Liberian Women Count: Evidence from a Macrosimulation of the Gender Dividend

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Abstract

Liberian women make significant economic contributions yet continue to remain marginalized in their homes and communities and are excluded from the same opportunities as men. In this study, we develop a macrosimulation model of the Gender Dividend that estimates the economic contributions of women and the societal costs incurred by excluding them from reaching their productive potential. Using data from Liberia, we first estimate the economic contributions that women make, including contributions that are made from non-tradeable sources of production such as housework and domestic chores. We then predict the potential economic contributions that women would be able to make if there were equality of opportunity and capability by gender (a closure of gender gaps) across a range of inputs to economic growth and productivity, including educational attainment, labor force participation, and wages. Our results indicate that 39 percent of economic activity in Liberia, measured by the aggregate output of labor, can be attributed to women. This proportion increases to 50.2 percent if gender gaps across the factor inputs were closed and 53 percent if we include contributions from non-tradeable production. The findings indicate that maximizing the potential of women would increase Liberia's GDP by 10-25 percent, yielding significant gains to economic growth and development.

1 Introduction

Women are the bedrock of the economy and of society in Liberia. As of 2016, women comprise 50 percent of the Liberian labor force (Johanssen da Silva, 2021), supplying 76 percent of labor for cash crop production and 93 percent of the labor for food crop production (GoL 2009). About 80 percent of women own small enterprises, compared to 57 percent of men (Johanssen da Silva, 2021). In addition, women in Liberia are responsible for overseeing household activities, particularly in rural communities where women enhance household food security and are responsible for caregiving of children and other household members.

In spite of their contributions to economic production, women are systematically excluded from fully contributing to economic gains that in Liberia since they are concentrated into lower productivity and lower earning sectors of the labor market. Approximately 86 percent of women are employed in petty trade or in the agriculture sector, which will remain a low productivity sector until broader market reforms are implemented (Johanssen da Silva, 2021). About 94 percent of women are informally employed compared to 79 percent of men (Liberia Institute for Statistics and Geo-Information Services, 2015). Among the non-farm self-employed, 55 percent of enterprises are owned by women, though their enterprises are smaller and less well established than those of men, and less than 5 percent of women hold formal sector jobs (Johanssen da Silva, 2021). In Liberia, women earn about 14 percent less than male counterparts with similar skills and engaged in similar work.

Liberian women's economic contributions are limited by a range of disadvantages. Women lag behind men in human capital accumulation, which is marked by significant disparities in educational attainment despite recent progress in increasing girls' schooling. The median years of schooling is 3.4 years for women compared to 6.5 years for men. The threat of violence likewise impedes the movement of women for economic, educational and civic activities (Gaussman et al, forthcoming). Fertility in Liberia is relatively high at 4.2 births per woman of reproductive age, and 30 percent of Liberian women have their first child before the age of 18 (Gupta, et al 2022). Women receive less financial credit and own fewer physical assets and land. The challenges that women face to resource ownership, schooling, and better health are compounded by a weak infrastructure, restrictive social norms, and poor institutions. In spite of electing the first female Head of State in Africa, women in Liberia remain significantly restricted in terms of their relative capacity for decision-making and sociopolitical autonomy; for example, only 16 percent of women who are married or in a union make their own choices over their contraceptive use and health care (Liberia Institute of Statistics and Geo-Information Services (LISGIS), 2014), and women only hold 12 percent of national parliamentary seats in Liberia (World Bank, 2022).

Women's severe disadvantage in Liberia begs the question as to where Liberia would be in terms of development if women were to have similar political, social, and economic opportunities as men. The realization of economic potential through increased investments in women and girls has been a focal point in the concept of the "gender dividend," which emphasizes that societies could be more productive and equitable if gender gaps, particularly in the labor market, were closed. Global estimates of the gender dividend have indicated that hundreds of trillions of dollars have been lost as a result of persisting social, political, and economic gender gaps (Wodon et al., 2020).

This study intends to quantify the economic costs of excluding Liberian women from productive opportunities by estimating the benefits from closing key gender gaps. We posit that Liberian women's current contributions are under-valued in the policymaking process, and that the social, political, and institutional discrimination against women creates an economic cost not only to women individually but also to society at large. To quantify the current economic contributions of women in Liberia, we adapt the macrosimulation model developed by Canning, Karra, and Wilde (2017), hereafter referred to as CKW 2017, to construct a model of the gender dividend[1] in which we 1) estimate the economic returns to closing gender gaps, particularly in the labor market; and 2) incorporate the value of women's unpaid and domestic work into our estimate of production. We identify the potential economic contributions that women would make if there were equality of opportunity and capability by gender (i.e., a convergence or closure of gender gaps) across a range of factors that have been identified as key determinants of the gender dividend and inputs to economic growth and productivity. These factors, which include educational attainment and human capital, labor force participation, demographic factors such as fertility, wages and returns to labor, among others, are included in the model as maneuverable policy levers and inputs to economic production.

We find that Liberia's gender dividend is large: women make significant contributions to Liberia's economy and could contribute even more if gender gaps were narrowed or closed. Currently, women are responsible for 39 percent of market-based output produced annually in Liberia, equivalent to USD 1.08 billion. If the gender gaps in labor force participation as well as intra-sectoral wages and representation were closed, GDP would be 11.5 percent higher. If further reforms were to equalize education and fertility rates would be reduced to a net-reproduction rate, GDP would be 23.7 percent higher. Finally, if we account for the value of non-tradable production, GDP would equal 5.89 billion or 45.3 percent higher than today's estimates, with women being responsible for 53 percent of the labor-market output.

