

Access to Infrastructure and Women's Time Allocation: Evidence and a Framework for Policy Analysis*

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Abstract

This paper studies the interactions between access to infrastructure, women's time allocation, and economic growth in developing countries. The first part provides a review of the evidence on the impact of poor infrastructure on women's ability to allocate their time to productive activities. The second part presents a quantitative framework for policy analysis, in the form of a gender-based, computable overlapping generations (OLG) model of economic growth that captures these interactions as well as of inter- and intra-generational health externalities. The model is then calibrated for a low-income country (Benin) and used to quantify the impact of a policy aimed at improving access to infrastructure on women's time allocation, growth and education and health outcomes. Implications of the analysis for strengthening the role of women in the growth process in developing economies are also discussed.

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Contents

- I. Introduction
- II. Infrastructure and Women's Time Allocation: Evidence
 - 1. Transportation
 - 2. Water and Sanitation
 - 3. Electricity
- III. Infrastructure, Gender, and Growth: A Policy Framework
 - 1. Model Description
 - 2. Women's Time Allocation and Long-Run Growth
- IV. Illustrative Calibration
- V. Policy Experiment: Higher Investment in Infrastructure
- VI. Conclusions and Policy Implications

References

Figures 1 to 7

I. Introduction

The role of women in economic development continues to occupy center stage in policy debates. As documented in a number of studies, including the recent *World Development Report 2012* by the World Bank (2011), gender inequality (in terms of access to education, health, formal sector employment, and income) remains a significant constraint to growth in many countries.¹ On the one hand, the gender gap in educational attainment has gradually narrowed or moved in favor of women in some regions; and in many individual countries the gender gap in primary school enrollment has pretty much disappeared. According to the United Nations (2010) for instance, in 2007 over 95 girls for every 100 boys of primary school age were in school in developing countries, compared with 91 in 1999. In a study of four decades of birth cohorts covering the period 1940-80 for Latin America and the Caribbean, Duryea et al. (2007) found that the gender gap in educational attainment has moved in favor of females at an average pace of 0.27 years of schooling per decade.

On the other, however, half of the girl population in Sub-Saharan Africa still does not complete even a primary school education (Herz and Sperling (2004), UNICEF (2005)). In addition, progress towards gender equality in secondary schooling has been slower, and in some regions gaps are widening. In Sub-Saharan Africa, the percentage of enrolment of girls compared with boys in secondary education fell from 82 per cent in 1999 to 79 per cent in 2007 (United Nations (2010)). Overall, only 53 of the 171 countries with available data had achieved gender parity in both primary and secondary education during that period. At this rate, achieving the Millennium Development Goal of complete parity by 2015 appears to be out of reach for many countries (see World Bank (2010, 2011)).

Related in part to gender bias in education, in today's low- and middle-income countries the labor force participation rate for women remains low; and in most regions female employment is concentrated in either services or agriculture, with fewer women than men employed in industry. Gender inequality in health remains large as well; maternal

¹See Blackden and Bhanu (1999), Blackden et al. (2006), Morrison, Raju, and Sinha (2007), and Momsen (2009). Some of the recent evidence is further discussed in subsequent sections.

mortality rates in many developing countries have only declined marginally (United Nations (2010)). Poor health often translates into low productivity; combined with gender bias in the work place, the consequence is large pay differentials between men and women. According to data compiled by UN WOMEN (2011), the gender pay gap ranges from 3 percent to 51 percent, with a global average of 17 percent.² Many of the world's poor (from a material perspective) are women or girls, so a focus on poverty reduction involves necessarily addressing the gender gap.

The purpose of this paper is twofold. First, it provides an overview of the evidence on how constraints on women's time allocation—specifically, lack of access to infrastructure—affect their ability to engage in market work and how, in turn, policy-induced changes in such allocation affect growth. Second, we provide an intuitive discussion of a policy-oriented, gender-based overlapping generations (OLG) model of endogenous growth, which has been recently developed to assess the long-term effects of gender-related policies. The model (which is calibrated for a low-income) is then used to illustrate the impact of a policy aimed at improving access to infrastructure services.

The remainder of the paper proceeds as follows. Section II begins with a review of the evidence on how inadequate access to infrastructure constrains women's time allocation to productive activities. Section III describes the quantitative model that we propose to study interactions between infrastructure, women's time allocation, and economic growth. It also discusses the properties of the model, in terms of women's optimal time allocation decisions and the equilibrium growth rate. Section IV presents an illustrative calibration, for a low-income country (Benin). The growth effects of increased access to public infrastructure, and its impact on women's time allocation, are discussed in Section V. The concluding section considers the broader implications of the analysis for strengthening the role of women in the growth process in developing economies.

²See World Economic Forum (2012) for a broader measure of the gender gap.

II. OVERVIEW OF THE EVIDENCE

While participation of women in the labor force has increased in recent decades in almost all regions of the world, there are still significant gender gaps in participation rates, occupational distribution, and wages. In today's low- and middle-income countries the labor force participation rate for women (the percentage of the women population aged between 15 and 65 years who are in the labor force) is only 57 percent, compared to 85 percent for men. The share of women above the working age and actually employed (the employment-to-population ratio) was about 50 percent in 2009 compared to a male employment-to-population ratio of about 74 percent (International Labour Office (2010)). While women labor force participation rates are about 65 percent in Sub-Saharan Africa, they are below 55 percent in Latin America and the Caribbean, below 35 percent in South Asia, and below 20 percent in the Middle East (see Table 1).³

Moreover, paid employment for women has expanded slowly and women continue to assume the largest share of unpaid work. Close to two thirds of all employed women in developing countries work as contributing family workers or as workers on their own account, typically in forms of employment that are highly vulnerable and lack job security and benefits. In that sense, the relatively high labor force participation rates for women in East Asia and Sub-Saharan Africa documented in Table 1 do not tell the full story. Indeed, women's share of waged non-agricultural employment has increased in the last decade but only marginally. The share of women employed in agriculture remains well above 60 percent in Sub-Saharan Africa and South Asia, whereas the share of women in the agricultural labor force continues to exceed 42 percent in Sub-Saharan Africa (Table 2 and Figure 1). In most regions female employment remains concentrated in either services or agriculture, with fewer women than men employed in industry (ranging from 7 to 23 percent, compared to 12 to 34 percent for men). In many countries the share of women in informal sector employment exceeds the share of men (Figure 2). The only region where men and women have similar

³Studies based on data pertaining to both developed and developing countries suggest the existence of a U-shape relationship between women labor force participation rates and the level of income per capita, with participation being the highest in the poorest and richest countries (see Mammen and Paxson (2000)). Agénor (2012*b*, Chapter 5) and World Bank (2011) provide a more detailed discussion of this issue.

patterns of employment by sector, both in relative composition and in trend, is East Asia and Pacific. There is also considerable variation in the gap between the proportions of males and females participating in the labor market in some regions, especially Asia and Sub-Saharan Africa (Figure 3).

