership rates, we do not find any effects on labor force participation.

Figure 6: Cohort Analysis - Appliance Ownership 50-65 year olds



Notes: This figure shows the results of the estimation of equation (2) where the dependend variable is ownership of appliances (refrigerator or washing machine). The x-axis denotes the cohort (birth year) while the y-axis refers to the estimated effect.The panels are divided by percentiles of electrification at the district level. All the effects are evaluated for individuals within 50-65 years old.

Figure 7: Cohort Analysis - Female Labor Force Participation 50-65 year olds



Notes: This figure shows the results of the estimation of equation (2) where the dependend variable is labor force participation. The x-axis denotes the cohort (birth year) while the y-axis refers to the estimated effect.The panels are divided by percentiles of electrification on the district. All the effects are evaluated for individuals within 50-65 years old.

These results characterize appliance ownership and labor force participation in different regions and for women of different ages in the aftermath of the price shock. This characterization is consistent with appliances being an investment cost that is are defrayed over time and are therefore more attractive to younger people. Therefore, we conclude that these results reinforce and add depth to the comparisons we presented in Section 3.3.

In summary, the evidence presented in Sections 3.1 to 3.4 strongly suggests a connection between appliance ownership and increased female labor force participation, facilitated by the reallocation of time from household chores to market activities. Furthermore, in developing countries like Peru, where domestic production of such technologies is limited, the rise in appliance ownership has been largely driven by international trade—particularly over the past 30 years, during a period of significant trade liberalization. Thus, trade openness emerges as a potentially important driver of female labor supply. Building on these insights, the next section develops a model to quantify the aggregate impact of this mechanism.

4 Model

In this section, we present a model to quantify the aggregate effects of a reduction in the import prices of appliances. In describing the model and in taking the model to the data, we focus on households consisting of a man and a woman residing in a small open economy.

4.1 Environment

We consider a small open economy trading only with the rest of the world. This assumption allows us to take the prices of certain goods, particularly appliances, and the interest rate as given.[13] Time is discrete and indexed by t, but we omit this index when it does not introduce confusion.

Demography and Household Composition. Each generation lives J periods, and at any given time, there are J generations alive. Households consist of a man and a woman, and at each time there is a mass one of households, equally distributed across generations.

[13]The home economy is the limit when the population size goes to zero relative to that of the rest of the world, as shown in Alvarez and Lucas (2007). Appendix B.2 shows how we obtain this limit, starting from a standard quantitative model with many countries.

Preferences, States, and Budget Constraints There are three types of goods: market goods m, home goods g, and household appliances. Throughout, we use the price of market goods as the numeraire, and set it to one.

A household's state each period is denoted by $(j, a, d, \ell) \in \mathcal{J} \times \mathcal{A} \times \mathcal{D} \times \mathcal{L}$, where j represents the household's age, a denotes the household's assets in units of the market good, d indicates the appliance ownership status (with $d = 2$ if the household bought an appliance in the past, $d = 1$ if the household buys an appliance in the current period, and $d = 0$ if the household does not have an appliance), and ℓ indicates whether the woman works in the labor market ($\ell = 1$), or stays at home ($\ell = 0$). We assume that men are employed in the labor market in every state.

The period utility function for the household is given by:

$$u\left(m, g\right) = \left[\mu^{\frac{1}{\eta}} m^{\frac{\eta-1}{\eta}} + \left(1-\mu\right)^{\frac{1}{\eta}} g^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{3}$$

where μ measures the preference for market goods and η is the elasticity of substitution in consumption between market and home goods. The utility function does not depend on the household's state.

Time Allocation. Each household member is endowed with one unit of time. The time men spend in the household is fixed at zero, and their time in the labor market is fixed at one. The household jointly decides whether the woman participates in the labor market or stays at home. If the woman in a household devotes h_f units of time to the labor market, the household income is

$$w_m + w_f \cdot h_f,$$

where w_m and w_f are wages for men and women, respectively.

If the woman stays at home, total household income is simply w_m, since $h_m = 0$. The total time devoted to household production is $l_f = 1 - h_f$.

The Household's Problem The following Bellman equation represents the dynamic problem of a household in state (j, a, d, ℓ) at the beginning of the period

$$V_{jk}\left(a\right) = \max_{m,g,a' \geq 0} \left\{ \ln u\left(m, g\right) + \beta \mathbb{E}_{\varepsilon} \max_{k' \in \mathcal{K}_k} \left[V_{j+1,k'}\left(a'\right) + \varepsilon_k\right] \right\}, \tag{4}$$

subject to the budget constraint

$$a' = Ra + w_m - w_f h_f - m - \mathbb{I}_k f, \tag{5}$$

the home production technology

$$g_k = b_k \cdot l_f, \tag{6}$$

and the time constraint $1 \geq l_f \geq 0$.

In the period budget constraint (5), R is the gross interest rate that households get on the assets a that they carry over from the previous period, a' is the choice of assets for the next period, and $\mathbb{I}_k$ is an indicator for whether the household purchases an appliance this period, which requires paying f units of market goods. In turn, home goods are produced according to equation 6, where l_f is time in home production and b_k is labor productivity in home production.

We highlight four important features of our formulation of this problem. First, in the expression above, we use the shorthand $k \in \mathcal{K} = \{1, \ldots, 6\}$ to denote discrete states (e.g. own appliance and work).[14] Second, a household's state k is predetermined at the beginning of the period, so the household first makes a decision of how much to save or borrow going into the next period, a'. After that, it draws a vector of taste shocks $\{\varepsilon_k\}$ i.i.d, from a Type-I Extreme Value distribution with parameters (G_k, ρ). Conditional on that draw, the household decides its state for next period, k'.[15] Third, we assume that individuals who are born in a given period start with zero assets, and choose optimally the state k in which to begin. Fourth, we normalize the terminal values for age $J + 1$ to zero and impose that households must keep positive assets at all times, $a \geq 0$.

In addition, note that transitions are only possible to states $k' \in \mathcal{K}'_k$, a function of the current state k, reflecting that (i) when the household purchases an appliance ($d = 1$), it necessarily moves to $d = 2$ in the next period, and (ii) if the household does not have an appliance ($d = 0$), it cannot transition to $d = 2$.

Market-goods Technology Market goods are produced by an aggregate technology, given by

$$Y_t = Z_t H_t, \tag{7}$$

where Z_t is an aggregate productivity shifter and H_t is a constant-elasticity index of time supplied by men and women:

$$H_t = \left(\alpha^{1/\sigma} H_{t,m}^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{1/\sigma} H_{t,f}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}. \tag{8}$$

[14] The set $\mathcal{K}$ lists the elements of the set $\mathcal{D} \times \mathcal{L}$ in order. For example, the state $k = 1$ denotes (no appliance, no labor force participation), $k = 2$ denotes (no appliance, labor force participation), and so on.

[15] The timing assumption is useful for tractability, since the choice of assets is independent of the shock ε_k, which makes the savings policy function depend only on the current state k.

In equation (8), $H_{t,m}$ and $H_{t,f}$ represent aggregate hours worked by men and women, and σ is the elasticity of substitution between male and female labor supply.

4.2 Aggregation

To describe the equilibrium, we begin by aggregating household decisions to derive the population's law of motion. Using the properties of Type-I shocks, we can rewrite the Bellman equation (4) as follows:

$$V_{jk}(a) = \max_{a' \geq 0, 1 \geq h_f \geq 0} \left\{ \ln u \left(Ra + w_m - w_f h_f - a' - \mathbb{I}_k f, b_k (1 - l_f) \right) + \beta \rho \log \Psi_{j+1,k}(a') \right\},$$

where

$$\Psi_{j+1,k}(a') \equiv \sum_{k' \in \mathcal{K}_k} \exp\left(\frac{1}{\rho} G_{k'} \right) \exp\left(\frac{1}{\rho} \left(V_{j+1,k'}(a') \right) \right)$$

captures the expected value of having decided to keep a' assets for the next period.

For a given asset choice, denoted by $x_{j,k}(a)$, the household's probability to choose state k' for age $j+1$, if currently in state k is given by

$$\lambda_{j+1,kk'}(a) = \frac{\psi_{j+1,k'}(x_{j,k}(a))}{\Psi_{j+1,k}(x_{j,k}(a))}, \tag{9}$$

where

$$\psi_{j+1,k'}(x_{j,k}(a)) = \exp\left(\frac{1}{\rho} G_{k'} \right) \exp\left(\frac{1}{\rho} V_{j+1,k'}(x_{j,k}(a)) \right). \tag{10}$$

In expressions (9) and (10), the dispersion parameter ρ serves as an inverse measure of the sensitivity of transitional probabilities to future values, given the optimal choice of assets as determined by the policy function $x_{j,k}(a)$.

Meanwhile, the optimal asset choice satisfies the Euler equation given below:

$$\frac{1}{u(m,g)} \frac{\partial u \left(Ra + w_m - w_f h_f - x_{j,k}(a) - \mathbb{I}_k f, b_k l_f \right)}{\partial m} = \beta \rho \frac{1}{\Psi_{j+1,k}(x_{j,k}(a))} \frac{\partial \Psi'_{j+1,k}(x_{j,k}(a))}{\partial a},$$

which states that the household chooses savings to equate the marginal utility of consuming market goods today with the expected marginal utility of saving for the next period. The expectation is taken over the distribution of shocks ε_k, which are unknown to the household at the time of the decision.

When the woman participates in the labor market, this Euler equation is coupled with an optimal static choice of h_f, which equates the benefit of working an additional hour, in terms of purchasing additional market goods, with the cost in terms of home goods

$$\frac{\partial u\left(Ra+w_m-w_f h_f-x_{j,k}\left(a\right)-\mathbb{I}_k f,b_k l_k\right)}{\partial m}\cdot w_f=\frac{\partial u\left(Ra+w_m-w_f h_f-x_{j,k}\left(a\right)-\mathbb{I}_k f,b_k l_k\right)}{\partial g}\cdot b_k,$$

but recall that if the state k is such that the woman does not work in the labor force, the household time choice is restricted to $l_f=1$, $h_f=0$.