The rest of the paper is organized as follows. Section 2 briefly describes our model of the gender dividend and key modifications to the CKW 2017 macrosimulation framework,

[1] This differs from Wodon et al (2020) in three principle ways. First, this paper uses a macrosimulation model that takes explicitly models the interaction of gender inequalities in different domains of girls' and women's lives while Wodon et al (2020) uses a reduced form model. Second, Wodon et al (2020) estimates global impacts while this paper focuses on Liberian women. Third, this model focuses on the aggregate economic consequences of gender gaps while Wodon et al (2020) considers economic, but also human capital implications, of the gender dividend.

including: 1) the addition of the key factors for closing gender gaps; and 2) the inclusion of both non-tradable production. Section 3 presents the data sources used to calibrate the model to the Liberian context. Section 4 presents and discusses the key findings from the macrosimulations, and Section 5 concludes.

2 Conceptual Framework and Methodology

2.1 Models of the Gender Gap: A Literature Review

Over the last 30 years, advances in endogenous growth theories in economic development have increasingly considered "human" dimensions of development, with a number of studies looking beyond the exogenously determined factors of production and growth (Roemer, 1996; Lucas, 1988; Barro & Sala-i-Martin, 1995). This discourse pushed for a deeper exploration of first-order determinants of economic output and their estimation in empirical studies. As part of this process, gender was identified as a fundamental driver of growth (Löfström, 2006; Boserup, Tan, & Toulmin, 2007; Natali & Kabeer, 2013), with a number of studies highlighting the contribution of women to long-run economic growth through both direct and indirect pathways (Galor & Weil, 1996; Klasen, 1999).

A range of modelling approaches have been used to quantify the economic loss caused by structural and systemic differences between men and women. Following the seminal work of Galor and Weil (1996), an overlapping generations framework by Agénor (2012) estimated the monetary valuation of a decline in the cost of childrearing (particularly sons), a decline in gender biases in the workplace, and an increase in women's bargaining power, and in mothers' time allocated to daughters. This model finds that policy regimes that focus on an increase in public spending may contribute to women's increased productivity, women's time allocation to work, and growth, particularly if investments were made to improve infrastructure (roads, access to water and sanitation, etc.) that would positively affect women's economic contributions. A simulation approach by Cavalcanti and Tavares (2007) examined differences in output and income by varying the degree of gender-based wage discrimination with endogenous savings, fertility, and labor force participation. The authors found that a 50 percent increase in the gender wage gap led to a 35 percent decrease in income per capita, noting that up to 60 percent of the gap in output per capita between countries could be attributed to continued gender inequality. In Niger, a Computable General Equilibrium (CGE) model based on a LINKAGE model[2] was applied to estimate the economic opportunity from gender equality and to isolate the monetary impact of gender differences[3]. The study concludes that reduced gender gaps have the ability to increase GDP in 2030 by 12.6% if reduced fertility and a scenario close to universal education are applied, and by 8.9 if increased labor force participation and productivity are applied (World Bank,

[2] See van der Mensbrugghe (2011) for a complete description.

[3] In the case of Niger, costs calculated are related to earnings, population growth, under-five mortality and standing, and savings for education.

2019). With a more transparent measure, the Employment Gap Index (GEGI) constructed by Pennings (2022) translates the inequalities in employment between men and women into the potential monetary gains (in GPD-per-capita). On average across the countries studied[4], the GEGIs estimate that long-run GDP per capita would be 19% larger if gender gaps could be closed by increasing female employment to that of men. With an application of a Lucas span-of-control model of occupational choice with heterogeneous entrepreneurial endowments, Cuberes and Teignier (2016) examine the impact of inequality between men and women in entrepreneurship and labor force participation on productivity and per-capita income, noting average income losses of 15 percent due to gender gaps.

More recently, Devadas and Kim (2020) use the World Bank Long-Term Growth Model (LTGM), which is built on a Solow-Swan growth model, to estimate the effect of increasing labor force participation and education for women on GDP growth. For the indirect impact of closing gender inequality, the study uses an extension of the LTGM-TFP model in which the total factor productivity (TFP) growth rate is a function of a TFP determinant index and initial TFP level. The authors find that the GDP-per-capita loss from gender gaps amounts to 7.9 percent in low-income countries, 21.3 percent in lower-middle income countries, 12.3 percent in upper-middle income countries and 6.4 percent in high-income countries. In a similar exercise, Wodon et al. (2020) employ a comprehensive and domain-specific framework to assess the economic opportunity associated with closing the gender gap by estimating the impact of inequalities using regression analyses or statistical differences. The authors highlight the importance of closing these gaps by estimating the impacts and economic costs of gender inequality across five domains: (1) earnings; (2) educational attainment, child marriage and early childbearing; (3) fertility and population growth; (4) health, nutrition, well-being, and violence; and (5) agency, decision-making, and social capital.

2.2 Simulation Modeling: A History

Attempts to assess the effect of structural factors of economic development can be divided into three categories: aggregate (macroeconomic) statistical analyses, microeconomic studies, and simulation exercises. In this paper, we favor a simulation approach. We outline the rationale for this decision below; however, given that the literature in each of these areas is vast, our summary is, by necessity, selective.