Table 1
Labor Force Participation Rates by Sex, World and Regions, 2000-2012 (in percent)

Males	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*
World	78.6	78.3	78.1	78.0	78.0	77.9	77.8	77.6	77.5	77.3	77.1	77.1	77.1
Developed Economies and European Union	70.2	69.8	69.4	69.1	68.9	69.0	69.0	69.0	69.0	68.4	68.0	67.6	67.5
Central and South-Eastern Europe (non-EU) and CIS	69.2	68.3	68.0	67.6	67.8	68.2	68.3	68.9	69.6	69.7	70.0	70.4	70.7
East Asia	82.1	81.7	81.4	81.1	80.9	80.7	80.4	80.3	80.0	79.8	79.6	79.6	79.4
South-East Asia and the Pacific	82.8	83.1	82.8	83.1	83.2	82.7	82.4	82.1	81.9	81.8	81.9	81.8	81.8
South Asia	83.3	83.3	83.3	83.3	83.3	83.4	83.1	82.6	82.1	81.7	81.4	81.3	81.3
Latin America and the Caribbean	80.7	80.5	80.3	80.0	80.2	80.2	80.1	79.9	80.0	79.7	79.8	79.6	79.5
Middle East	74.0	73.9	73.8	73.8	73.8	74.0	73.5	73.3	72.7	73.1	73.6	74.0	74.3
North Africa	74.9	74.2	74.1	74.5	75.0	75.2	74.1	74.1	74.1	74.1	74.1	74.2	74.3
Sub-Saharan Africa	77.0	76.7	76.5	76.2	75.9	75.9	75.9	76.0	76.2	76.1	76.1	76.2	76.3
Females	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*
World	52.0	52.0	52.1	52.1	52.2	52.4	52.2	52.0	51.7	51.4	51.2	51.1	51.1
Developed Economies and European Union	51.8	51.7	51.7	51.9	52.0	52.2	52.5	52.7	53.0	53.0	53.0	52.8	52.8
Central and South-Eastern Europe (non-EU) and CIS	49.2	48.6	49.1	48.7	48.3	48.5	48.8	49.1	49.3	49.6	49.7	50.0	50.2
East Asia	69.7	69.4	69.1	68.7	68.3	68.0	67.8	67.7	67.2	67.0	66.9	66.7	66.4
South-East Asia and the Pacific	58.5	58.8	58.4	58.4	58.4	58.5	58.3	58.5	58.7	58.5	58.6	58.7	58.8
South Asia	35.0	35.4	35.8	36.3	36.8	37.4	36.3	35.1	33.9	32.8	31.7	31.8	31.8
Latin America and the Caribbean	48.1	48.7	49.6	49.8	50.8	51.3	51.5	51.8	52.1	52.6	53.1	53.3	53.6
Middle East	16.3	16.7	17.2	17.8	18.3	19.0	18.7	18.5	17.7	17.8	18.1	18.4	18.7
North Africa	22.1	21.7	21.2	21.9	22.4	22.6	22.7	23.6	23.7	23.8	24.0	24.2	24.4
Sub-Saharan Africa	62.7	63.1	63.5	63.8	64.0	64.1	64.2	64.2	64.4	64.4	64.4	64.5	64.6

Source: ILO, *Global Employment Trends* (January 2013, p. 138).

There are a number of reasons that may help to explain why women in developing countries may have significantly lower labor force participation rates than men. They include social norms and religious beliefs, which often translate into women devoting more time to

household production activities than men.⁴ In many countries, cultural norms are that women are expected to continue to do most of the housework and childrearing—even if they are engaged full time in market work.⁵ But of particular importance are constraints in access to infrastructure. In general, the role of infrastructure in promoting growth in developing countries has been the subject of renewed scrutiny in recent years; some of the “new channels” that have been identified in the literature are summarized in Figure 4.⁶ While many of these channels are not gender specific, some of them do affect disproportionately women and their ability to allocate their time. In what follows we therefore provide a brief review of some of the empirical evidence on how constraints on access to transport infrastructure, water and sanitation, and electricity, affect women's time allocation.

1. Transportation

Lack of roads and other transport infrastructure constrains the ability of women to travel to perform activities related to household production and income generation. Women often end up traveling on foot, while at times carrying heavy loads. As documented by Riverson et al. (2006) for instance, in Ethiopia, 73 percent of women's trips and 61 percent of their travel time is dedicated to meeting their household's energy, water, and food needs. On average, women in rural Sub-Saharan Africa spend between 0.9 and 2.2 hours per day on transporting water and firewood (see Blackden and Wodon (2006)); they travel on average between 1 and 5km per day on foot for 2.5 hours, while carrying a load of about 20kg (Riverson et al. (2006)).

⁴See for instance Kevane and Wydick (2001) for the case of Burkina Faso and Ilahi and Grimard (2000) for an overview. There is also evidence that, despite reductions in gender gaps in the workplace and large increases in female labor participation rates, women in some industrial countries continue to spend nearly twice as much time on housework than their male counterparts. See for instance Schaffnit-Chatterjee (2009) for Germany. A recent study by INSEE shows that in 2010 employed women in France allocated 3.5 hours a day on average to household chores, compared to 2 hours for employed men—down from 4 hours in the former, and unchanged in the latter, compared to 1999. However, as documented by Del Boca and Locatelli (2006), although in many industrial countries mothers continue to devote more time to childcare than fathers, the gender gap has fallen in some of them and husbands' contribution to home production has become more relevant.

⁵This tendency is often exacerbated by a lack of government programs to alleviate constraints associated with child care.

⁶Agénor (2012b) provides an extensive review of these channels, which include health and education, an effect on the durability of private capital, network externalities, and an impact on innovation.

Table 2
Employment Shares by Sector and Sex, World and Regions, 2000-2012 (in percent)

Males	Agriculture				Industry				Services			
	2000	2007	2011	2012*	2000	2007	2011	2012*	2000	2007	2011	2012*
World	38.2	33.6	32.0	32.6	23.9	26.1	26.3	26.0	37.9	40.4	41.7	41.4
Developed Economies and European Union	6.0	4.5	4.3	4.2	36.4	35.0	32.1	32.0	57.6	60.5	63.6	63.7
Central and South-Eastern Europe (non-EU) and CIS	25.2	19.1	20.4	18.3	30.9	33.3	29.7	33.7	43.9	47.6	49.9	48.0
East Asia	41.4	34.3	30.1	31.3	26.3	30.1	32.6	31.2	32.2	35.6	37.3	37.5
South-East Asia and the Pacific	48.5	43.5	40.1	42.0	18.4	20.8	21.5	21.2	33.1	35.6	38.4	36.8
South Asia	53.3	46.3	44.5	44.3	17.4	21.6	23.0	23.0	29.3	32.1	32.5	32.6
Latin America and the Caribbean	25.1	21.5	20.8	20.7	26.3	28.2	27.6	27.6	48.6	50.3	51.6	51.7
Middle East	19.8	16.5	14.1	14.0	26.6	28.4	29.2	29.3	53.6	55.2	56.7	56.7
North Africa	30.3	28.3	25.5	29.0	21.8	24.0	26.8	24.6	47.9	47.7	47.8	46.3
Sub-Saharan Africa	65.3	62.4	61.1	61.8	9.6	10.6	10.7	10.6	25.1	27.0	28.2	27.6
Females	Agriculture				Industry				Services			
	2000	2007	2011	2012*	2000	2007	2011	2012*	2000	2007	2011	2012*
World	44.0	38.4	35.4	35.0	15.1	16.2	16.9	17.1	40.9	45.4	47.7	47.9
Developed Economies and European Union	4.7	3.2	2.8	2.7	15.5	12.9	11.0	11.1	79.8	83.9	86.1	86.2
Central and South-Eastern Europe (non-EU) and CIS	25.2	18.5	19.1	19.4	18.2	17.6	18.3	18.9	56.7	63.9	62.5	61.7
East Asia	55.2	44.5	37.5	36.7	19.9	23.7	26.4	26.8	24.9	31.8	36.1	36.5
South-East Asia and the Pacific	51.1	45.0	41.7	40.7	13.7	14.8	15.6	16.0	35.2	40.2	42.7	43.3
South Asia	75.2	70.1	68.6	68.4	11.0	14.2	15.5	15.6	13.8	15.7	16.0	16.0
Latin America and the Caribbean	12.4	10.2	8.6	8.4	13.8	13.9	13.2	13.2	73.8	75.9	78.2	78.3
Middle East	36.4	32.0	28.5	28.3	11.7	14.9	12.2	12.0	51.9	53.0	59.4	59.7
North Africa	39.9	39.6	32.9	32.3	11.1	11.6	14.6	14.9	49.0	48.9	52.5	52.8
Sub-Saharan Africa	67.8	63.9	62.6	62.2	5.7	6.1	6.4	6.5	26.5	30.0	31.0	31.3