Aggregate Law of Motion. To characterize the law of motion for the aggregate population, let $n_{jk,t}\left(a\right)$ denote the share of individuals in year t, aged j, in state k, and owning assets a. The law of motion is then given by

$$n_{jk,t}\left(a\right)=\int_{\mathcal{A}}\sum_{k'}\lambda_{j,k'k,t}\left(z\right)\gamma_{j,k',t}\left(a,z\right)n_{j-1k',t}\left(z\right)dz+\bar{n}_{jk,t}\left(a\right), \tag{11}$$

where $\gamma_{j,k,t}\left(a,z\right)$ is an indicator equaling one if $x_{j,k}\left(z\right)=a$ and and $\bar{n}_{jk,t}\left(a\right)$ represents the flow of households, capturing age-1 individuals, who are born in period t.

Labor Markets. Given the population $n_{jk,t}\left(a\right)$, we can derive the optimal labor supply in each period by aggregating across households in each state. Accordingly, the total supply of hours for men and women is given by:

$$H_{m,t}=\sum_j\sum_k\int_{\mathcal{A}}1\cdot n_{jk,t}\left(a\right)da \tag{12}$$

$$H_{f,t}=\sum_j\sum_k\int_{\mathcal{A}}h_{f,jk,t}\left(a\right)\cdot n_{jk,t}\left(a\right)da. \tag{13}$$

Demand for appliances and aggregate savings We can compute the total demand for new appliances as

$$D_t=\sum_j\sum_{k\in\mathcal{K}_{d=1}}\int_{\mathcal{A}}n_{jk,t}\left(a\right)da,$$

where $\mathcal{K}_{d=1}$ denotes the states in which appliances are purchased, and total assets carried between periods t and $t-1$ as

$$A_{it}=\sum_j\sum_k\int_{\mathcal{A}}x_{jk,t-1}\left(a\right)n_{jk,t-1}\left(a\right)da.$$

Recall that under the assumption of a small open economy, the interest rate R is given, and the current account adjusts accordingly.

4.3 Equilibrium

We begin by defining a static equilibrium, followed by a dynamic equilibrium, for our small open economy. Appendix B explains in detail how we obtain this system as the limit of a quantitative model in which the size of the country goes to zero (see e.g. Alvarez and Lucas, 2007).

4.3.1 Static Equilibrium.

Given aggregate labor supply choices $\{H_{m,t}, H_{f,t}\}$, a static equilibrium at time t consists of wages $\{w_{m,t}, w_{f,t}, W_t\}$ and an hours aggregator, H_t, such that labor markets clear:

$$W_t = B_t \left(\frac{H_t}{\nu_t}\right)^{-1/\theta}, \tag{14}$$

$$H_{t,m} = \alpha \left(\frac{w_{m,t}}{W_t}\right)^{-\eta} H_t \tag{15}$$

$$H_{t,f} = (1-\alpha) \left(\frac{w_{f,t}}{W_t}\right)^{-\eta} H_t \tag{16}$$

and the aggregator H_t satisfies (8). In (14), B_t represents an aggregate demand shifter, and ν_t denotes the total population size (which is normalized to one).

4.3.2 Dynamic Equilibrium.

Given initial conditions n_0, exogenous inflows of young people $\{\bar{n}_t\}_t$, the total number of households ν_t, pricing functions $\{w_{m,t}, w_{f,t}, W_t\}_t$, and external forces $\{B_t, p_t, f_t\}$, a dynamic equilibrium consists of paths for household counts in country i, $\{n_t\}_t$, and labor supplies by gender $\{H_{t,m}, H_{t,f}\}_t$ such that the law of motion (11) holds and the hour aggregations are satisfied.

4.4 Characterizing Household Behavior

Next, we examine how a household responds to a permanent, unexpected change in the price of appliances, which takes effect in period t. To show transparently the key mechanisms, as well as the key parameters and data moments that inform this response, we analyze a model in which households live for two periods. Appendix B.3 contains the proofs and further details.

We begin by defining the labor force participation rate, φ_t, which is the share of households in which the woman works in the labor market:

$$\varphi_t = \sum_j \underbrace{\sum_{k \in \mathcal{K}_{\ell=1}} \int_{\mathcal{A}} n_{jk,t}(a)\, da}_{\equiv n_{j,t} \cdot \varphi_{j,t}.}, \tag{17}$$

where $\mathcal{K}_{\ell=1}$ is the set of states in which the woman works, and $\varphi_{j,t}$ is the participation rate in households of age j at time t.

4.4.1 Effects on Impact

Age-1 Households. We begin by characterizing labor force participation of age-1 households which, under our assumptions on entry, is given by[16]

$$\varphi_{1,t} = \sum_{k \in \mathcal{K}_{\ell=1}} \lambda_{j,k_0 k,t}, \tag{18}$$

i.e., all those young households that decide to start life working. In equation (18), k_0, is simply a stand-in for all households in state $k = 1$ at "age 0".

Consider next the impact of a change in appliance prices, f. The household's response will reflect three main forces: (i) changes in lifetime utility, (ii) initial shares across states, and (iii) the elasticity ρ. In particular,

$$\frac{\partial \varphi_{1,t}}{\partial f} = \frac{1}{\rho}\left[\lambda_{1,k_0 4,t}\frac{\partial V_{14,t}}{\partial f} - (\lambda_{1,k_0 2,t} + \lambda_{1,k_0 4,t})\left[\lambda_{1,k_0 3,t}\frac{\partial V_{13,t}}{\partial f} + \lambda_{1,k_0 4,t}\frac{\partial V_{14,t}}{\partial f}\right]\right], \tag{19}$$

where, to avoid clutter, we omit the dependence of transition probabilities and value functions on assets. Recall that $\lambda_{j,k'k,t}$ denotes the transition probability of a household of age j, currently in state k', to state k, at time t. Recall as well that states $k = 3$ and $k = 4$ are those in which the household purchases an appliance this period.

Consider first the role of the changes in lifetime utility, captured by the derivatives $\partial V_{13,t}/\partial f$ and $\partial V_{14,t}/\partial f$, which essentially reflect the utility change in the period when appliances are purchased. Households where the woman does not work, yet purchase appliances ($k = 3$), have lower incomes. As a result, the reduction in appliance prices has a disproportionately larger impact on their overall utility. Second, consider the role of the initial observed shares. The baseline continuation value of having an appliance and working is larger, given the substantial productivity gain that appliances entail. This is especially

[16] Recall we assume all households start life with zero assets and not owning appliances nor working, and choose their initial state k optimally. The assumption that initial assets equal zero yields simplifications that we exploit here.

true for young and low-wealth households, in which the marginal value of additional income is large.[17] Such forces are captured in the differences in the initial shares $\lambda_{1,k_0 3,t}$ and $\lambda_{1,k_0 3,t}$, which reflect precisely those continuation values (see equations (9) and (10)). The balance of (i) and (ii) determines whether this derivative is positive. In fact, equation (19) shows that the derivative $\partial\varphi_{1,t}/\partial f$ is more likely to be positive when $\lambda_{1,k_0 3,t}$ is small (i.e., the continuation value of having appliances and not working is relatively low) or when $\partial V_{13,t}/\partial f$ is low. Third, note that given initial shares and changes in lifetime utility, the impact on labor force participation is scaled by $1/\rho$, the inverse measure of dispersion of idiosyncratic Type-I shocks.

Age-2 Households. To characterize households in their second period of life, note first that female participation rate is now

$$\varphi_{2,t} = \sum_{k'} \sum_{k \in \mathcal{K}_{\ell=1}} \int_{\mathcal{A}} \lambda_{2,k'k,t}(a) \cdot n_{1k',t-1}(a)\, da, \tag{20}$$

where $n_{1k',t-1}(a)$ is predetermined at the time of the shock. Then,

$$\frac{\partial\varphi_{2,t}}{\partial f} = \left\{ \sum_{k'=1,2} n_{1k',t-1} \left(\frac{1}{\rho} \left[\lambda_{2,k'4,t} \frac{\partial V_{24,t}}{\partial f} - (\lambda_{2,k'2,t} + \lambda_{2,k'4,t}) \left(\lambda_{2,k'3,t} \frac{\partial V_{23,t}}{\partial f} + \lambda_{2,k'4,t} \frac{\partial V_{24,t}}{\partial f} \right) \right] \right) \right\}, \tag{21}$$

where the term in square brackets is analogous to that in equation (19), and it is positive—and thus the change in labor force participation following the shock—when the share of households who buy appliances, $\lambda_{2,k'3,t}$, without working is low or when the direct impact on those households utility at the time of the shock, $\partial V_{23,t}/\partial f$, is small.[18]

In addition, Appendix B.3 shows that, as one would expect, the rate of appliance ownership rises unambiguously at t and in the periods that follow, and in a larger magnitude than labor force participation.

4.4.2 Effects Following the Shock

Although the shock is a permanent reduction in the price of appliances, its effects accumulate over time, due to the cohort structure of the model. To understand why, note first that in equation (18), labor force participation of age 1 households only depends on contemporaneous

[17]Note that as households accumulate wealth, the value of working decreases and households value home production relatively more. This behavior is absent in age-1 households, but it turns out to matter in our quantification. We return to it in Section 5.

[18]Again, we omit assets here, but note that because the optimal choice in age $j = 1$ is always the same for a household in state k', we can drop the integrals.

decisions (i.e., there are no lagged variables given that the initial asset allocation is exogenous and fixed at zero). Equation (20), in contrast, shows that age-2 participation rates depend on the choices made in the previous period, captured by the term $n_{1k',t-1}$. In particular, an increase in participation at age 1 in period $t = T$ will show up as increased participation at age 2 in all periods $t > T$, if those households that purchase appliances tend to remain in the labor force (i.e., if $\lambda_{j,k4,t} > \lambda_{j,k3,t}$). Thus, the effects of the permanent shock accumulate over time as younger cohorts make their way through the age distribution, after having made different decisions while young.

4.4.3 Intensive and Extensive Margins of Labor Force Participation

Finally, our model allows for separate response of the extensive and intensive margins of labor force participation. We have already discussed the extensive margin decisions and the conditions under which appliance ownership is complementary with labor force participation. We now discuss the response of the intensive margin of hours worked when a household acquires an appliance.