Aggregate macroeconomic regression models have been used extensively to analyze the effect of demographic or social changes on macroeconomic outcomes. Since the early 1990s, many analyses of the effect of population on economic outcomes have followed the "growth regression" model popularized by Barro (1991) and Mankiw, Romer, and Weil

[4] The study has a full variant that differs from the basic variant, as instead of aggregate employment gaps, it uses a weighted average of employment gaps in "better employment" and "other" types of employment. According to this difference, the study uses 185 countries for the basic GEGI and 159 for the full GEGI.

(1992). In these regressions, terms representing population growth, labor force growth, or dependency ratios are included as right-hand side variables, while growth rates of levels of GDP per capita are the dependent variables of interest (see Kelley and Schmidt, 2005; Bloom and Canning, 2008; and others).

While this approach fortunately studies the correct outcome of interest, it suffers from three major drawbacks. First, these aggregate analyses fail to elucidate any mechanisms behind the aggregate change. Simply put, macro-level correlations are too broad to elucidate the complex relationship and heterogeneities behind aggregate outcomes and social and demographic factors. Second, very little of the literature taking an aggregate approach to the effects of population growth on economic outcomes has dealt adequately with the issue of identification. For example, changes in fertility – an important channel through which women's equality may affect economic outcomes – are not only themselves affected by economic outcomes directly, but are also affected by additional unobserved variables that may also have direct effects on the economy, such as education, health, institutional characteristics, and cultural factors. Given these problems of omitted variables and reverse causation, it has become well known within the economics literature that it is inadvisable to draw inferences from the conditional correlations in growth regressions.[5] Finally, it is difficult in a macro-regression to appropriately assess the time frame in which these changes are operative, given well-known issues of auto-correlation amongst both dependent and independent variables of interest.

A second approach to examining the relationship between social or demographic factors and economic outcomes has been to turn to a finer level of analysis, usually at the household- or individual-level rather than at countries or sub-national regions. The examination of household data often allows for identification to be achieved in a way in which it cannot using macro data (see Joshi and Schultz, 2007; Schultz, 2009; Miller, 2010; and Rosenzweig and Zhang, 2009, for examples of demographic-economic linkages). Unfortunately, these studies cannot directly answer the question of how these social and demographic factors affect the aggregate economy for three reasons. First, many of the effects run through channels that are external to the household—either via externalities in the classic economic sense (e.g., environmental degradation) or through changes in market prices, such as wages, land rents, and returns to capital (Acemoglu, 2010). Second, even if one ignores external effects, aggregating the different channels by which demographic and social changes affect economic outcomes is challenging. Finally, as in the macroeconomic

[5] While a handful of studies have attempted to circumvent the identification problem in the macroeconomic context using instrumental variables (see Acemoglu and Johnson (2007), Li and Zhang (2007), and Bloom et al. (2009) for well-known examples), instruments at the macro level generally are well-known to be imperfect due to the complex nature of aggregate relationship, and have led to significant doubts regarding the causality behind these findings.

literature, the long-time horizon over which the effects of demographic and social changes are manifested limits the ability of a single study to capture them.

In contrast to the macro and micro regressions above, if one 1) knows the structural mechanisms that relate economic and social or demographic variables and 2) can correctly and causally parameterize each one through well-designed causal inference methods, these can be combined into a single simulation model that can effectively deal with the issues of aggregation and general equilibrium. The intellectual ancestor of modern economic–demographic simulation models is the Coale–Hoover model (Coale and Hoover, 1958), which studies the effect of fertility change in India and has been followed by many others since (see Enke, 1971; Simon, 1976; Ahlburg, 2002; Kelley, 1988; Lee and Mason, 2010; Ashraf et al., 2013; and Karra et al., 2017). However, there are several drawbacks to simulations. While simulations are able to incorporate many theoretical channels into their analysis, adding too many channels could create a situation where the model becomes a "black box". Ahlburg (2002), referring to simulations in this area, argued that they "vary considerably in their complexity.... the cost of the models' increased complexity is that it is often very difficult to uncover the underlying assumptions and, particularly, since few carry out sensitivity analysis, the key assumptions." Similarly, Kelley (1988) cited general equilibrium feedbacks, the difficulty of constructing credible long-range demographic forecasts, potential changes in policy or institutions that may occur over the forecast interval, and the lack of available data to specify and validate such a model as potential limitations.