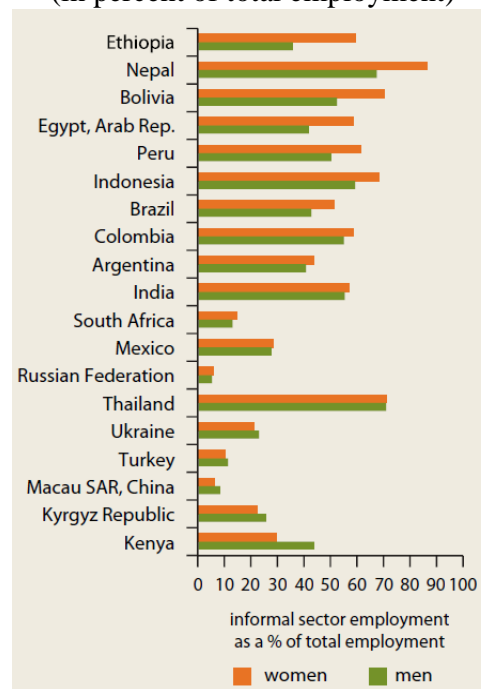
Source: ILO, *Global Employment Trends* (January 2013, p. 140).

Figure 1
Percentage of Women in Total and Agricultural Labor Force



Source: Mehra and Rojas (2008).

Figure 2
Selected Countries: Informal Sector Employment, by gender
(in percent of total employment)



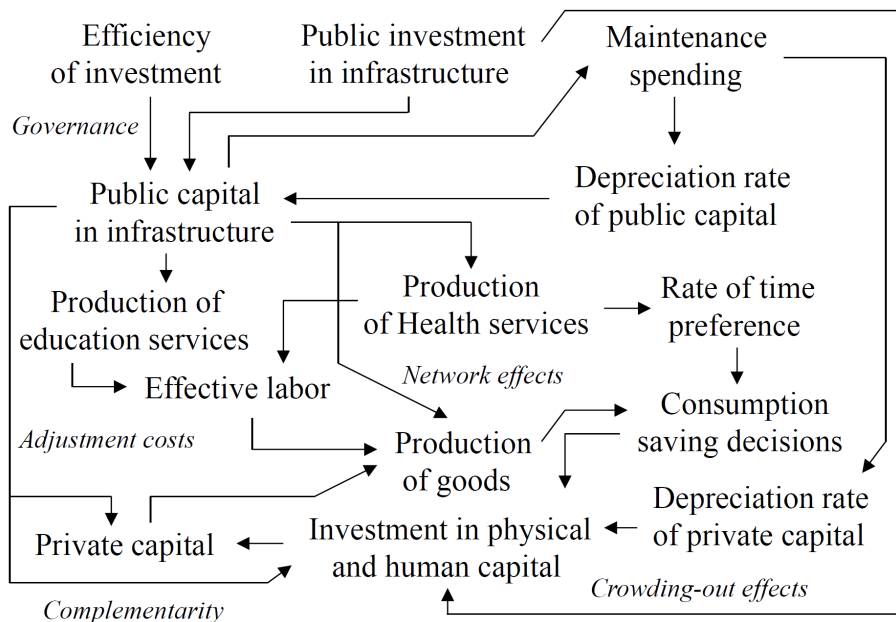
Source: World Bank (2011, p. 79)

(Percentage Points)



Source: ILO, *Global Employment Trends*, January 2010 (p. 13).

Channels through which Infrastructure Affects Economic Growth



Women also depend on transportation for health care, for themselves and their children. In many countries in Sub-Saharan Africa, a majority of women in rural areas rank distance and inadequate transportation as major obstacles in accessing health services (African Union (2005)). Women may have to travel long distances sometimes to reach obstetric care, and may die or lose their babies as a result (see Mills et al. (2007)). In Lesotho, lack of transportation is one of the key reasons why women with HIV/AIDS failed to visit health facilities often enough to seek treatment. Thus, lack of access to transport infrastructure not only constrains time available for market-related activities but may also have direct adverse implications for women's health—and thus their productivity and earning potential.

2. Water and Sanitation

Women in low-income countries allocate a significant amount of time to collecting water for household use (see Isha (2007) for an overview). In Pakistan, women allocate an average of 27 hours per month—or approximately 15 percent of their monthly work time—to this activity (see Ilahi and Grimard (2000)). In Madagascar and Benin, women spend 164 hours per year and 273 hours per year, respectively, collecting water; this corresponds to 14 and 23 hours a month, or 8.8 percent and 14.4 percent, respectively, of monthly working time (see Blackden and Wodon (2006)). In Kenya, as documented by d'Adda et al. (2009), women devote 3.8 hours a week collecting water (compared to 1.3 for men), or equivalently 15.2 hours a month (compared to 5.2 hours a month for men). In Guinea, lack of access to water also imposes a very high time cost on women (see Bardasi and Wodon (2009)). At a more general level, the WHO estimates that 40 billion “woman-hours” are spent carrying water in Africa annually (see Temin and Levine (2009)).

Lack of access to water and sanitation (combined with poor access to transportation services) may also have an adverse indirect effect on education outcomes for girls—especially in rural areas. Studies have indeed found that when sanitation facilities are lacking, dropout rates for girls tend to be higher.

3. Electricity

A number of studies have shown that lack of access to electricity—or, more generally, an efficient and clean source of energy—acts as a significant constraint on women's time, by forcing them to rely on fossil fuels and to devote less time to income-generating activities, rearing children and furthering their education, and accessing health care for themselves and their children. For instance, Ilahi (2001) found that women living in rural Peru who rely on firewood or coal as a source of energy tend to allocate a smaller proportion of their time to self-employment activities and a greater proportion of time to housework, compared to women who use gas or electricity. In Kenya, as documented by d'Adda et al. (2009), women devote 2.7 hours a week collecting firewood (compared to 0.3 for men), in addition to the almost 4 hours a week that they spend collecting water.

Lack of access to electricity may also hamper women's ability to take care of their own health and the health of their children, both directly and indirectly.⁷ Infants' and children's health may also be adversely affected because of greater exposure to indoor air pollution produced by the burning of fossil fuels, or greater exposure to bacteria and parasites due to lack of refrigeration of food and the inability to boil water. Indirectly, poor access to electricity may affect child health outcomes by limiting the amount of time that women can devote to market work—thereby constraining (as noted earlier) their ability to generate income and spend on basic necessities.

To the extent that it leads to more intensive use of wood charcoal, and thus to environmental degradation, lack of access to electricity may contribute to a larger work burden for children. In turn, children who spend more hours on resource collection work are less likely to go to school; this is particularly so for girls. This means that environmental degradation affects children's school performance, but the impact on girls may be much more

⁷Wang (2003) found that access to electricity had the greatest impact on decreasing infant mortality in poor countries compared to other significant variables, namely income, access to water and sanitation, vaccination in the first year of life, and the share of health expenditures to GDP. Similarly, access to electricity explained 64 percent of the variation in mortality among children under five.

damaging. It has been argued that this may partly explain the increased gender gap in education in Malawi (Nankhuni and Findeis (2003)).