The response of hours worked depends crucially on the degree of complementarity between household and market goods, measured by the elasticity η in the period utility (3). In what follows, we discuss the case $\eta \to 0$, in which household and market goods are perfect complements. We do so for two reasons: (i) it affords analytical tractability and (ii) as we show in our quantification, it provides a reasonable fit to the data. Under this assumption, the amount of hours worked is given by

$$h_f^* = 1 - \frac{(1-\mu)}{b_k}\frac{w_f + y_k}{P}, \tag{22}$$

where $y_k = w_m + Ra - a'$ is cash at hand for the household, and the denominator, P, is the household price index

$$P = (1-\mu)\, w_f / b_k + \mu,$$

where we have used that the price of market goods is normalized to 1. In equation (22), the amount of hours worked increases in b_k, labor productivity in home production (conditional on state k). The reason is that appliance ownership increases the household's productivity in the production of home goods. When home and market goods are complements, the household wants to increase consumption of both, which requires releasing labor to the market.

Before moving on to the quantification, note that the analytical characterization we provide in this section abstracts from general equilibrium forces, such as reductions in the aggregate wage that might shift some women to drop out of the market. Having established the analytical properties of our model, as well as what are the key parameters that govern the response to changes in appliance prices, we turn to evaluating quantitatively the shock that Peru experienced between 1993 and 2017.

5 Quantification

To calibrate the model, we use data from the 1993 census, focusing on households consisting of a man and a woman, where the woman is aged 25 to 50 years and the household has access to electricity. We calibrate the model with a yearly frequency, and under the assumption that the economy was in a steady state in 1993. Beginning in 1994, we introduce a permanent, unexpected 75 percent reduction in appliance prices. We describe the procedure briefly below, and relegate details to Appendix C.

5.1 Calibration Procedure

This section outlines our calibration approach. We divide the parameters to be calibrated into three groups. The first group includes those parameters that we calibrate externally, following existing estimates. We describe these parameters in Panel A of Table 6.The second group consists of parameters identified by matching aggregate moments from the Peruvian microdata. These moments are listed in Panel B of Table 6. The third group consists of parameters that we estimate by indirect inference, matching the reduced-form evidence discussed earlier. These are listed in Panel C of Table 6.

5.2 Indirect Inference and Model Fit

Before presenting the quantitative results, we first outline how we map the targeted data moments through indirect inference and evaluate the model's ability to replicate them. In Section (3), we presented suggestive evidence that declining import prices drove an increase in appliance ownership and, consequently, female labor force participation. To calibrate the model, we adopt the following strategy, while acknowledging the challenges of establishing a causal link with a time series limited to just three observations.

Our strategy proceeds in two steps. In the first step, we construct a price index that varies at the district-time level, by interacting baseline levels of access to utilities (Figure 3) with the aggregate relative prices of appliances, as observed in the data (Figure 2a). We then follow a two-step estimation exploiting the same structure as in Equation 1. The first stage regresses ownership on our price index, while the second stage regresses female labor force

Table 6: Calibrated Parameters

Panel A. External Calibration			
Parameter	**Notation**	**Source**	**Value**
Discount factor	β	Greenwood et al. (2005)	0.95
EoS between men and women	σ	Johnson and Keane (2013)	2
Returns on assets	R	Greenwood et al. (2005)	1.05
Labor productivity w/ appliance	$b\,(a>0)$	Greenwood et al. (2005)	26
Labor productivity w/o appliance	$b\,(a=0)$	Greenwood et al. (2005)	1
Panel B. Calibration in Steady State			
Fundamentals	**Notation**	**Target**	**Value**
Price of appliances	f	Trade and income data	$0.6 \cdot w_{m,1990}$
Wages by gender	$w_{it,m}, w_{it,f}$	Household surveys; choice of units	$w_{it,m}=1, w_{it,f}=0.63$
Initial distribution	$\bar{n}_{0,t}{}^*$	Population Census in 1993	-
Relative male labor productivity	α	Ratio of wages by gender, 1998	0.89
Location of EV shocks	G_k	Census 1993 Agg Ownership and LFP rates	-
Goods prices	p	Numeraire choice	1
Preference for market goods	μ	Ratio of market hours, with and without appliance	0.87
EoS between market and non-market goods	η	Set to 0	
Panel C. Indirect Inference			
Parameters	**Notation**	**Target**	**Value**
Shape parameter of EV shocks	ρ	Moments in Table 7	0.10

participation on ownership (instrumented by the price index). One interpretation of this estimation procedure is as follows: Under the assumption that the only difference between regions with different levels of access is their capacity to take advantage of lower appliance prices, our first stage estimates a reduced-form demand equation for appliances, while the second stage captures the causal impact of having an appliance on labor force participation.

The estimation delivers the coefficients in the first column of Table 7. Since we estimate a linear probability model, the first stage coefficient, -2.5, implies that a 0.3 unit decrease in our price index–approximately what we observe in the data–increases the probability of having an appliance by 75 percentage points. In addition, the second stage coefficient, 0.59, implies that having an appliance increases the probability of a woman participating in the labor market by 59 percentage points. Although these estimates are large, recall that given our IV strategy, they have a local average treatment effect interpretation, meaning that they are identified off of those households shifted by the price change. The aggregate effects of the price change require modeling the distribution of returns across household, which our model does by introducing unobserved heterogeneity.

The second step in our estimation leverages the information in the data, by simulating a sample of individuals and replicate the two-stage strategy in equations C.14 and C.13, but in our simplified environment. In particular, we use the total change in the relative price of appliances to males wages, as observed in the data. This is equivalent to comparing exogenous price variation in a region with 100 percent electrification and one without any, and using it to match the responses we see in the data.

These moments are informative about ρ, the dispersion parameter of our T1EV shocks, since it governs the response of both ownership and labor force participation to changes in the price of appliance (given initial observed shares). This is shown analytically in equations (19) and (21) above. Table 7, in addition, shows that the model does a reasonable job at fitting the two moments, with a single parameter. We choose to match the second-stage coefficient, and use the first-stage coefficient as a check on our model fit. We do so for to reasons. The first reason is that this coefficient is informative about the key economic mechanism in the model. The second is that, through the lens of our model, it already implies a relatively low value of ρ (which means a larger quantitative response) and is thus the more conservative choice.In fact, with this choice of ρ, the model generates only about one-quarter of the first-stage response we see in the data.

Table 7: Fitting IV Estimates

	Data	Simulation
First-stage coefficient	-2.53	-0.55
Second-stage coefficient	0.59	0.59

5.3 Quantitative Results

5.3.1 The Impact of a Reduction in Appliance Prices

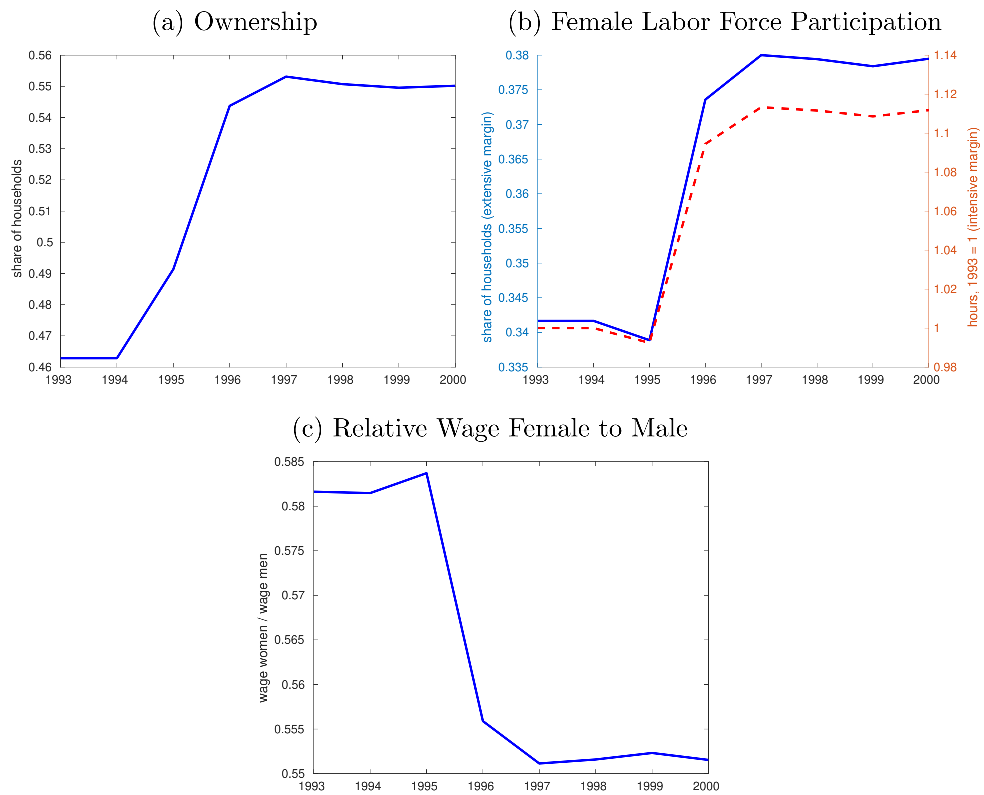
Using the calibrated model, we quantitatively evaluate the equilibrium impact of the reduction in appliance prices of the same magnitude as observed in the data. We model the shock as an unexpected, permanent reduction of the price of appliances of 75 percent, relative to male wages. The shock starts in the year 1994. Recall we focus in this quantification on households that have electricity or running water and that consist of at least of a man and a woman. Such households constitute about 50 percent of the total population in the 1993 Census.

Figure 8 shows the aggregate impacts of introducing this change in appliance prices, keeping all other fundamentals constant. The results provide a quantitative parallel to the analytical results discussed in Section 4.4. Panel (a) shows the evolution of appliance ownership, i.e., the fraction of households that own appliances. The price reduction leads to an approximately 10 percentage point (or 20 percent) increase in ownership. Considering the share of married households with electricity, the reduction in the price of appliances accounts for about one-quarter of the observed increase in ownership (which was 22 percentage points). Note that there is no response in the year 1994, due to the timing convention of our model in which choices of states k are fixed at the beginning of the period.

Panel (b) shows that aggregate female labor force participation also increases by about 4 percentage points (or 10 percent). Female hours in the labor market, in turn, increase by about 12 percent, which means that women engage more in the labor market and work longer hour per person than before. The effect on labor market participation are smaller than that on ownership, as part of the new owners purchase appliances without working, and because as wages fall in equilibrium, the labor force response of those who do not own appliances decreases. Still the effects are large: for the extensive margin, which is easily measurable, the price decline accounts for about one-tenth of the observed evolution over this period.