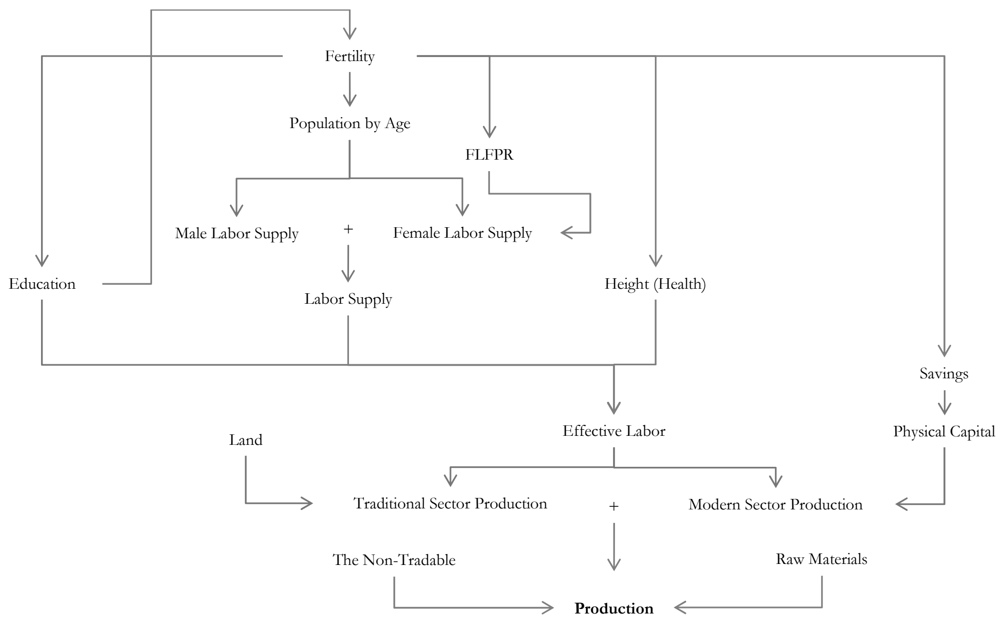
Given the relative opacity of these models, the popularity of simulation approaches waned in academic and applied policy circles after the mid-1980s. However, with recent renewed interest in human capital and overlapping-generations approaches, and the increased aversion to regression modeling with poor identification strategies beginning in the mid-1990s, simulation modeling has made a comeback. For example, the national transfer accounts (NTA) model of Lee and Mason (2010), the macroeconomic-health model of Ashraf et al (2009), and, most recently, the CKW model of the demographic dividend (Ashraf et al., 2013; World Bank, 2015; Karra et al., 2017) have reinvigorated the field. Work by macroeconomists interested in long-run growth has extended this approach to create fully "micro-founded" (i.e., micro-foundation-based) computable general equilibrium models to analyze the interaction of social and demographic and economic outcomes (e.g., Doepke, 2004).

2.3 The Gender Dividend Model: Extending CKW 2017

Our model of the gender dividend that attempts to estimate the current and foregone economic contributions of women is based on the CKW 2017 demographic-economic macrosimulation framework. The CKW model was specifically developed to estimate the size of the "demographic dividend", or the increase in income per capita as a result of fertility decline, in low- and middle-income countries. Predecessors of this model were used to evaluate the macroeconomic effects of disease (Ashraf et al., 2009). In principle, the CKW modelling framework can be used to evaluate the dynamic macroeconomic effects of any structural economic change which affects a nation's demographics, productivity, or productive factors such as land, labor, or capital. As such, it is an ideal framework for evaluating the macroeconomic effects of increased gender equity, since these changes would impact many productive channels beyond fertility decline (the primary channel of interest in the CKW 2017 model), such as reduced gender wedges in human capital, wages, and labor force participation, among others.

As depicted in Figure 1, the CKW model considers a two-sector production schedule that is driven by demographics, human-capital, physical capital, and labor supply inputs. The coefficients that we use to parameterize the model are drawn from the published literature and summarized in Appendix 3. We account for aspects of gender equality that have proven important for economic growth with persuasive evidence but not exhaustively as the contextual nature and pathways through which greater equality contributes to the economy are intricate and multi-dimensional. Among others, gender-relevant mechanisms that are not accounted for in the adopted framework – due to modelling complexity and insufficient coefficients to parametrize them therein – but are important precursors to economic output are the systemic access barriers to formal financial services such as saving and credit products (Demirguc-Kunt, Klapper, & Singer, 2013), the role of gender-based violence (Day, McKenna, & Bowlus, 2005) or cultural norms regarding gender roles (Hiller, 2014).

Figure 1. Generalized Modelling Framework (CKW 2017)



2.4 Demographic Module and Effective Labor

The CKW 2017 model posits a demographic foundation to the gender dividend model, namely, it begins by projecting the size and gender composition of the labor force, by age- and sex-specific population at each five-year period. The model uses fertility rates of women by five-year age groups in each five-year period. These projections are further used to calibrate the age-and sex-specific mortality rates and the sex ratio at birth[6]. The labor supply[7] at each five-year time period is then calculated by assuming that the population enters the labor force at the age of 20[8] and exits the labor force at the age of 65. Constraining the range of years depends on the marginal labor income and the marginal share of lifetime earnings that apply to the children and the elderly populations (Karra, Canning, & Wilde, 2017). The age- and sex- specific workforce is calculated by weighting the age-group population with the corresponding age- and sex-specific labor force participation rates in the respective five-year period at baseline.[9] We assume that age-specific male participation rates are fixed at this level over time, but we modify the age-specific female labor force participation rate in each period to reflect the impact of fertility change and women's substitution between childcare and work on total female labor supply. In this manner, the age-specific female labor force participation rates are endogenized with a factor that reflects the impact of fertility on the labor supply of women, as has been calculated by Ashraf, Weil and Wilde (2013).

Fertility and demographic change influence the accumulation of human capital, captured by the educational attainment and health of the age-specific cohort. These are respectively calculated by the weighted sum of the average years of schooling and adult height for each age- and sex-specific cohort and in each period separately. Health is proxied by the height of the adult, which is correlated with the productivity in adulthood (Schultz, 2002). The age and sex-specific estimates of educational attainment and health are then aggregated

6 A low variant, a medium variant and a high variant are available from the World Population Prospects of the UN (2010). Since the comparison of the projected output is undertaken at the next available period from the baseline, the difference between the variants becomes negligible. Here, the low variant is adopted.