The evidence reviewed in the previous subsections has important analytical implications for understanding and modeling the links between infrastructure, gender, and growth. When women lack access to core infrastructure services, they must allocate a greater proportion of their time to household chores. The opportunity costs of poor infrastructure for women include wage labor, acquiring an education, and investing in their own health and the health of their children. Thus, to a significant extent, the gender gap in employment and wages in adulthood may result from women's lack of access to infrastructure—a possible source of gender bias at home as well, if girls are kept away from school to perform household chores.

By implication, improved access to core infrastructure services may enable women to devote more time to market activity for instance, possibly reducing the gender gap and promoting growth. Improved market activity, by raising family income, may induce higher spending on boys and girls alike and improve their health status and productivity in adulthood.⁸ At the same time, it may lead to improved learning monitoring (in the case of electricity, for instance) as well as improved child care practices (including breast feeding), which may strengthen the health status of children and their ability to learn.⁹ Greater access to

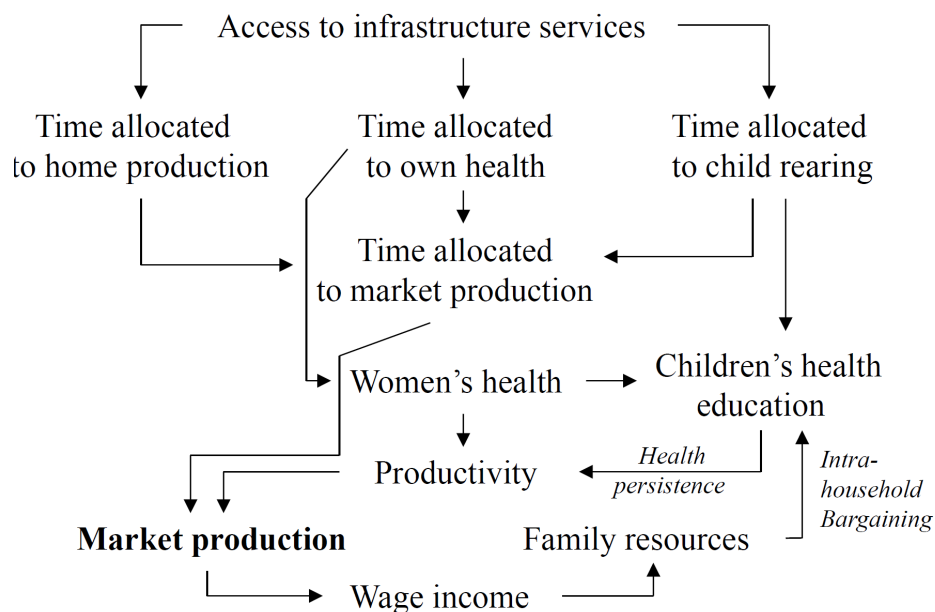
⁸Some evidence suggests that women's market activity may have an adverse effect on food supply (domestically produced) and thus on children's health status; see for instance Arndt et al. (2011) for Mozambique. This could mitigate (although not eliminate) the benefit of such activity on children's health.

⁹In developed countries, a number of studies have focused on how greater access to consumer durables (made possible by improved technologies and access to electricity) helped to "liberate" women from domestic production activities and led to dramatic increases in married female labor force participation rates. Studies for the United States include Greenwood and Seshadri (2005), Greenwood et al. (2005), and Coen-Pirani et al. (2010). Cavalcanti and Tavares (2008) provide a cross-country analysis. Coen-Pirani et al., in particular, estimated the effect of household appliance ownership on the labor force participation rate of married women using micro-level data from the 1960 and 1970 US Censuses. The results showed that the diffusion of household appliances contributed significantly to the increase in that rate during the 1960s. It may also be an explanatory factor for the subsequent increase—today, 80 percent of college-educated women are in the labor force, compared to 62 percent in 1963; as of July 2010, women accounted for almost 47 percent of the work force and 51 percent of professional workers. However, the spread of contraception methods may have played an equally (if not more) important role in that process, by allowing women to postpone marriage and child bearing and increasing their incentives to invest time in the acquisition of advanced skills.

safe water and sanitation in schools may also raise attendance rates for girls, in addition to reducing the time that they may be forced to allocated to family tasks.

The time saving associated with improved access to infrastructure may also induce women to devote more time to their own health (thereby increasing their productivity) and to child rearing, as illustrated in Figure 5. The latter is particularly important given the widely document facts (illustrated as well in the figure) that children’s health depends on their mother’s health, and that health in childhood is an important determinant of health in adulthood. Thus, there is both *intergenerational* and *intragenerational* transmission of health.¹⁰ From that perspective, women’s time allocation plays a crucial role in determining health outcomes, productivity and wages in adulthood, and the overall growth process.

Figure 5
Infrastructure and Women’s Time Allocation: Transmission Channels



However, it is possible that the increase in time that women devote to market work come at the expense of time allocated to child care; if so, and given health persistence, the

¹⁰See Agénor (2012b, Chapter 3) and Agénor, Canuto, and Pereira da Silva (2012) for a review of the evidence on the transmission of health within and across generations.

longer-run effects on growth associated with improved access to infrastructure could be mitigated, or possibly reversed—despite the fact that higher earnings may allow mothers to spend more on goods and medical supplies for their children (see Agénor, Canuto, and Pereira da Silva (2012)). The issue is therefore a largely empirical question; to address it, it is important to use models that are detailed enough to quantify carefully how access to infrastructure affects, both directly and indirectly, the time women allocate to various potential activities and how, in turn, changes in women's time allocation affect economic growth and human development. The next section presents such a model.

III. AN ANALYTICAL FRAMEWORK

While many studies have examined the relationship between gender, growth, and development, there have been few attempts to rigorously model the impact of access to infrastructure in this context. In line with the foregoing discussion, this section describes a gender-based overlapping generations (OLG) model of economic growth with infrastructure that accounts for women's time allocation between market work, home production, and child rearing.¹¹ Unlike some recent contributions, the model is rich enough to provide, once quantified, a serious starting point for policy analysis.

1. Model Description

The starting point of the model is an economy where two goods are produced, a marketed commodity and a home good, and individuals live for (at most) three periods: childhood, adulthood (or middle age) and retirement. The marketed commodity can be either consumed in the period it is produced or stored to yield capital at the beginning of the following period. Each individual is either male or female, and is endowed with one unit of time in childhood and adulthood, and zero units in old age. In addition to individuals, the economy is populated by firms and a government. The structure of the model can conveniently be described by decomposing it into the following blocks: families; home

production; market production; human capital accumulation; health status and productivity; government activity; and women's bargaining power.

1.1 Families

Families consist each of two parents (one male, one female) and children. Schooling in childhood is mandatory and a full time activity, so children devote all their time to education.¹² They depend on their parents for consumption and any spending associated with schooling and health care. All individuals, males and females, work in middle age; the only source of income is therefore wages in the second period of life. Savings can be held only in the form of physical capital. In adulthood, individuals match randomly into couples with someone of the opposite sex to form a family. Fathers and mothers have different preferences in terms of consumption in adulthood and the health of children; husbands have a relatively higher preference for current consumption, whereas wives have a higher preference for children's health. However, despite these differences, all income is pooled and couples therefore are joint decision makers. Importantly, the family-wide preference parameters for consumption and children's health depend on women's bargaining power, whose determination is discussed later.

Once married, individuals do not divorce; couples retire together (if they survive to old age) and die together.¹³ Boys and girls have the same innate abilities and thus the same intrinsic capacity to acquire human capital. The cost of rearing children involves the cost of schooling and the cost of keeping them healthy. In turn, these costs involve both parental time and spending on marketed commodities (school supplies, medicines, etc.). As a result of

¹¹The model is described in detail in Agénor (2012a). See Agénor, Canuto, and Pereira da Silva (2012) for a brief review of the literature on gender-based OLG growth models.