Panel (c) completes the characterization of the aggregate response to the shock, by comparing the evolution of male and female wages. The reduction in appliance prices drives an expansion in female labor force participation, which drives down female wages. The extent of this decline is governed by two parameters: the trade elasticity, which governs the slope of

Figure 8: Counterfactual Response of Appliance Ownership, Female LFP, and Wages



demand for aggregate labor in the economy, and the elasticity of substitution between men and women in production. As a result, the gender wage gap increases by about 3 percentage points.

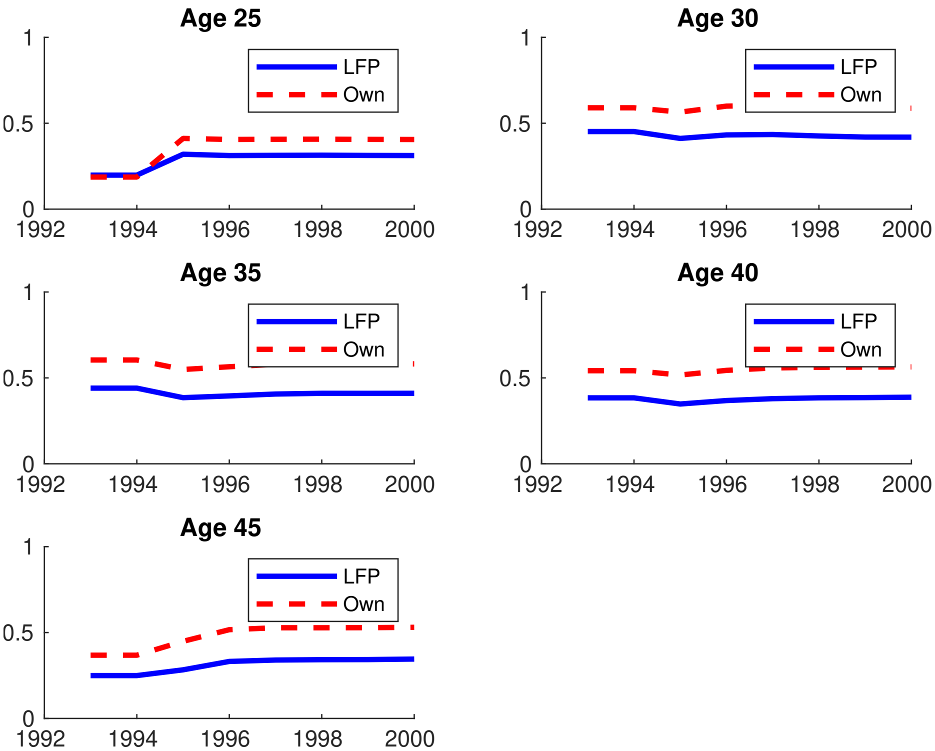
These effects are substantial, even though they are probably closer to a lower bound for the economy. The reason is that access to electricity and running water both grew substantially since 1993, so the fraction of households that were able to benefit from lower appliance prices consequentially grew. Our simulation, instead, focuses only on households that had access in 1993. The aggregate impacts of the price decline are bound to be larger when the share of households with access to utilities increases.

Although the shock is immediate and permanent, the effects take several years to fully unfold. The key to the slow evolution of the household responses lies in the demography of the model, as discussed in Section 4.4 and shown in Figure 9, which traces the response for households of a given age over time. We present results only for households aged 25, 30, 35, 40, and 45. The figure shows that the immediate response of ownership and labor force participation diminishes with age, eventually reaching zero or slightly negative levels for middle-aged households. This smaller response among older households reflects that they have accumulated wealth over their lives, which lowers the continuation value of states in which the woman works. Additionally, the influx of younger workers increases labor supply, exerting downward pressure on wages and making employment less appealing for women near the decision margin.

Over time, however, this effect reverses as households adjust and partially recover their losses in labor force participation. The rebound in ownership and labor force participation in the longer run occurs because younger generations—who enter the labor market in greater numbers—gradually move through the age distribution, reshaping the aggregates. [19]

[19] The calibrated model relies on a limited set of parameters and, at present, targets only aggregate rates of labor force participation and appliance ownership, without leveraging detailed information on the distribution across cohorts. This limits the extent to which we directly control the variation in responses over the lifecycle.

Figure 9: Counterfactual Response of Female LFP, Appliance Ownership, by Age



5.3.2 The Impact of Opening up to Trade

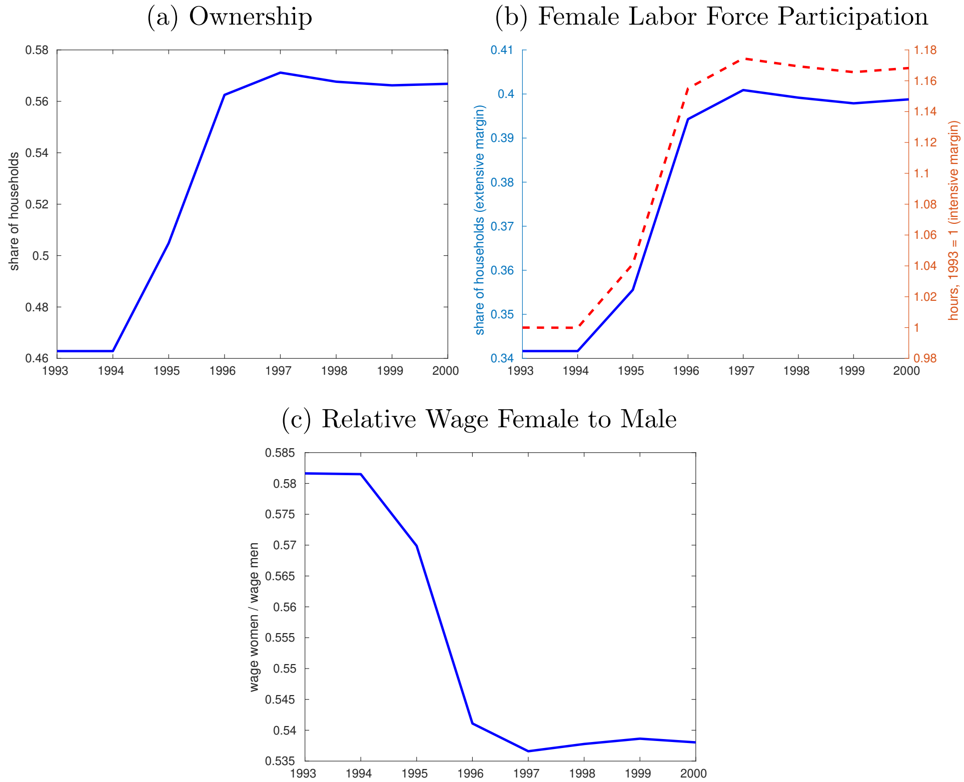
We next assess the impacts of international trade more broadly. Our previous exercise focuses narrowly on the impact of cheaper imported appliances, but our model also speaks to other reasons why labor force participation responds to openness. In particular, opening up to trade reduces the price of market goods relative to local wages. Thus, we consider next a scenario in which the price of appliances relative to male wages drops by 75 percent, as above, while additionally the price of the market good relative to male wages drops by 2 percent.[20] Figure 10 shows that, relative to our previous exercise, doing so produces a stronger response of ownership, labor force participation, female market hours, and a sharper drop in the wage gap.

These outcomes are the balance of two effects. First, an increase in real wages increases the value of female time in the market relative to the household, and thus provides an incentive to increase labor force participation at both the extensive and the intensive margin. Second, all households are now richer, whether they work or not, which can lead to a reduction

[20] In a one-sector quantitative trade model of the type studied in Arkolakis, Costinot, and Rodriguez-Clare (2012), with a trade elasticity of four, this is the change in real wages implied by an 8 percent reduction in Peru's domestic trade share since 1993. Unfortunately, we lack the data to compute domestic trade shares for this period, but not that this number is not out of line with evidence for other countries (e.g. Eaton and Kortum (2012), Table 2).

of labor supply. As Figure 10 shows, the first effect dominates, as it drives larger increases in both ownership and labor force participation, as compared to our simulation in which only the price of appliances changes. Adding this labor-demand channel to our quantification boost the role of international trade in explaining the growth of both appliance ownership and female labor force participation, as the model now accounts for half of the former and about one-fourth of the latter.

Figure 10: Counterfactual Response of Appliance Ownership, Female LFP, and Wages



6 Conclusion

We study the relation between household production—which continues to be carried out mostly by women in the developing world—, participation in labor markets, and international trade. A productive research agenda has studied the ways in which international trade impacts labor demand, either reducing it through import competition or increasing it via new trade opportunities. We focus instead on how international trade affects labor supply decisions, as well as time use within and outside of the household.

Trade policy is often designed with the goal of protecting certain groups from foreign competition, whether those groups are workers or firms exposed to international trade or industries whose growth the government wants to foster. Our results so far point to an overlooked impact of trade policy, namely, encouraging labor force participation by making appliances that substitute for household labor more accessible. Understanding this mechanism is particularly important in countries where domestic appliance production is limited, a prevalent scenario in many middle- and low-income countries.

References

Aguiar, M., and E. Hurst (2005): "Consumption versus Expenditure," *Journal of Political Economy*, 113(5), 919–948.

——— (2007a): "Life-Cycle Prices and Production," *American Economic Review*, 97(5), 1533–1559.

——— (2007b): "Measuring Trends in Leisure: The Allocation of Time Over Five Decades," *The Quarterly Journal of Economics*, 122(3), 969–1006.

Alvarez, F., and R. J. Lucas (2007): "General equilibrium analysis of the Eaton-Kortum model of international trade," *Journal of Monetary Economics*, 54(6), 1726–1768.

Arkolakis, C., A. Costinot, and A. Rodriguez-Clare (2012): "New Trade Models, Same Old Gains?," *American Economic Review*, 102(1), 94–130.

Autor, D., D. Dorn, and G. Hanson (2019): "When Work Disappears: Manufacturing Decline and the Falling Marriage Market Value of Young Men," *American Economic Review: Insights*, 1(2), 161–78.

Autor, D. H., D. Dorn, and G. H. Hanson (2013): "The China Syndrome: Local Labor Market Effects of Import Competition in the United States," *American Economic Review*, 103(6), 2121–2168.

——— (2016): "The China Shock: Learning from Labor-Market Adjustment to Large Changes in Trade," *Annual Review of Economics*, 8(1), 205–240.