7 The original CKW model was a fully supply- side model, meaning there is an implicit assumption of full employment. In the context of many LMICs, this full employment assumption likely does not hold in the short run. However, there are a number of theoretical and practical reasons to not independently model labor demand. Most importantly among these, modelling labor demand in a traditional manner (by deriving labor demand curves from the production function) is inappropriate, as this also assumes full utilization and costless movement of factors -- the same underlying rationale behind a full employment assumption. As a result, any modelling of labor demand outside of this traditional method would be necessarily ad hoc, and likely introduce even more untenable assumptions into the analysis, and add to the complexity of the model without guaranteeing more accurate results. In addition, the model already does consider several labor market inefficiencies by introducing multiple sectors with difference wage regimes (average product wages in the traditional sector versus marginal product wages in the modern sector), further blunting the necessity of independently modelling labor demand.

8 While the lower-bound for the labor force is commonly 16 or 18, we use age 20 to align with the five-year cohorts that we are using for population projections.

9 Labor force participation rates are obtained from the International Labour Office's ILOSTAT database (International Labour Office (ILO) 2013).

into a weighted average that reflects the human capital stock accumulated for the entire workforce at each period. In following the CKW methodology, fertility-to-education and fertility-to-health elasticities are then incorporated into the analysis, where human capital accumulation investment, as the number of children decreases, are modelled.

Similar to the CKW approach, the evolution of fertility is characterized by a feedback channel with the education of each female-specific cohort, whereby the projected fertility rates decrease as the years of education attained increase. The modelling of the education-to-fertility channel is appropriate in Liberia as fertility decline has shown to be correlated with the educational attainment of women since the 1980s (Parr, 1995). To this end, the education-to-fertility and fertility-to-education channels are critical in the context given the large bandwidth for improvement in female education for Liberia.

2.5 Capital Accumulation and Savings

We continue to follow the CKW approach by applying a Solow framework for capital accumulation and assuming that the evolution of capital stock is dependent on the aggregate output weighted by the savings rate and a standard depreciation parameter. The estimation strategy follows the linear specification of Bloom, Canning, Mansfield et al. (2007) by modelling the periodic savings rate as a function of preceding savings, income and the old-age dependency ratio. Accordingly, savings behavior hinges on the demographics as we assume that it is highest for prime-age workers and declines with age. The income component is likewise crucial considering that savings increases as income grows considerably in a developing country setting. The model further assumes that investment is limited to domestic savings, following the original CKW methodology.

International capital flows are not accounted for in this model, and we recognize that their inclusion could produce a more accurate valuation and change the size of the demographic and gender dividend. However, from an empirical perspective, the value of adding these flows to the model is unclear. Wilde and Karra (2022) evaluate different capital accumulation scenarios within the CKW model framework – including one which includes international capital flows – and find that the historical co-evolution of demographics, income, investment, savings, and capital accumulation more closely follows a pattern similar to a constant domestic savings rate rather than one that incorporates international capital flows. This finding is consistent with micro evidence put forth by Deaton (1992). In addition, since capital markets are not segregated by gender, gender inequalities in capital accumulation are not incorporated into the model, and it is therefore unlikely that a different modelling of investment dynamics would change the central conclusions of this exercise. Finally, on a more practical level, the unavailability of the sex- and age-specific capital accumulation rates needed for this modelling strategy limits its estimation.

2.6 Aggregate Production

The production module of the model follows the Lewis (1954) model of economic development, which is comprised of three key inputs: estimated effective labor, capital stock, and land, which is a proxy for the natural resource stock. The supply of labor is parametrically allocated into sectors of production by gender, as later described. We assume that the economy is comprised of a modern sector, a traditional sector and a raw material sector.[10] The traditional sector is comprised of the informal sector including agriculture while the remaining workforce is allocated to the modern sector. The aggregate production in the modern sector is parametrized by a standard Cobb-Douglas production function which uses physical capital, allocated labor (demographics), and human capital in the form of average years of schooling in the workforce (as a proxy for education) and average height of the workforce (as a proxy for health). The aggregate production in the traditional sector is likewise composed by a Cobb-Douglas production function, with agricultural land[11] and allocated labor as inputs.[12] The assumed irrelevance of capital in the traditional sector production is aligned with evidence on the low marginal capital intensity of the agricultural and informal production processes in sub-Saharan African countries (Schmidhuber, Bruinsma, & Boedeker, 2009). By the same token, the use of unskilled intensive production and the almost non-existent availability of estimates of its employed capital is also well documented (Pratap & Quintin, 2006). Earning-relevant characteristics of workers are likewise under-rewarded in the traditional sector so human capital is not included, either. Finally, production from natural capital and resources is integrated through a constant additive term, as its production is assumed to be entirely dependent on the natural resource endowments of the country, with no physical or human capital or allocated labor contributing to its production.

As in CKW, all other aspects of the production function (productivity, the role of government, elasticities of substitution between factors, etc.) are assumed to be constant

[10] The model of production diverts from the previously adopted CKW categorization originally defined by solely a modern, capital-intensive sector (i.e., manufacturing) and a traditional, labor-intensive sector (i.e., subsistence agriculture) as the latter is comparable with informal production processes in developing settings.