¹²The model therefore abstracts from child labor. As long as total time available in childhood is fixed, and that children must spend a given fraction of it in school, accounting explicitly for the fact that children (especially girls) are involved in household chores does not make any qualitative difference to the analysis. However, accounting for child labor would matter if the time that girls spent in household chores can be reduced by improved access to infrastructure, because it would affect their ability to attend school, build human capital, and increase their productivity in adulthood.

¹³This assumption, which was dubbed the "sorrow" argument in Agénor and Agénor (2014), has some basis in reality: spouses often die within a few years of each other. This is clinically known as stress

biological differences—women are the ones who actually bear children and are capable of breast feeding—or social norms, mothers incur the whole time cost involved in rearing children. Thus, women “specialize” in that activity within the family. For simplicity, male spouses are not involved at all in child rearing and allocate inelastically all their time to market work. By contrast, female spouses must consider three alternatives: market work, raising children, and home production (which includes time spent collecting water and firewood, for instance).¹⁴ At a formal level, women choose only time devoted to child rearing and time allocated to home production; the overall time constraint that they face implies that time allocated to market activity is determined residually.

At the beginning of adulthood all men and women are randomly matched into married couples. Each couple produces n children. Parents raising a child face two types of costs. First, the child's mother must spend time with each of them, because she provides tutoring or and takes care of the child's health (going to the hospital for checkups and vaccination, etc.). Second, raising children involves costs in terms of marketed commodities, measured in terms of a fraction of the family's net income. This cost is related to sending children to school and educating them at home (which involves buying school supplies, etc.), and to taking care of their health needs (buying medicines). Thus, although access *per se* to schooling and health services is free, families face a cost in terms of foregone wage income and foregone consumption.

Finally, at the beginning of the first period of life and the end of the second, there is a non-zero probability of dying. Survival rates from childhood to adulthood, as well as from adulthood to old age, are treated as distinct. Although the survival probabilities for boys and girls are the same in childhood, in adulthood the survival probability of women is higher than that of men, as suggested by the evidence.

cardiomyopathy. At a more technical level, it simplifies matters considerably by allowing the gender composition of the population to remain constant at all times.

¹⁴The model does not account for leisure, on the count that (consistent with the evidence) women actually enjoy little very little of it in poor countries. Agénor and Alpaslan (2013) extent the analysis to consider girls' time allocation and study is implications for child labor, whereas Agénor and Canuto (2013) endogenize women's time allocated to human capital accumulation. In both studies, women's bargaining power ends up being also a function of access to infrastructure.

1.2 Home Production

Home production (which includes cooking dinner, doing laundry, cleaning the house, etc.) affects positively the family's utility and involves combining women's time allocated to that activity with (congested) infrastructure services. For simplicity, these factors are assumed to be perfect substitutes and production is subject to decreasing returns to scale.

1.3 Market Production

Market production of the nonstorable commodity requires using private capital, male effective labor (obtained by multiplying male productivity by the number of male adult workers and male human capital, given that all male time is allocated to work), female effective labor (obtained by multiplying female productivity by the number of female adult workers, female human capital, and the amount of time women allocate to market work), and public infrastructure. Although infrastructure is nonexcludable, it is partially rival because of congestion effects. For tractability, congestion is taken to be proportional to the aggregate private capital stock; for instance, the higher the number of trucks used by the private sector to deliver goods, the more likely it is that the benefits of roads get eroded due to traffic jams.¹⁵ The “gender gap” (or direct discrimination) in the workplace is captured by assuming that women only earn a fraction of their marginal product. The smaller that fraction, the larger is the effective wage differential between men and women.¹⁶

1.4 Human Capital Accumulation

As noted earlier, schooling is mandatory so children allocate all of their time to education. Boys and girls have identical innate abilities and have access to the same “out of home” learning technology. In addition to children's time, the production of either type of

¹⁵In the present context, a public good is excludable if a firm can prevent other firms from using it concomitantly, and it is rival if the use of it by one firm reduces availability of the good for use by other firms.

¹⁶The gender bias parameter is kept exogenous. This is consistent with the evidence reported in Nopo et al. (2011), which shows that much of the earnings gaps between males and females are not explained. In addition, this assumption also allows us to perform simulation experiments in which gender bias is reduced.

human capital requires several other inputs. First, it depends on the time that mothers allocate to tutoring their children at home. A sequential process is considered, whereby mothers determine first the total amount of time allocated to child rearing, and then subdivide that time into a fraction $0 < \alpha < 1$ allocated to sons and the rest, $1 - \alpha$, allocated to daughters. A bias in parental preferences toward boys can therefore be captured in a simple manner by assuming that the fraction of time allocated to them, α , exceeds 0.5. At it turns out, this parameter also plays a critical role in the determination of women's bargaining power.

Second, the production of human capital depends on the stock of public infrastructure, taking into account a congestion effect measured again by the (aggregate) private capital stock. This variable captures the importance of infrastructure for education outcomes.¹⁷ Third, knowledge accumulation depends on average government spending on education per (surviving) child. Finally, in line with the empirical evidence (see Blackden et al. (2006)), human capital accumulation depends on a mother's human capital. Because individuals are identical within a generation, a mother's human capital at any given period is equal to the average human capital of the previous generation. Assuming that the human capital technology exhibits constant returns to scale in government spending and the average human capital of mothers, the model implies that the male-female human capital ratio depends positively on the ratio $\alpha/(1 - \alpha)$, the relative time allocated by mothers to boys. Thus, if $\alpha > 0.5$, a boy's human capital will exceed systematically a girl's human capital—as a result solely of the greater time allocated by mothers to rearing their sons. Put differently, differences in lifetime achievements between men and women may be fundamentally related to gender bias experienced in the home in childhood.

1.5 Health Status and Productivity

Health status in childhood is assumed to depend on the mother's health, on the effective amount of time allocated by the child's mother to child rearing, and the provision of

¹⁷See Agénor (2012*b*, Chapter 2). Although the link between infrastructure and education is not in general gender specific, it may have gender effects. As noted earlier, access to water and sanitation in schools has been shown in some countries to have a particularly large effect on girls' attendance rates.

(congested) health services by the government. Health status of both males and females in adulthood is determined by health status in childhood and by the relative level of women's human capital. The first effect is consistent with the evidence (mentioned earlier) suggesting that early childhood health affects cognitive and physical development, which in turn has a large impact on health outcomes later in life. The second effect captures the fact that when women are relatively more educated, it benefits not only their own health (presumably because they are more aware of the health risks that they face) but also the health of their husbands (possibly by increasing awareness in the family about health risks, improving the diet of all members of the household, and so on). In addition, if more educated women are healthier, they also end up taking better care of their children. Put differently, when women are relatively more educated—at least up to a certain point—they help to mitigate the nutritional risks that their husbands and children face.¹⁸ In line with the empirical evidence, there are therefore important health externalities associated with women's education—which themselves depend on mothers' time allocation between their sons and daughters. As it turns out, the magnitude of these externalities plays an important role in some of the gender-based experiments reported later. Finally, adult productivity is positively related to health status, with decreasing marginal returns. The solution of the model shows that if $\alpha > 0.5$, a boy's health in childhood, and productivity in adulthood, will exceed systematically a girl's health and productivity in midlife, again solely as a consequence of bias toward boys in mothers' time allocation.

1.6 Government

The government invests in infrastructure and spends on education, health, and some unproductive (or, rather, not directly productive) items. Shares of spending are all taken to be constant fractions of government revenues. These revenues, in turn, consist only of taxes on the wage income of adults, both males and females. All public services are provided free of charge to firms and families. The government cannot borrow and therefore must run a balanced budget in each period.