Caliendo, L., M. Dvorkin, and F. Parro (2019): "Trade and Labor Market Dynamics: General Equilibrium Analysis of the China Trade Shock," *Econometrica*, 87(3), 741–835.

Coen-Pirani, D., A. Leon, and S. Lugauer (2010): "The effect of household appliances on female labor force participation: Evidence from microdata," *Labour Economics*, 17(3), 503–513.

Costa, F., J. Garred, and J. P. Pessoa (2016): "Winners and losers from a commodities-for-manufactures trade boom," *Journal of International Economics*, 102(C), 50–69.

Dinkelman, T. (2011): "The Effects of Rural Electrification on Employment: New Evidence from South Africa," *American Economic Review*, 101(7), 3078?3108.

DIX-CARNEIRO, R. (2014): "Trade Liberalization and Labor Market Dynamics," *Econometrica*, 82(3), 825–885.

DIX-CARNEIRO, R., AND B. K. KOVAK (2017): "Trade Liberalization and Regional Dynamics," *American Economic Review*, 107(10), 2908–46.

EATON, J., AND S. KORTUM (2012): "Putting Ricardo to Work," *Journal of Economic Perspectives*, 26(2), 65–90.

GADDIS, I., AND J. PIETERS (2017): "The Gendered Labor Market Impacts of Trade Liberalization: Evidence from Brazil," *Journal of Human Resources*, 52(2), 457–90.

GERTLER, P. J., O. SHELEF, C. D. WOLFRAM, AND A. FUCHS (2016): "The Demand for Energy-Using Assets among the World's Rising Middle Classes," *American Economic Review*, 106(6), 1366?1401.

GREENLAND, A., AND J. LOPRESTI (2016): "Import exposure and human capital adjustment: Evidence from the U.S.," *Journal of International Economics*, 100, 50–60.

GREENLAND, A., J. LOPRESTI, AND P. MCHENRY (2019): "Import Competition and Internal Migration," *The Review of Economics and Statistics*, 101(1), 44–59.

GREENWOOD, J., A. SESHADRI, AND M. YORUKOGLU (2005): "Engines of Liberation," *Review of Economic Studies*, 72(1), 109–133.

HACKETT, L., AND F. MARQUEZ-PADILLA (2022): "Working for Change: the Effect of Labor Force Participation on Fertility," .

HARRISON, A., J. MCLAREN, AND M. MCMILLAN (2011): "Recent Perspectives on Trade and Inequality," *Annual Review of Economics*, 3(1), 261–289.

HUMMELS, D., R. JORGENSEN, J. MUNCH, AND C. XIANG (2014): "The Wage Effects of Offshoring: Evidence from Danish Matched Worker-Firm Data," *American Economic Review*, 104(6), 1597–1629.

JUHN, C., G. UJHELYI, AND C. VILLEGAS-SANCHEZ (2014): "Men, women, and machines: How trade impacts gender inequality," *Journal of Development Economics*, 106, 179–193.

MANSOUR, H., P. MEDINA, AND A. VELASQUEZ (2022): "Import Competition and Gender Differences in Labor Reallocation," *Labour Economics*, 76, 102149.

OECD (2011): *Society at a Glance 2011: OECD Social Indicators*chap. Cooking and caring, building and repairing: Unpaid work around the world., pp. 9–27. Paris: OECD Publishing.

Pierce, J. R., and P. K. Schott (2016): "The Surprisingly Swift Decline of US Manufacturing Employment," *American Economic Review*, 106(7), 1632–62.

——— (2020): "Trade Liberalization and Mortality: Evidence from US Counties," *American Economic Review: Insights*, 2(1), 47–64.

Proexport-Colombia (2003): "Estudio de Mercado Peru - Estudio de electrodomesticos," Discussion paper, Proexport Colombia - Banco Interamericano de Desarrollo - Fondo Multilateral de Inversion.

Topalova, P. (2010): "Factor Immobility and Regional Impacts of Trade Liberalization: Evidence on Poverty from India," *American Economic Journal: Applied Economics*, 2(4), 1–41.

Traiberman, S. (2019): "Occupations and Import Competition: Evidence from Denmark," *American Economic Review*, 109(12), 4260–4301.

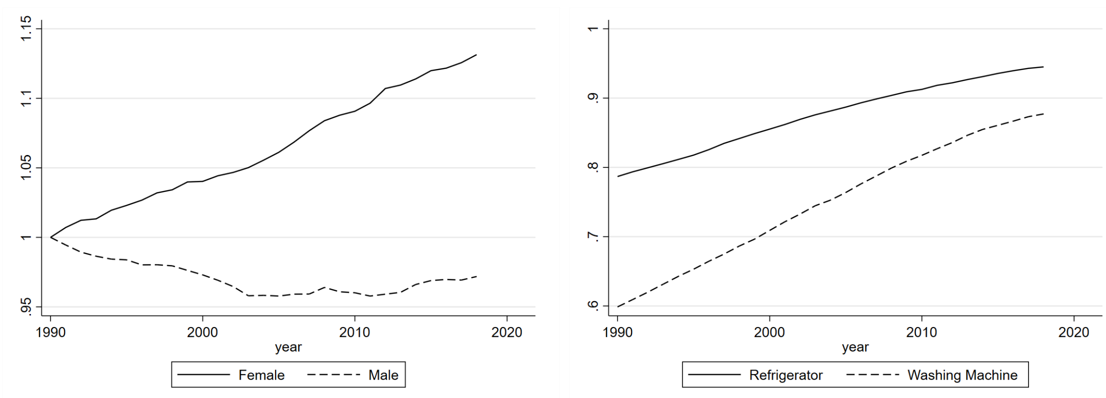
Yamada, G. (2005): "Horas de trabajo: determinantes y dinÃ¡mica en el PerÃº urbano," Documento de Trabajo 71, Universidad del Pacifico, Centro de Investigacion.

A International Trends

Over the last 30 years, global female labor force participation has increased substantially. Panel (a) of Figure A.1 illustrates that average cross-country female labor force participation has increased by 15 percentage points between 1990 and 2020, while male participation appears to have slightly decreased and stagnated during the same period. Although not depicted in the figure, this trend in female labor force participation has been primarily driven by low- and middle-income countries. Moreover, this inflow of women into the labor force has coincided with a widespread adoption of household appliances that substitute for time spent on household production. Panel (b) of Figure A.1 shows a surge in ownership of refrigerators and washing machines over the past 30 years.

Figure A.1: Overall Trends

(a) Labor Force Participation (b) Ownership of Appliances



Notes: In Panel (a) each series is an index (base year is 1990). Source: ILO. In panel (b), each series shows the fraction of households who report owning the appliance. Source: Euromonitor's Passport Consumer Appliances Data

B Model Derivations

B.1 The household's Static Decisions

In this section we characterize the household choices within each period, under the assumption that $\eta \to 0$ in the utility function 3. We omit time and regional subindices to avoid clutter. Utility is then:

$$u = \min\left\{\frac{m}{\mu}, \frac{g}{1-\mu}\right\},$$

with the following period constraints:

$$h_f + l_f = 1,$$

$$a' = Ra + w_m + w_f h_f - pm - \mathbb{I}_k f,$$

$$g = b_k l_f,$$

which state that the woman's time use must add up to one; that there is a constraint on income, expenditure and savings, and that household goods are produced with women's time. Denoting y_k cash at hand in state k, $y_k = Ra + w_m - \mathbb{I}_k f - a'$, and substituting for h_f and l_f in the time budget constraint, we obtain

$$\max_{g,m} \min\left\{\frac{m}{\mu}, \frac{g}{1-\mu}\right\},$$

subject to

$$\frac{pm - y_k}{w_f} + \frac{g}{b_k} = 1.$$

Thus, when the household is unconstrained (i.e., when it can participate in the labor market), it chooses

$$\begin{aligned}
g^* &= (1-\mu)\frac{w_f + y_k}{(1-\mu)\frac{w_f}{b_k} + \mu p}, \\
l^* &= \frac{(1-\mu)}{b_k}\frac{w_f + y_k}{(1-\mu)\frac{w_f}{b_k} + \mu p}, \\
m^* &= \frac{\mu}{1-\mu} g^*, \\
u^* &= \min\left\{\frac{m^*}{\mu}, \frac{g^*}{1-\mu}\right\}.
\end{aligned}$$

If, instead, the household is constrained (i.e., when it does not participate in the labor market), it chooses

$$
\begin{aligned}
g^* &= b_k, \\
l^* &= 1, \\
m^* &= y_k/p, \\
u^* &= \min\left\{\frac{b_k}{1-\mu}, \frac{y_k/p}{\mu}\right\},
\end{aligned}
$$

since all the woman's time is devoted to home production and all cash at hand to market consumption.

B.2 Obtaining the Small Open Economy Limit in the Static Equilibrium

We begin by stating the environment and equilibrium in the N-country economy.

B.2.1 Environment

Preferences. The household maximizes the bellman equation given by

$$
V_{i,jk}(a) = \max_{m,g,a'\geq 0}\left\{\ln u(m_i, g_i) + \beta\mathbb{E}_\varepsilon \max_{k'\in K_k}\left[V_{i,j+1,k'}(a') + \varepsilon_k\right]\right\}, \tag{B.1}
$$

with

$$
a' = Ra + w_m - w_f h_f - m - \mathbb{I}[d=1]\, f,
$$

where

$$
u(m_{it}, g_{it}) = \left[\mu^{\frac{1}{\eta}} m_{it}^{\frac{\eta-1}{\eta}} + (1-\mu)^{\frac{1}{\eta}} g_{it}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{B.2}
$$

and

$$
m_{it} = \left[\sum_{i'} (m_{i'it})^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}.
$$

Technology. Home goods are produced according to the following technology:

$$
g_{it} = b(d)\cdot l_{it,f}. \tag{B.3}
$$

Market goods are produced according to

$$
Y_{it} = Z_{it} H_{it},
$$

where Z_{it} is a country-specific productivity and H_{it} is a constant-elasticity index of labor supply of men and women:

$$H_{it} = \left(\alpha^{1/\sigma} H_{it,m}^{\frac{\sigma-1}{\sigma}} + (1-\alpha)^{1/\sigma} H_{it,f}^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}. \tag{B.4}$$

Appliances are produced using market goods as input, with a constant productivity Z_{it}^{d}, and differentiated according to their region of origin, with elasticity θ.