[11] The endowment of natural resources is assumed to be fixed across all time periods. While using arable land as a proxy for natural resources is problematic (such land could be reduced due to depletion, desertification, or other environmental processes, as well as endogenous changes in land use), but modelling such processes is complex and not first-order related to the gender dividend. Therefore, we abstract from these changes.

[12] Our choice of a Cobb-Douglas production function was chosen primarily for tractability. Such a choice assumes a unit elasticity of substitution between all factors of production within each sectoral production function, which is not trivial given the importance of the relationship between movements of labor and subsequent changes in wages, by gender, in our model. One may be concerned that such a unit elasticity may over-estimate the reduction in wages from changes in labor supply. However, this unit elasticity of labor within sectors masks a very large elasticity of substitution between labor and other factors across the aggregate economy, since labor can change sectors if the wage begins falling too quickly. As a result, we are hesitant to change to a different within-sector production function (such as CES), which will not only complicate the model further, but also under estimate the relationship between changes in labor and changes in the wage in the aggregate production function.

over time within each sector. Therefore, the model implicitly assumes that results are independent of all these factors, meaning any additional effects of gender egalitarianism through these channels are not captured by this model.

Another possible critique of the model is the lack of sub-national estimation of the gender dividend. While subnational heterogeneities in the gender dividend are of first-order interest to many policy makers and academics, none of the previous iterations of the CKW model allowed for such estimation due to intractable complexities regarding migration. For example, while it is intuitive to think that demographic dynamics -- such as a lopsided age structure due to regional differences in fertility or mortality -- may lead to a larger or smaller demographic or gender dividend, in the presence of intra-regional migration fertility rates in one region may sever this relationship. This is particularly acute in many LMICs, which have very high rural-urban migration patterns. In addition, the lack of sub-national data on gender wedges in labor markets and on other key economic inputs (e.g., capital stock) also prohibits the estimation of regional heterogeneities.

3 Departures from the CKW Model

Our model of the gender dividend departs from the established CKW framework in several key ways to more effectively capture gender differentials and gender-specific contributions across the production process. The adjustments made to the CKW methodology, including the applied equations and their detailed descriptions, are described in Appendix 1.[13] In the following sections, we highlight the specific amendments to our model.

3.1 Labor Allocation by Sector and Gender

A key departure from the CKW framework is our characterization of the differential role of gender on human capital attainment, labor supply, and production. In particular, our gender-specific approach requires that modern sector and traditional sector wages endogenously adjust by gender and within their respective sectors, and in turn determine equilibrium male and female labor supply allocations across the two sectors that employ workers. This modification is motivated by the fact that gender disparities within the labor market in developing countries and the relative disadvantage of women, both in terms of the type and the quality of their employment and labor market potential, are widespread (Filipiak, Kolev, & Arbache, 2010). This is the case for Liberian women, as discussed above, where a sizeable share of the disadvantage is often characterized by the fact that: 1) Liberian women are more often employed informally and, to a considerably smaller extent, in public and private formal wage employment; 2) women are significantly underrepresented in more productive sectors

[13] The model by Karra, Canning & Wilde (2017) includes detailed equations for all processes that are adopted, which are not repeated in Appendix 1. The modelling processes are described in the following section, but Appendix 1 includes adjustments made to the original technique.

of employment; 3) all other factors being equal, women are less likely to achieve higher employment status; and 4) the female-to-male difference in labor income are substantial.

In following CKW 2017, modern sector wages by gender are represented as the marginal product of labor for an additional worker with average levels of human capital. Since we assume that the traditional sector is not capital intensive, we allow the wage by gender to be determined instead by the average product of labor. The condition for which resources are shared equally among members in developing countries setting and especially in informal and more traditional settings is the basis for the sectoral differences that are applied in this model and in other macro-economic applications (Cypher, 2014; Lewis, 1954). The inefficient allocation of labor between sectors and the barriers to entry to the more productive (i.e., the formal) sector is here parametrized by a constant term, which is set to explain any baseline differential and is held constant over time.

In our model of the gender dividend, we update this approach to equilibrium wage and labor equalization across sectors by also allowing for initial gender-specific differences and frictions in wages, labor supply allocation, and mobility between sectors. The parametrization occurs in a similar fashion to the sectoral equalization as two gender-specific constant terms calibrated to initial gender-specific differences at baseline are adopted and are held constant over time. The resulting sectoral wage is given by the average of male and female wages in each sector, weighted by the relative proportion of men and women in that sector.

3.2 Non-Tradable Production

Conventional aggregate production measures often underestimate the economic contribution of women by neglecting to account for the unpaid provision of services, which theoretically could have been purchased on the market. In our model, we do a monetary accounting of these "non-tradeable" activities and include their value into aggregate production. In this manner, we seek to capture a more complete picture of the gender dividend, which would better reflect both the market and the intra-household contribution of a population to its economy.