¹⁸See Agénor (2012*b*, Chapter 5) for a review of the evidence.

The government also produces health services by combining public capital in infrastructure and the flow of spending on health. Thus, access to infrastructure is essential to the production of health services.¹⁹ With full depreciation for simplicity, the stock of public capital in infrastructure at the beginning of any period is simply equal to the flow of investment in the previous period. However, investment in infrastructure, as well as spending on health and education, are all inefficient—only a fraction of these flows is actually converted into public capital (in the first case) and effectively serves (in the second and third cases) to enhance the production of health and education services.²⁰

1.7 Bargaining Power

An important feature of the model is the bargaining power of women, which is assumed to evolve as a function of the relative levels of human capital of husband and wife.²¹ The model implies that in equilibrium women's bargaining power depends fundamentally on a key structural parameter: the allocation of mothers' time to their sons and daughters, as measured by α . The stronger the bias toward boys in childhood (the higher α is), the lower the human capital women eventually accumulate, and the weaker their bargaining position later in life. In that sense, inequality in the family (the consequence of social norms) leads to inequality in the work place. The model also implies that, consistent with the evidence, a higher level of women's bargaining power translates into a higher savings rate for the family and more resources devoted to child rearing.^{22, 23}

¹⁹See Agénor (2012*b*, Chapter 3). For instance, access to electricity is essential for hospitals to function, whereas roads allow qualified medical personnel to travel back and forth between urban and rural areas.

²⁰In the actual model, the production of public capital in infrastructure requires combining the flow spending on infrastructure and the existing stock of public capital. We abstract from this complication here.

²¹Other measures that have been suggested in the literature as determinants of bargaining power include the male-female ratio of earned incomes, the share of assets that they hold within the household or patterns of decision-making within the household (as revealed by surveys), and women's access to financial services. However, it can be argued that (at least) some of these measures are likely to be highly correlated with relative educational outcomes.

²²As documented by Morrison et al. (2007), Doss (2011), and World Bank (2011), studies consistently show that when mothers' control over a family's resources increases, households allocate more of these resources to children's health and education.

²³Note also that, as indicated earlier, government spending shares are assumed to be fixed fractions of tax revenues; it is possible that these shares could also be a function of women's bargaining power, in the sense

Women's bargaining power plays a significant role in the model. The reason is that, as noted earlier, men and women have different preferences in terms of current consumption and preference for children's health: men value consumption in adulthood more, whereas women value children's health more. Because the family-wide preference parameters in both cases (given the joint optimization process) depend on the bargaining power parameter, a change in that parameter changes the (weighted) averages as well. In particular, an increase in women's bargaining power lowers preference for current consumption (which promotes savings) and increases the relative preference of the family for children's health. In addition, the average survival probability also tends to increase, which also promotes savings.²⁴

Finally, the model is closed by imposing an asset-market clearing condition, which requires tomorrow's private capital stock to be equal to today's savings by adults currently alive. For simplicity, and in parallel with the assumption about public capital, private capital is assumed to depreciate fully within a period.

2. Women's Time Allocation and Long-Run Growth

As shown in Agénor (2012a), the solution of the family's optimization problem yields equilibrium values for women's time allocation and the total fertility rate. A key relationship is the inverse link between time allocated to home production and access to public capital; it implies that both time allocated to market work and time allocated to child rearing (which are both productive in this setting) are positively related to greater access to infrastructure.

The solution of the complete model (accounting for human and physical capital accumulation, both public and private) leads to an explicit expression for the economy's long-

that an increase in that parameter could lead, through women's role in the political process, to more spending allocated to education and health. However, there is scant evidence of this effect.

²⁴Note that if it had been assumed that women's bargaining power depends on relative wages, rather than relative stocks of human capital, it would be a function of the parameter that measures gender bias at work; thus, gender bias in the workplace would translate into gender bias in the family—and vice versa, given that it would affect women's time allocation and eventually the health, productivity, and wages of daughters and sons. This two-way causality may be important in some countries.

run growth rate, which depends on the long-run value of the public-private capital ratio and the health status of adult females, as well as women's time allocation parameters. Both the male-female health status ratio, and the male-female human capital ratio are constant and depend positively on the family bias parameter, α .

It is worth stressing that in the model presented earlier, the subutility functions were both assumed to have a log-linear form. This simplifies significantly the analysis—by leading to a savings function that depends linearly on wages only, and by allowing an explicit derivation of the economy's long-run growth rate. This is a critical step for policy analysis, as discussed later. In addition, it implies that wages do not matter in fertility and women's labor allocation decisions.²⁵

However, in general higher wages induce two opposite effects: a positive income effect, which raises both consumption and leisure (and thus reduces women's time allocated to market work), and a substitution effect, which stems from the increase in the opportunity cost of leisure (and therefore raises women's time allocated to market work).²⁶ These two effects exactly offset each other with logarithmic utility. By contrast, with a more general utility function, an increase in the wage rate or the interest rate would have ambiguous effects on women's time allocated to market work.²⁷ This ambiguity may explain why microeconomic studies of women's labor supply response to changes in access to infrastructure have often found conflicting results. For instance, Dinkelman (2011) found that women's time allocated to market work increases in response to improved access to electricity. By contrast, Koolwal and van de Walle (2010), in a study of eight countries, found that improved access to safe water increases women's leisure and raises school enrollment rates—possibly through more

²⁵By implication, the parameter measuring gender bias in the workplace has no effect either on women's labor supply to the market.

²⁶Recall that in the model men allocate all their time to market work; so we abstract in this discussion from the labor supply effects of changes in wages and focus instead on women's response.

²⁷As can be inferred from the results in Boucekkine et al. (2009) in particular, if the intertemporal elasticity of consumption is less than unity, an increase in the market wage would unambiguously raise women's labor force participation rate.

time allocated by mothers to their children, a productive activity in the present setting—rather than off-farm labor market participation for women.²⁸

The fact that a change in the market wage has an ambiguous effect on women's market work with more general utility preferences is potentially important. The reason is that the stock of public capital, through its effect on the marginal productivity of labor, has a positive effect on wages. So when that stock increases, there are now two effects on women's labor supplied to the market: a direct (negative) effect on time allocated to home production, as identified earlier, and an indirect effect through an increase in wages. If the effect on labor supply associated with a change in wages is positive (because the substitution effect dominates the income effect), then the reallocation of time toward market work associated with the reduction in time spent in home production is magnified. But if it is negative, the net, general equilibrium impact on women's time allocated to market work (accounting for both direct and indirect effects) may be negligible or even negative. However, the income effect would have to be fairly large relative to the substitution effect and the direct time reallocation effect combined, for this outcome to prevail. There is no strong empirical evidence to suggest that this is actually the case for women in poor countries.

Note also that the impact on women's labor supply may depend on the *type* of infrastructure that they have access to. In addition, indivisibility in labor supply decisions, and the lack of market employment opportunities for women (as argued by Bhalotra and Umana-Aponte (2010)) may explain a muted response. In particular, if labor supply decisions are indivisible (or equivalently, part-time work is not feasible), changes in the amount of time saved as a result of greater access to infrastructure would need to be very large to have a detectable impact on labor supplied to the market. These effects are important to keep in mind when evaluating the results of policy experiments.