B.2.2 Aggregation

Populations evolve according to

$$n_{it,jk}(a) = \int_{\mathcal{A}} \sum_{k'} \lambda_{ij,k'k}(z)\, \gamma_{it,j-1k'}(a,z)\, n_{it-1,j-1k'}(z)\, dz + \bar{n}_{it,jk}(a), \tag{B.5}$$

and labor supplies are given by

$$H_{it,m} = \sum_{j} \sum_{k} \int_{\mathcal{A}} 1 \cdot n_{it,jk}(a)\, da, \tag{B.6}$$

$$H_{it,f} = \sum_{j} \sum_{k} \int_{\mathcal{A}} h_{it,jkf}(a) \cdot n_{it,jk}(a)\, da. \tag{B.7}$$

Aggregate Savings and Demand for Appliances. At each point in time, we can compute the total demand for new appliances as

$$D_{it} = \sum_{j} \sum_{k\in\{3,4\}} \int_{\mathcal{A}} n_{it,jk}(a)\, da,$$

and total assets carried between periods t and $t-1$ as

$$A_{it} = \sum_{j} \sum_{k} \int_{\mathcal{A}} x_{it,jk}(a)\, n_{t-1,jk}(a)\, da. \tag{B.8}$$

B.2.3 Equilibrium

Static Equilibrium. At time t, given the workers choices of labor supply, $\{H_{it}\}$ and asset holdings $\{A_{it}\}$, a static equilibrium is a set of wages $\{W_{it}\}$, a world interest rate, R, such that labor and capital markets clear:

$$W_{it}H_{it} = \sum_{i'} \pi^m_{ii't} X^m_{i't} + \frac{1}{Z^a_{it}} \sum_{i'} \pi^a_{ii't} X^a_{i't}, \tag{B.9}$$

$$0 = \sum_{i} A_{i,t} - RA_{i,t-1} \tag{B.10}$$

and the aggregator $\{H_{it}\}$ satisfies equation (8), and where $\pi^s_{ii',t}$ is the standard Armington expenditure share for sector $s = m, a$. In this definition, country i's total expenditure in market goods and in appliances is given by

$$X^m_{it} = \sum_j \sum_k \int_{\mathcal{A}} P_{it} m_{it,jk}(a)\, n_{it,jk}(a)\, da,$$

and

$$X^a_{it} = f_{it} D_{it},$$

and the price indices of market goods and appliances are given by

$$P_{it} = \left(\sum_{i'} (W_{i't}\tau_{i'i,t}/Z_{i't})^{1-\theta} \right)^{\frac{1}{1-\theta}},$$

and

$$f_{it} = \left(\sum_{i'} \left(\frac{W_{i't}\tau^a_{i'i,t}}{Z_{i't}Z^a_{i't}} \right)^{1-\theta} \right)^{\frac{1}{1-\theta}}.$$

Dynamic Equilibrium. Given initial conditions, $\{A_{i,0}\}$, and optimal pricing functions for $\{W_{i,t}\}$ and R_t, defined by the static equilibrium, a dynamic equilibrium is a path of labor supplies and assets $\{H_{i,t}, A_{i,t}\}$, for $t = 1, 2, \ldots$ such that the law of motion of population and asset holdings hold.

B.2.4 The Small Open Economy (SOE) Limit

In our quantification and analysis, we exploit the notion of a small open economy, a limiting case of the economy described above (Alvarez and Lucas, 2007). To this end, suppose (i) the home country does not produce appliances, $Z^a_{i,t} = 0$, (ii) the home country is small in the sense that $\kappa_{it} \equiv \lim Z^{\theta-1}_{it}/\nu_{it}$ as $\nu_{it} \to 0$, where ν_{it} is the population size in country i.

With these assumptions we can rewrite the labor market clearing condition B.9 for country i as:

$$W_{it} = \underbrace{\left(\frac{\tau_{iF}^{1-\theta}}{P_{Ft}^{1-\theta}}\kappa_{it}X_{Ft}^{m}\right)^{1/\theta}}_{B_{it}}\left(\frac{H_{it}}{\nu_{it}}\right)^{-1/\theta},$$

where the second term, H_{it}/ν_{it} is a rate of participation in the labor market. The world capital market equilibrium given in equation (B.10) boils down to

$$0 = \sum_{j\neq i} A_{j,t} - RA_{j,t-1},$$

which means that the SOE takes the interest rate as given. Equation (B.8), in turn, determines the SOE's asset holdings, for any interest rate.

Discretizing the Space of Assets To solve the model computationally, we discretize the asset space into a grid with I points, denoted a^{ι}. We let $a^1 = 0$ and $a^I = 20 \times w_{i1993,t}$.[21] We call this grid A. The state space then becomes $\mathcal{S} = \mathcal{K} \otimes A$, with with $|\mathcal{S}| = S$.

Let $\Lambda_{t,j}$ be a S by S matrix, that collects the transition probabilities $\lambda_{t,jkk'}^{\iota} = \lambda_{t,jkk'}(a^{\iota})$. In particular,

$$\Lambda_{t,j} = \begin{bmatrix} \lambda_{t,j11}^{1} & \lambda_{t,j12}^{1} & \dots & \lambda_{t,j1K}^{1} \\ \lambda_{t,j11}^{2} & \lambda_{t,j12}^{2} & \dots & \lambda_{t,j1K}^{2} \\ \vdots & & & \\ \lambda_{t,j11}^{I} & & & \lambda_{t,j11}^{I} \\ \lambda_{t,j21}^{1} & \lambda_{t,j22}^{1} & & \lambda_{t,j2K}^{1} \\ \vdots & & & \\ \lambda_{t,j21}^{I} & \lambda_{t,j22}^{I} & & \lambda_{t,j2K}^{I} \\ \vdots & & & \\ \lambda_{t,jK1}^{I} & \dots & & \lambda_{t,jKK}^{I} \end{bmatrix} \otimes \mathbf{1}_{1\times I},$$

and let $\tilde{\Pi}_{t,j}$ be a S by S transition matrix for assets that collects the decisions to transition from asset state ι to ι', conditional on starting on state k,

$$\Gamma_{t,j} = \mathbf{1}_{1\times K} \otimes \begin{bmatrix} \mathbb{I}_1[1,1] & \mathbb{I}_1[1,2] & \dots & \mathbb{I}_1[1,I] \\ \vdots & & & \\ \mathbb{I}_1[I,1] & \mathbb{I}_1[I,2] & \dots & \mathbb{I}_1[I,I] \\ \vdots & & & \\ \mathbb{I}_K[I,1] & \mathbb{I}_K[I,2] & \dots & \mathbb{I}_K[I,I] \end{bmatrix},$$

[21] In practice, our simulations never reach this upper limit.

where

$$\mathbb{I}_{jk}\left[\iota,\iota'\right]=\begin{cases}1 & if \quad x_{jk}\left(a^{\iota}\right)=a^{\iota'}\\ 0 & \text{otherwise}\end{cases}.$$

Finally, letting $\tilde{\Pi}_{j,t}=\Gamma_{j,t}\Lambda_{j,t}$, the discretized version of the law of motion in equation 11 is given by:

$$n_t=\Pi_t n_{t-1}+\bar{n}_t,$$

where

$$\Pi_t=\begin{bmatrix}0 & \dots & & & & 0\\ \tilde{\Pi}_{t,1}^T & & & & & \\ \vdots & \tilde{\Pi}_{t,2}^T & & & & \\ & & \tilde{\Pi}_{t,3}^T & & & \\ & & & \ddots & & \\ 0 & \dots & & & \tilde{\Pi}_{t,J-1}^T & 0\end{bmatrix}.$$

B.3 Characterizing the Ownership and Labor Participation Rates

B.3.1 Ownership

We begin by characterizing the aggregate ownership rate, ω, which is defined as

$$\omega_t=\sum_j\underbrace{\sum_{k\in\mathcal{K}_\omega}\int_{\mathcal{A}}n_{jk,t}\left(a\right)da}_{n_{j,t}\omega_{j,t}}.$$

We characterize this rate in our two-period model, starting with age-1 households:

$$\omega_{1,t}n_{1,t}=\sum_{k\in\mathcal{K}_\omega}\lambda_{1,k_0k,t}\left(0\right),$$

where we already use the assumptions that individuals start without any assets. Noting that only households that are currently purchasing the appliance are directly affected in period t

by the price reduction, we obtain

$$\begin{aligned}
\frac{\partial \omega_{1,t}}{\partial f} &= \sum_{k \in \mathcal{K}_\omega} \partial_f \lambda_{1,k_0 k,t} \\
&= \sum_{k=3,4} \left[\lambda_{1,k_0 k,t} \frac{1}{\rho} \partial_f V_{1k,t} - \lambda_{1,k_0 k,t} \sum_{k'} \lambda_{1,k_0 k',t} \frac{1}{\rho} \partial_f V_{1k',t} \right] \\
&= \left[\lambda_{1,k_0 3,t} \frac{1}{\rho} \partial_f V_{13,t} - \lambda_{1,k_0 3,t} \sum_{k'} \lambda_{1,k_0 k',t} \frac{1}{\rho} \partial_f V_{1k',t} \right] + \left[\lambda_{1,k_0 4,t} \frac{1}{\rho} \partial_f V_{14,t} - \lambda_{1,k_0 4,t} \sum_{k'} \lambda_{1,k_0 k',t} \frac{1}{\rho} \partial_f V_{1k',t} \right] \\
&= \left[\lambda_{1,k_0 3,t} \frac{1}{\rho} \partial_f V_{13,t} + \lambda_{1,k_0 4,t} \frac{1}{\rho} \partial_f V_{14,t} - (\lambda_{1,k_0 3,t} + \lambda_{1,k_0 4,t}) \sum_{k'} \lambda_{it,1k'} \frac{1}{\rho} \partial_f V_{it,1k'} \right] \\
&= \frac{1}{\rho} \left[\lambda_{1,k_0 3,t} \partial_f V_{13,t} + \lambda_{1,k_0 4,t} \partial_f V_{14,t} - (\lambda_{1,k_0 3,t} + \lambda_{1,k_0 4,t}) \left[\lambda_{1,k_0 3,t} \partial_f V_{13,t} + \lambda_{1,k_0 4,t} \partial_f V_{14,t} \right] \right] \\
&= \frac{1}{\rho} \left[\left[1 - (\lambda_{1,k_0 3,t} + \lambda_{1,k_0 4,t}) \right] \left[\lambda_{1,k_0 3,t} \partial_f V_{13,t} + \lambda_{1,k_0 4,t} \partial_f V_{14,t} \right] \right],
\end{aligned}$$

where we use the shorthand $\partial_x y = \partial y / \partial x$. Given that the baseline shares $\lambda_{1,k_0 3,t} + \lambda_{1,k_0 4,t}$ add up to less than one, this shows that ownership rate for age-1 households rises on impact, with a strength governed by $1/\rho$.