Aggregate non-tradable production is estimated through a minimal opportunity-cost framework in which the annual output of an individual is proxied by the income the worker would have earned if she had been allocated to the traditional sector of the labor market, which would allot them the minimal wage level that she could have earned for her labor input. The cumulative value of the non-tradable production is given by the yearly number of hours devoted to the domestic chores and housework activities by gender, it is therefore quantified in monetary terms following a cost function approach. The approach applies the average traditional-sector wage, as not doing so would transfer the gender wage inequities from the market to the valuated output (Chadeau, 1985). The model does not predict or impute the wages respective to earning-related characteristics such as the employment status or age-group of the different shares of the population partaking in non-tradable activities as this is deemed problematic for an aggregate standpoint (Hill, 2009). Instead, the alternative that is adopted ascribes the traditional-sector wage as the single and minimum remuneration with which the non-tradable production is valued by the economy.

4 Parametrization

4.1 Data Sources

A wide range of data are used to calibrate the model. In following the CKW 2017 approach, the demographic module is comprised of total fertility rates (TFR) and projected quinquennial population by five-year age group that are gathered from the World Population Prospects of the United Nations (2010). The module of two-sector production is divided between modern sector and the traditional sector. The data on sectoral share of labor is taken by the Liberian Labor Force Survey (LFS) of 2010 and the sectoral share of GDP are taken from the 2007-2013 estimated average of Abid (2016). The amount of arable land and the value rendered by the natural resources are likewise inputted into the production module and taken from the World Development Indicators (WDI) database. The capital stock estimates and the Gross Domestic Product (GDP) statistics are drawn from the Penn World Tables (Feenstra, Inklaar, & Timmer, 2015).

Baseline data on labor force participation rates (LFPR) by sex and five-years age groups are obtained from the ILOSTAT repository (ILO, 2020). The earnings by sex which are taken for the parametrization of wages are taken by the Household Income and Expenditure Survey (HIES) 2014 data (Liberia Institute for Statistics and Geo-Information Services, 2015). Baseline data on human capital is composed of the average educational attainment (in years) by sex and five-years age groups, obtained from the Barro-Lee dataset (Barro & Lee, 2013), and the average height (in meters) by sex and five-years age groups, obtained from the Demographic and Health Survey (DHS) by the Liberia Institute of Statistics and Geo-Information Services, The Ministry of Health and Social Welfare/Liberia, National AIDS Control Program/Liberia, and ICF International (2014). Baseline estimates of age-specific savings rates are gathered from Bloom, Canning, Mansfield, & Moore (2007).

The non-tradable production module is composed of the average time (in hours) allocated to housework and domestic chores by sex, obtained at baseline from the United Nations Global SDG Database of the United Nations Statistics Division (2020) and UN Women (2019). To these measures, the time allocated to fetching water or firewood are added and obtained at baselined from the HIES 2014 from LISGIS (2015). Appendix 1 describes each source of data that was used to obtain the above cited data adopted for the macro-economic simulation.

4.2 Calibration and Convergence

We use parameters generated in CKW 2017 and impute additional parameters for our extension to the model. The CKW 2017 model parametrizes the reduction in labor market participation due to an additional child, the endogenous response of fertility to changes in education, the impact of fertility on human capital, the effect of adult height on worker productivity and wages, standard estimated values for production factor shares and the effect of schooling and height on earnings. Appendix 1 describes the parameter values that were used to calibrate the model and the sources from which these values were obtained. We continue by describing the additional parameter values inputted to the expanded version of CKW 2017 model and the way in which these contribute to the estimates.

Firstly, we parametrize the sectoral gender-specific friction and the gender-wage gap. This parametrization is drawn from a secondary-data analysis of the HIES 2014 from LISGIS (2015). The secondary source facilitates the estimation of earning per unit worked (month, week and hour) for each employed person. We recognize that earnings measurement at the micro-level has a noisy and volatile nature[14] but it has the advantage of being detailed to the intended population of interest for the adoption at the macro-level in this study. We find that the sectoral friction is noticeable in the higher wages of the modern sector across gender. The wage of female workers in the modern sector is 72.2 percent higher than the wage of female workers in the traditional sector. The average wage of a male worker in the modern sector is 46.2 percent higher than the average wage of a male worker in the traditional sector. Likewise, we find that women have lower wages than men in both the modern and the traditional sector. The average wage of a male worker in the modern sector is 6.5 percent higher than the average wage of a female worker in the same sector. And the average wage of a male worker in the traditional sector is 25.5 percent higher than the average wage of a female worker in the traditional sector.[15] The modern-traditional divergence is substantially accentuated, particularly for women, and the gender-pay gap is observed in both the modern sector and the traditional sector to differing degrees.

Secondly, we use the adapted CKW 2017 model to estimate gender-specific contributions to output when we incorporate a series of convergences. This exercise seeks to inform policymakers of the potential monetary gain of the gender dividend. Namely, the modeling of these estimates is intended to demonstrate how interventions to close the gender gap within domains such as family planning, women's educational attainment, returns to labor and the like can ultimately generate economic returns that would not occur under business-as-usual circumstances. For each selected input to production (e.g., educational

[14] For instance, during an economic downturn (e.g., Ebola, COVID-19) low-skilled workers are the first to be discharged and suffer from temporary dismissals or breaks in employment. Since more affluent workers are the ones to remain in the workforce, the measurement of wages or earnings at that time may be biased upwards. Other type of biases exists, such as mis-reporting from respondents or seasonal fluctuations.

[15] These estimates slightly differ from the wage gap discussed in the introduction since the latter condition on worker characteristics.

attainment), we estimate the change in productive output when the existing gender gap within that factor is mechanically closed.