²⁸ Another explanation for the improved schooling outcomes, as noted by Koolwal and van de Walle (2010), may be related to the fact that water collection was the main responsibility of children. This is

IV. ILLUSTRATIVE CALIBRATION

To illustrate possible outcomes, and examine the impact of public policy, the model is calibrated for a low-income country, Benin. Calibration uses five sources of information. The first source is information gleaned from the literature on applied OLG models. For instance, the rate of discount (on an annual basis) is set at a conventional level of 0.04. The second source is information based on various econometric or quantitative studies for developing countries, which provide evidence on production elasticities and spending efficiency parameters. For instance, the elasticity of marketed output with respect to private capital is set at 0.35, whereas the elasticity with respect to public capital is set at 0.15; both are conventional estimated values for developing countries (see Agénor (2012a)). Dabla-Norris et al. (2012, Table 1) provide an estimate of the efficiency parameter for public investment in Benin, which is of the order of 0.39, on a scale of 0 to 1.²⁹ Thus, according to this estimate, in Benin more than 60 percent of public investment on infrastructure is “wasted,” in the sense that it does not turn into public capital. In the absence of data specific to the education and health sectors in Benin, the efficiency parameters for spending on education and health are set at the same value.

The third source of information is based *directly* on country data, which include a variety of sources—the World Development Indicators (WDI) database of the World Bank, reports by the International Monetary Fund (IMF), and documents published by the United Nations (UN). For instance, from UN data, the fertility rate is taken to be 5.0. Survival probabilities are calibrated as follows. According to UN data, in 2009 life expectancy at birth in Benin was 56.7 years on average, with 55.6 years for men and 57.8 years for women. This gives an annual death rate of $1/55.6 = 0.018$ for men and $1/57.8 = 0.017$ for women. The survival probabilities (or, equivalently here, survival rates) can thus be estimated as $1 - 0.018 = 0.982$ for men and $1 - 0.017 = 0.983$ for women. The survival rate for children is calculated in a similar manner, using also UN data; it is estimated by taking one minus the under-five mortality rate (defined as the number of deaths of children under five per 1,000 live births),

tantamount to child labor, which is not considered explicitly in the model.

which is about 146/1000 for Benin according to UN data. Thus, the child survival rate is equal to $1 - 0.146 = 0.854$.

The effective tax rate on output (the main source of government revenue in the model) is set at 16.3 percent, which corresponds to the average ratio of tax revenues to GDP given in WDI for Benin during the years 2004-07. The share of government spending on health is based on the average estimate from WDI for the period 2004-07 and is set at 0.12. The share of government spending on education is based on the average estimate from WDI for the years 2004, 2006, and 2007 and is set at 0.17. The share of government investment on infrastructure is set at 0.05, based on unpublished World Bank data. These numbers imply from the budget constraint that the share of spending on other items is 0.66.

The fourth source of information is based *indirectly* on country data, that is, parameters that are obtained by transforming raw data available directly. For instance, the bargaining power of women is set at 0.34. This corresponds to the relative literacy rate of adult females (ages 15 and above) for Benin in 2008, as given in WDI, divided by the sum of literacy rates for males and females, that is, $28.1/(28.1+53.5)$. The idea is that this ratio provides a good proxy for the relative human capital of women, and that this corresponds to the main determinant of bargaining power, as hypothesized in the model.

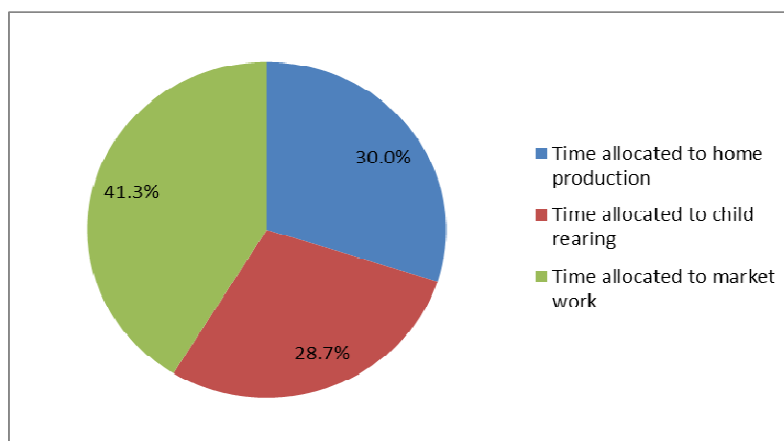
Based on the information collected from all these previous sources, a final set of parameters is derived by induction, to ensure that all the formulas (and composite parameters) in the model hold as they appear in the reduced-form expressions for women's time allocation, female health status, the public-private capital ratio, and the long-run growth rate of the economy. This set consists mainly of underlying preference parameters (for both males and females) which are typically unobservable. For instance, the private savings for Benin is estimated on the basis of the preliminary data for 2009 for "Nongovernment saving", published by the IMF (2011, Table 1). Combining that piece of information with the estimated survival probabilities given earlier, the family's preference parameter for current

²⁹Dabla-Norris et al. (2012) define their metric on a range of 1 to 4, with a value of 1.56 for Benin; this value was simply divided by 4 to obtain an indicator bounded by unity.

consumption is derived residually from the formula provided by the model for the savings rate; and given the value of the bargaining parameter derived earlier, individual parameters for males and females are derived. These estimates are such that, as discussed in the previous section, the preference parameter for males is higher than the parameter for females.³⁰ A similar procedure is used to estimate male and female parameters for children's health.

The result of the calibration exercise shows, for instance, that in the benchmark case the initial public-private capital ratio is 0.28 and that women allocate 30 percent of their time to home production, 28.7 percent to child rearing (in total, that is, as given by the gross number of children, 5.0, multiplied by the childhood survival rate, 0.854, and by the time allocated to each of them, 0.067), and 41.3 percent to market work (see Figure 6). These numbers show that an index of “anti market” bias in women's time allocation, given by the ratio of time allocated to market work relative to time allocated to other tasks, $41.3/(30+28.7)$, is 0.7, which is quite high compared to a “neutral” value of 0.5.

Figure 6
Benchmark Calibration: Women's Time Allocation



³⁰ At the same time, however, some parameters remain hard to pin down; in such conditions the strategy is to choose low values to begin with, and then to perform sensitivity analysis.

V. POLICY EXPERIMENT: HIGHER INVESTMENT IN INFRASTRUCTURE

To illustrate the gender and growth effects of infrastructure in the model, we consider a policy aimed at promoting women's access to infrastructure.³¹ What we have in mind is an investment program aimed at investing in areas (such as rural roads, power grids, etc.) that may have a direct impact on women's ability to reallocate their time away from household chores.³² This can be captured by considering an increase in the share of investment in infrastructure, which is initially 0.05, to 0.08. We assume here that the increase in investment in infrastructure is budget neutral, that is, it is offset by a change in another component of spending, in such a way to leave total tax revenues constant on impact.

Consider first the case where the increase in investment is financed by a cut in unproductive spending. The immediate effect of the shock is of course an increase in the public-private capital ratio, which rises from an initial value of 0.28 to 0.44 and promotes growth directly, by increasing the productivity of private inputs. In addition, an increase in the share of government spending on infrastructure lowers women's time allocated to home production. The drop in home production time is associated with an increase in time allocated to market work and time spent on child rearing—with the latter leading to better children's health and, later in life, improved health in adulthood.³³ In addition, the increase in the public-private capital ratio raises the government's ability to supply health services and the efficiency of time that mothers allocate to child rearing. Thus, all of these effects also help to promote growth per worker and health outcomes.