For age-2 households, we have

$$\omega_{2,t} n_{2,t} = \sum_{k'} \sum_{k \in \mathcal{K}_\omega} \int_{\mathcal{A}} \lambda_{it,2k'k}(a) \cdot n_{it-1,1k'}(a)\, da$$

$$\frac{\partial \omega_{2,t}}{\partial f} = \sum_{k'} \sum_{k \in \mathcal{K}_\omega} \int_{\mathcal{A}} \left[\partial_f \lambda_{it,2k'k}(x_{it,k'}(0)) \right] \cdot n_{it-1,1k'}(0)\, da$$

because n does not change on impact.

$$\frac{\partial \omega_{2,t}}{\partial f} = \sum_{k'} \sum_{k=3,4} \left[\partial_f \lambda_{it,2,k'k}(x_{it,k'}(0)) \right] \cdot n_{it-1,1k'}(0) + \sum_{k'=3,4} \sum_{k=5,6} \left[\partial_f \lambda_{it,2,k'k}(x_{it,k'}(0)) \right] \cdot n_{it-1,1k'}(0),$$

where we again can simplify because the choice of savings, $x_{it,k'}(0)$, is unique for each k'. Note next that the second term on the right-hand side is zero: conditional on being in state $k' = 3$ in age one, the household can only move to states that are not affected directly by the price of appliances; the same is true for $k'=4$. So we simplify to

$$\frac{\partial\omega_{2,t}}{\partial f}=\sum_{k'}n_{it-1,1k'}\left(0\right)\sum_{k=3,4}\left[\partial_f\lambda_{it,2k'k}\left(x_{it,k'}\left(0\right)\right)\right]$$
$$\frac{\partial\omega_{2,t}}{\partial f}=\sum_{k'}n_{it-1,1k'}\left(0\right)\frac{1}{\rho}\left[\left[1-\left(\lambda_{it,1k'3}+\lambda_{it,1k'4}\right)\right]\left[\lambda_{it,1k'3}\partial_f u_{it,1k'3}+\lambda_{it,14}\partial_f u_{it,1k'4}\right]\right],$$

and where we ignore the impact of appliance prices on probabilities λ through changes in assets, by invoking the envelope theorem.

B.3.2 Participation Rate

We proceed analogously to characterize the labor force participation rate:

$$\varphi_t=\sum_j\underbrace{\sum_{k\in\mathcal{K}_{\ell=1}}\int_{\mathcal{A}}n_{jk,t}\left(a\right)da}_{\equiv n_{j,t}\cdot\varphi_{j,t}.},\tag{B.11}$$

Using again our two period model, starting with age-1 households:

$$\varphi_{1,t}=\sum_{k\in\mathcal{K}_{\ell=1}}\lambda_{j,k_0k,t}\left(0\right),$$

where we already use the assumptions that individuals start without any assets. Noting that only households that are currently purchasing the appliance are directly affected in period t by the price reduction, we obtain

$$\begin{aligned}\frac{\partial\varphi_{1,t}}{\partial f}&=\sum_{k\in\mathcal{K}_{\ell=1}}\partial_f\lambda_{j,k_0k,t}\left(0\right)\\&=\sum_{k=2,4}\left[\lambda_{j,k_0k,t}\frac{1}{\rho}\partial_f V_{1k,t}-\lambda_{j,k_0k,t}\sum_{k'}\lambda_{j,k_0k',t}\frac{1}{\rho}\partial_f V_{1k',t}\right]\\&=\left[-\lambda_{j,k_02,t}\sum_{k'}\lambda_{j,k_0k',t}\frac{1}{\rho}\partial_f V_{1k',t}\right]+\left[\lambda_{j,k_04,t}\frac{1}{\rho}\partial_f V_{it,14}-\lambda_{j,k_04,t}\sum_{k'}\lambda_{j,k_0k',t}\frac{1}{\rho}\partial_f V_{1k',t}\right]\\&=\frac{1}{\rho}\left[\lambda_{1,k_04,t}\frac{\partial V_{14,t}}{\partial f}-\left(\lambda_{1,k_02,t}+\lambda_{1,k_04,t}\right)\left[\lambda_{1,k_03,t}\frac{\partial V_{13,t}}{\partial f}+\lambda_{1,k_04,t}\frac{\partial V_{14,t}}{\partial f}\right]\right].\end{aligned}$$

Note that when $\lambda_{it,1,13}=0$,this reduces to

$$\frac{1}{\rho}\left[\lambda_{1,k_04,t}\frac{\partial V_{14,t}}{\partial f}\left[1-\left(\lambda_{1,k_02,t}+\lambda_{1,k_04,t}\right)\right]\right],$$

which is always positive.

To characterize age-2 households, we proceed analogously as with ownership above.

C Calibration Procedure

In this section we explain in detail our calibration procedure. We proceed in the following steps:

1. Assume the census year 1993 is a steady state of the economy, before the reduction of the price of appliances.

2. Calculate the population shares in each cell, $\hat{n}_{it,jk}$, $t = 1993$, aggregating states $k = 3, 5$ and $k = 4, 6$ together. Calculate $\bar{h}_m$ and $\bar{h}_{f,it}(j, a, \ell, e) = \bar{h}_f$ from time use surveys (Yamada, 2005) and wages $w_{m,it}$ and $w_{f,it}$ from ENAHO surveys (the earliest year we use here is 1998). Normalize $h_m = 1$ and adjust h_f accordingly.

3. Using $\bar{h}_m$ and $\bar{h}_f$, calculate aggregate labor supplies, $\hat{H}_{m,it}$ and $\hat{H}_{f,it}$ using the definitions 12 and 13. Then recover α by taking the ratio of equations 15 and 16 and solving out for α.

4. Recover international demand, B_{it}. Using 8 and its corresponding wage index to compute $\hat{H}_{it}$ and $\hat{W}_{it}$. Then use labor market clearing 14 to solve for B_{it}.

5. For each guess of ρ

   (a) Recover $\{G_k\}$ such that the model reproduces the targets for aggregate ownership and aggregate female labor for participation (extensive margin). We impose the following parameterization

$$G_k = \begin{cases} 0 & \text{if } k = 1 \\ G_{\text{work, no own}} & \text{if } k = 2 \\ G_{\text{no work, own}} & \text{if } k = 3, 5 \\ G_{\text{work, own}} & \text{if } k = 4, 6 \end{cases}$$

   (b) Recover μ such that the model reproduces the target for relative hours in the market, for households with and without appliance (conditional on working).

   (c) Solve the model under this parameterization.

(d) Taking n_{it}, $t = 1993$ as an initial condition, simulate the model forward introducing the shock $\hat{f}/\hat{w}_{it,m}$, starting at $t = 1995$ and forward.

(e) Draw 10000 individuals for each cohort and simulate their behavior using the aggregate prices obtained in the previous step (d) and their own idiosyncratic T1EV shocks.

(f) Replicate the 2SLS regression strategy described in Section 5.2.

(g) Construct a vector of moments to target in the simulation

$$m = \left[\beta_{1st\,stage}, \beta_{2nd\,stage}\right]^T.$$

6. Search over ρ to minimize the objective

$$L(\rho, \mu) = m^T m.$$

C.1 IV Regression

We detail here the regression used to construct the moments that we will match by indirect inferenced, as mentioned in Section 5.2. We define an instrument, Relative price$_{d,t}$, for district d and census year t, as the exposure to a price shock in refrigerators and washing machines (relative to average national income). We measure the exposure to the relative price of refrigerators as the share of households in the district with electricity in their dwelling in our baseline year, and we measure the exposure to the price of washing machines as the share of households with water in their dwelling. After interacting each exposure with the nationwide relative price of the corresponding appliance, we take the simple average, as follows:

$$\begin{aligned} \text{Relative price}_{d,t} &= \frac{1}{2}\text{sh electricity}_{d,1993} \times \left(\frac{\text{price refrigerator}_t}{\text{avg. income}_t}\right) \\ &+ \frac{1}{2}\text{sh water}_{d,1993} \times \left(\frac{\text{price washing machine}_t}{\text{avg. income}_t}\right), \end{aligned} \tag{C.12}$$

where sh electricity$_{d,1993}$ and sh water$_{d,1993}$ refer to the percentage of households in district d in 1993 with electrical or water connections in 1993, respectively; price refrigerator$_t$ and price washing machine$_t$ denote the nominal import prices in US\$ of refrigerators and washing machines, respectively; and avg. income$_t$ refers to the average income per worker in Peru, expressed in US\$, as reported by the World Bank.

Using our sample of individuals aged 25-50 in the population censuses from 1993, 2007, and 2017, and we estimate the following 2SLS specification:

$$\text{Work}_{idg,t} = \gamma_d + \gamma_t + \beta_2 \text{Own}_{idg,t} + \delta' X_{i,t} + \alpha' \left(t \cdot W_{gd,1981}\right) + \tau' \text{Trade}_{gd,t} + \epsilon^y_{idg,t} \quad \text{(C.13)}$$

$$\text{Own}_{idg,t} = \gamma_d + \gamma_t + \beta_1 \text{Relative price}_{d,t} + \delta' X_{i,t} + \alpha' \left(t \cdot W_{gd,1981}\right) + \tau' \text{Trade}_{gd,t} + \epsilon^o_{idg,t} \quad \text{(C.14)}$$

where an observation is denoted by individual i of gender g in district d in census year t, $\text{Work}_{idg,t}$ is an indicator that equals one if the individual participates in the labor market and zero otherwise, and $\text{Own}_{idg,t}$ is an indicator that equals one if the individual owns a refrigerator, washing machine, or both. The first stage, equation (C.14), is akin to an appliance demand equation that regresses ownership on exogenous variation in the relative price of the appliance, as captured by our price instrument. The second stage, equation (C.13), measures the causal impact of having an appliance on the decision to participate in the labor market. We cluster standard errors at the district level.

In both equations, we include the following battery of controls to account for individual and household characteristics, time trends, and labor demand effects driven by trade. First, $X_{i,t}$ represents a set of individual-level characteristics, including age and age squared, as well as indicators for urban residence, living in a household with access to electricity and access to water, and dummy variables for different education levels. As in our main specification, we also include trade controls, denoted by $\text{Trade}_{gd,t}$, which accounts for gender-specific shifts in labor demand induced by trade. Third, $t \cdot W_{gd,1981}$ represents the interaction of linear time trends with district-level covariates for individuals of gender g in 1981, including average labor force participation, and income.

D Appendix Figures and Tables

Table D.1: Appliance Definition

APPLIANCE	6-DIGIT HTS CODES	DESCRIPTION
Refrigerators	841810	Refrigerators and freezers; combined refrigerator-freezers, fitted with separate external doors, electric or other
	841821	Refrigerators; for household use, compression-type, electric or other
	841829	Refrigerators; household, electric or not, other than compression-type
	841830	Freezers; of the chest type, not exceeding 800l capacity
	8418540	Freezers; of the upright type, not exceeding 900l capacity
	841850	Furniture incorporating refrigerating or freezing equipment; for storage and display, n.e.c. in item no. 8418.1, 8418.2, 8418.3 or 8418.4 (chests, cabinets, display counters, show-cases and the like)
Washing/Drying Machines	845011	Washing machines; household or laundry-type, fully-automatic, (of a dry linen capacity not exceeding 10kg)
	845012	Washing machines; household or laundry-type, with built-in centrifugal drier, (not fully-automatic), of a dry linen capacity not exceeding 10kg
	845019	Washing machines; household or laundry-type, not fully-automatic, without built-in centrifugal drier, of a dry linen capacity not exceeding 10kg
	845020	Washing machines; household or laundry-type, of a dry linen capacity exceeding 10kg
	845090	Washing machines; parts for household or laundry-type
	845110	Dry-cleaning machines
	845121	Drying machines; of a dry linen capacity not exceeding 10kg
	845129	Drying machines; of a dry linen capacity exceeding 10kg

Table D.2: Changes in Appliance Ownership in Regions with Different Access, Men

	(1)	(2)	(3)	(4)	(5)	(6)
Access Trend	0.0146	0.0077	0.0143	0.0135	0.0147	0.0133
	(0.0007)***	(0.0009)***	(0.0010)***	(0.0012)***	(0.0012)***	(0.0012)***
Mean Dependent	0.317	0.317	0.330	0.336	0.345	0.346
District FE	X	X	X	X	X	X
District + Year FE		X	X	X	X	X
Ind. Controls			X	X	X	X
Trade Controls				X	X	X
LFP_{81} x t					X	X
$Income_{81}$ x t						X
N.Districts	1,622	1,622	1,622	1,535	1,064	1,055
N.Obs.	13,158,105	13,158,105	12,150,069	11,899,902	9,151,914	9,080,931

Notes: Appliances bundle is defined as a dummy variable that takes value of 1 if the household owns a refrigerator or a washing machine. The unit of observation is men aged between 25 and 50. Column 1 includes district fixed effects (γ_d), Column 2 adds year fixed effects (γ_t) , Column 3 includes individual controls $(X_{i,t})$, Column 4 adds trade exposure controls $(Trade_{gd,t})$, and Columns 5 and 6 account for pre-trends in labor force participation and income $(t.W_{gd,1981})$.Standard errors shown in parentheses and clustered at the district level.

Table D.3: Changes in Labor Forece Participation in Regions with Different Access, Men

	(1)	(2)	(3)	(4)	(5)	(6)
Access Trend	0.0010	0.0033	0.0042	0.0041	0.0034	0.0037
	(0.0001)***	(0.0003)***	(0.0003)***	(0.0004)***	(0.0005)***	(0.0005)***
Mean Dependent	0.901	0.901	0.900	0.900	0.897	0.897
District FE	X	X	X	X	X	X
District + Year FE		X	X	X	X	X
Ind. Controls			X	X	X	X
Trade Controls				X	X	X
LFP_{81} x t					X	X
$Income_{81}$ x t						X
N.Districts	1,622	1,622	1,622	1,535	1,064	1,055
N.Obs.	13,158,105	13,158,105	12,150,069	11,899,902	9,151,914	9,080,931

Notes: Labor force participation is defined as a dummy variable that takes value of 1 if the individual participates from the labor market and 0 if they do not. The unit of observation is men aged between 25 and 50. Column 1 includes district fixed effects (γ_d), Column 2 adds year fixed effects (γ_t) , Column 3 includes individual controls $(X_{i,t})$, Column 4 adds trade exposure controls $(Trade_{gd,t})$, and Columns 5 and 6 account for pre-trends in labor force participation and income $(t.W_{gd,1981})$. Standard errors shown in parentheses and clustered at the district level.

Table D.4: Changes in Appliance Ownership and Labor Force Participation in Regions with Different Access, Province level

	App. Ownership		Participation	
	(1)	(2)	(3)	(4)
	Women	Men	Women	Men
Access Prov Trend	0.0109	0.0127	0.0077	0.0040
	(0.0028)***	(0.0027)***	(0.0012)***	(0.0007)***
Mean Dependent	0.382	0.346	0.363	0.897
Prov FE	X	X	X	X
Prov + Year FE	X	X	X	X
Ind. Controls	X	X	X	X
Trade Controls	X	X	X	X
LFP_{81} x t	X	X	X	X
$Income_{81}$ x t	X	X	X	X
N.Prov	128	128	128	128
N.Obs.	9,855,634	9,080,931	9,855,634	9,080,931

Notes: Appliances bundle is defined as a dummy variable that takes value of 1 if the household owns a refrigerator or a washing machine. Labor force participation is defined as a dummy variable that takes value of 1 if the individual participates from the labor market and 0 if they do not. The unit of observation is individuals aged between 25 and 50. Columns 1 and 2 refer to appliance ownership effects for women and mean, respectively, while Columns 3 and 4 refer to labor force participation changes. All specifications include district fixed effects (γ_d), year fixed effects (γ_t) , individual controls $(X_{i,t})$, trade exposure controls $(Trade_{gd,t})$, and pre-trends in labor force participation and income $(t.W_{gd,1981})$. Standard errors shown in parentheses and clustered at the district level.

Table D.5: Changes in Appliance Ownership and Labor Force Participation in Regions with Different Access, for ages 25-65

	Women		Men	
	(1)	(2)	(3)	(4)
	App. Ownership	LFP	App. Ownership	LFP
Access Trend	0.0123	0.0071	0.0133	0.0045
	(0.0012)***	(0.0006)***	(0.0012)***	(0.0005)***
Mean Dependent	0.385	0.334	0.353	0.873
District FE	X	X	X	X
District + Year FE	X	X	X	X
Ind. Controls	X	X	X	X
Trade Controls	X	X	X	X
LFP_{81} x t	X	X	X	X
$Income_{81}$ x t	X	X	X	X
N.Districts	1,055	1,055	1,055	1,055
N.Obs.	12,877,732	12,877,732	11,915,575	11,915,575

Notes: Appliances bundle is defined as a dummy variable that takes value of 1 if the household owns a refrigerator or a washing machine. Labor force participation is defined as a dummy variable that takes value of 1 if the individual participates from the labor market and 0 if they do not. The unit of observation is individuals aged between 25 and 50. Columns 1 and 2 refer to appliance ownership and labor force participation effects for women, while Columns 3 and 4 replicates these regression for men. All specifications include district fixed effects (γ_d), year fixed effects (γ_t) , individual controls $(X_{i,t})$, trade exposure controls $(Trade_{gd,t})$, and pre-trends in labor force participation and income $(t.W_{gd,1981})$. Standard errors shown in parentheses and clustered at the district level.

Table D.6: Changes in Migration Rates in Regions with Different Access

	Women		Men	
	(1)	(2)	(3)	(4)
	Low Access	High Access	Low Access	High Access
Access Trend	-0.0003	0.0017	0.0007	0.0016
	(0.0022)	(0.0016)	(0.0027)	(0.0016)
Mean Dependent	0.106	0.218	0.144	0.244
District FE	X	X	X	X
District + Year FE	X	X	X	X
Ind. Controls	X	X	X	X
Trade Controls	X	X	X	X
LFP_{81} x t	X	X	X	X
$Income_{81}$ x t	X	X	X	X
N.Districts	606	449	606	449
N.Obs.	1,890,007	7,965,627	1,847,024	7,233,907

Notes: Migration is defined as a dummy variable that takes value of 1 if the individual have migrated over the last 5 years and 0 if they do not. Columns 1 and 2 refer to the effects for women living in low-access districts (below nationwide median) and high-access districts (above nationwide median), while Columns 3 and 4 replicates these regression for men. All specifications include district fixed effects (γ_d), year fixed effects (γ_t) , individual controls $(X_{i,t})$, trade exposure controls $(Trade_{gd,t})$, and pre-trends in labor force participation and income $(t.W_{gd,1981})$. Standard errors shown in parentheses and clustered at the district level.

Table D.7: Treatment and Control Cohorts

Cohort	1993	2007	2017
1942-1946	47-51	61-65	71-75
1947-1951	**42-46 (C)**	56-60	66-70
1952-1956	**37-41 (C)**	51-55	61-65
1957-1961	**32-36 (C)**	46-50	56-60
1962-1966	27-31	**41-45 (T)**	51-55
1967-1971	22-26	**36-40 (T)**	46-50
1972-1976	17-21	**31-35 (T)**	**41-45 (T)**
1977-1981	12-16	26-30	**36-40 (T)**
1982-1986	7-11	21-25	**31-35 (T)**
1987-1991	2-6	16-20	26-30
1992-1996	(-3)-(1)	11-15	21-25
1997-2001	(-8)-(-4)	6-10	16-20

Notes: Cohorts, in rows, are defined by birth year. Census years are in columns. Numbers in each cell are the age range of the cohorts at each observed census (1993, 2007, and 2017). The cohorts considered for the analysis are highlighted in bold. (C) refers to whether the cohort is on the treatment group. (T) refers to the cohorts that have been treated.