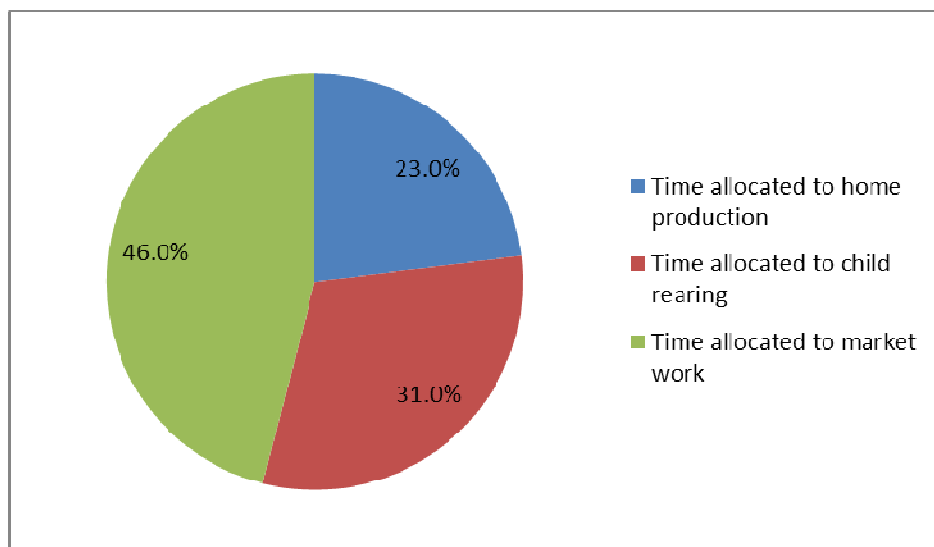
³¹Although our focus in this paper is on the impact of infrastructure on women's time allocation and growth, the model described in the previous section can be used to analyse a great variety of public policies, both "general" (changes in spending on education and health, improvements in the quality of public expenditure, taxation, etc.) and gender specific (changes in the cost of child rearing, increase in women's bargaining power, etc.). Agénor (2012a) discusses several of these experiments.

³²The model does not allow an explicit distinction between infrastructure-related spending that is "time-saving" specifically for women, and other types of infrastructure. Some of the latter type of spending may not lead to an increase in the "public" capital stock *per se*, but rather to a buildup of private assets (for instance, solar-powered cookers). Accounting for these assets and their implications for time allocation and growth would be a useful extension of the framework presented here.

³³The increase in child rearing time is consistent with the results of Koolwal and Van de Walle (2010) on the impact of greater access to water infrastructure on women's time allocation.

Overall, after accounting for both the direct and indirect effects of infrastructure, the growth rate of output of marketed goods increases by about 0.8 percentage points, at an annual rate. Time allocated by women to home production drops from a share of 0.3 initially to about 0.23, whereas time that they spend in market work increases from 0.41 to 0.46. At the same time, total time spent in child rearing increases from 0.287 to 0.316; this largely reflects the fact that individual time spent on each child rises from 0.067 to 0.074, given that the policy does not have a noticeable effect on the fertility rate (see Figure 7).³⁴

Figure 7
Increase in Share of Spending on Infrastructure: Women's Time Allocation



Consider now the case where the increase in investment in infrastructure is financed by a cut in another *productive* component of government spending, say, the case where the increase in the share of investment from 0.05 to 0.08 is matched by a drop in spending on education, whose share therefore falls from 0.17 to 0.14. This case involves consequently a trade-off between components of public expenditure. Indeed, although the transmission effects highlighted above continue to operate, they tend to be mitigated because the reduction in spending on education lowers the rate of human capital accumulation—which tends in turn

³⁴In this experiment, the implicit assumption is that labor supply decisions are divisible, or equivalently that part-time work is feasible. Otherwise, changes in women's time allocation would be either negligible (as noted earlier) or subject to thresholds.

to slow growth in the long run. The numerical results indicate that the increase in the annual growth rate is now only 0.3 percentage points, compared to 0.8 previously. Qualitatively similar results would obtain by considering an offsetting decrease in the share of spending on health services.

V. SUMMARY AND POLICY IMPLICATIONS

The purpose of this paper has been to study the effects of externalities associated with health transmission and women's lack of access to infrastructure on economic growth. The first part provided a review of the evidence on these issues. The second part presented a computable overlapping generations (OLG) model of endogenous growth that captures these interactions—as well as inter- and intra-generational health externalities—and characterized its properties, namely, the determination of the equilibrium time allocation for women, the equilibrium public-private capital ratio, and the long-run growth rate of the economy. The model was then calibrated and used to analyze quantitatively the impact of a policy aimed at improving access to infrastructure on women's time allocation. It was shown that such a policy (especially when increases in infrastructure investment are financed by a cut in unproductive spending) can have sizable benefits in terms of growth and health outcomes. In a nutshell, our framework provides an important tool for studying the gender dimension of growth-promoting policies and how gender interacts with other variables in the growth process.

Our analysis suggests several broader lessons for promoting the role of women in the growth process. First, the empirical evidence on women's time allocation shows clearly that women bear the brunt of domestic tasks—processing food crops, providing water and firewood, and caring for children, etc. While social, religious and institutional factors are important, economic and structural constraints—especially lack of access to core infrastructure services in rural areas—play a significant role as well in explaining these patterns. Growth-promoting supply-side policies may not yield desirable effects, independently of other constraints (such as gender bias in credit markets), if women are

unable to reallocate their time to new activities because of poor access to infrastructure. Alleviating infrastructure-related constraints and providing time-burden-reducing public goods may thus be essential to reduce the share of time that women devote to domestic tasks and promote their participation in the labor force. From that perspective, providing better access to roads may be as important as improving access to local community facilities (e.g. wells, nurseries, sanitation provision, etc.).

Second, giving greater priority in development programs to access to water supply and sanitation (e.g., standpipes in poor countries), energy for household needs, access to appropriate means of transport, can all contribute to improving women's health as well; and to the extent that improved health lead to higher life expectancy and a reduction in the rate of time preference, it may promote investment in education, which in turn may increase wages and savings and induce a reallocation of family resources toward children—all of which contributing to higher growth.

Finally, health is an important mechanism through which intergenerational transmission of poverty takes place—children born into poorer families experience poorer health in childhood, lower investments in human capital and poorer health in early adulthood, all of which tend to be associated with lower earnings in middle age. Although policies aimed at promoting increased access to infrastructure have important benefits for women (in addition to other positive effects on growth), it is important to ensure that the reallocation of mothers' time toward market work is not to the detriment of the health of their children—by leading to a drop in time devoted to child rearing, with persistent effects in their adult life.³⁵ Thus, macroeconomic policies may need to be complemented by *microeconomic* measures aimed, in particular, at making it easier for mothers to provide adequate care to their children.³⁶ A possible route to explore in this context is to consider using instruments that

³⁵Floro (1995) was one of the first to draw attention to the possibility that women's time reallocated to market work may be detrimental to children, and possibly to economic growth. Agénor, Canuto, and Pereira da Silva (2012) consider formally a case where improved access to infrastructure, by reducing transportation costs, may lead to a reduction in time allocated to child rearing.

³⁶Moreover, the fact that time allocated by mothers to child rearing is productive as a result of health persistence means that one should be cautious in using concepts such as "time poverty" (see Blackden and Wodon (2006)). For instance, if we were to introduce intergenerational transfers in our formal analysis, it could

create pecuniary incentives for mothers to increase the quantity and quality of time devoted to child rearing. For instance, refining further conditional cash transfer programs (CCTs) such as *Oportunidades* or *Bolsa Familia* in Latin America could provide incentives, conditional on health outcomes, without necessarily inducing mothers to divert time too hastily toward market activity (Fiszbein and Schady (2009)). An additional well-designed and targeted payment for such services, while controlling for the quality of health outcomes for children among beneficiaries, would be worth exploring.

well be that allocating more time to child rearing today is an optimal strategy for a family because it raises the earning ability of children when they become adults—and thereby future transfers to parents in old age.

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