We run various exercises for each selected input to production.[16] First, we allow a complete convergence between men and women for each domain and which we refer to as the ideal case. We regulate the fertility to an instant-replacement rate for the ideal case, or a quantity necessary to ensure a net reproduction rate of 1.0 starting in the 2015-2020 period (United Nations, 2010). Second, we allow for partial convergences within selected domains through benchmarking, which allow a comparison to averages found either in the sub-Saharan Africa region or in the OECD region. Some of the bench-marking with sub-Saharan Africa and OECD regions are not estimated due to domain-specific circumstances, which relate to data availability or relevance of the convergence given the data available. For the sectoral difference, we further hypothesize a complete convergence with depreciation of modern-sector wages and appreciation of traditional-sector wages driven by the surplus of female workers contributing to modern-sector production and incurred by the triggered convergence. We conclude with a simultaneous convergence by firstly allowing the labor-relevant domains to be completely closed and secondly by accounting also for the remaining domains modelled.

We continue by parametrizing the additive sub-module for which convergence is not necessarily relevant or accounted for, namely the non-tradable production. We parametrize the former by drawing statistical measures from the HIES 2014 and the UN Women (2019). According to these sources, we calibrate the time spent on non-tradable production activities to be different between men and women and therefore modelling the higher allocation of female time to unremunerated activities. The female population aged 15+ is estimated to allocate 8.1 percent of their time to non-tradable activities (or 1.95 hours a day) compared to 3.9 percent (or 0.93 hours a day) allocated by men. Note that under a more equitable redistribution between men and women, the total value of non-tradable production would still be higher for women than men since the female population aged 15+ is larger than the male population aged 15+.

Our approach to modeling closures in the gender gap for a given factor assumes that convergence occurs instantaneously in the starting period, and the effects of this convergence are therefore immediately reflected in subsequent periods. To some extent, this modeling feature reflects the upper bound of the potential impact of closing gender gaps since the effects of an instantaneous convergence are able to accrue over the longest time horizon.

5 Results

We present a range of estimates, including macroeconomic measures as well as estimated labor-market and earning-relevant statistics. We begin by depicting the current economic

[16] See Appendix 4 for the list of estimates modelled by category.

contribution of Liberian women. This is followed by the estimates of the gender dividend for each of the sub-module or characteristic studied. Within each section, we describe the initial condition relevant to the sub-module and then provide the macro-economic estimate, depicted as a share of GDP, and its disaggregation into per capita, per worker and per sector-gender output. In relevant cases, estimated differences in the labor-market composition or wages are given. Finally, we present the estimates given by the simultaneous convergence of the individually studied input to output. Appendix 4 summarizes the convergence experiments for each domain while Appendix 5 presents the results of each convergence experiment. Table 2 summarizes the experiments and estimates presented throughout this section.

Table 1 Convergence Estimated by Domain, by the Calibration Exercise

Category	Estimated increase to GDP, %	Calibration
Education	8.4	Closure
	4.9	SSA
	8.65	OECD
Fertility	3.1	net-reproduction rate
	0.57	SSA
	3.7	OECD
LFPR	2.3	Closure
Pay-Gap	4.8	Closure
	2.0	OECD
Sectoral	5.3	Closure
	2.5	Closure+
Non-Tradable	19.3	Additive of NTP
LFPR, Pay-Gap and Sectoral	11.9	Closure
	9.6	Closure+
Complete Convergence	23.6	Closure
	22.1	Closure+
	45.5	Additive of NTP

Notes: Closure represents complete convergence of the respective gap. Closure+ represents appreciation/depreciation is applied to wages due to the displacement of workers between sectors. SSA and OECD stands for benchmarking with averages found in sub-Saharan Africa and OECD countries, respectively. Additive represents the additional value added by the non-tradable sector which is summed to the status-quo.

5.1 The Current Economic Contribution

According to the baseline of model, the current contribution of women to the Liberian economy is USD 1.08 billion in 2020 (Table 2). According to medium-variant UN projection, the population of Liberia is 5.06 million individuals. The working age (20-65) population is 45.4 percent of the entire population and has an average educational attainment of 4.6 years.

Table 2. Macro-Economic Statistics for Baseline Scenario

1. GDP	
1.1. GDP (in USD)	$4,049,744,636
1.2. GDP per capita (in USD)	$800.71
1.3. GDP per worker (in USD)	$2,125.44
2. Contribution of Women	
2.1. in USD, bil.	$1,084,390,549
2.2. as % of GDP	26.78%
2.3. as % of Labor Output	39.04%
3. Value Added by Sector	
3.1. traditional, female (in USD)	$647,951,018
as % of GDP	16.00%
3.2. modern, female (in USD)	$436,439,531
as % of GDP	10.78%
3.3 traditional, male (in USD)	$735,858,976
as % of GDP	18.17%
3.4. modern, male (in USD)	$957,620,009
as % of GDP	23.65%

Source: Authors' simulation based on expanded version of CKW 2017 model.

The Liberian economy is estimated to have a GDP of USD 4.05 billion, a per-capita GDP of USD 800.7 and per-worker GDP of USD 2,125. The additive economic contribution of natural resources is estimated at USD 1.27 billion, or 31.4 percent of GDP. Women's contribution represents 26.8 percent of GDP and 39 percent of labor's contribution to GDP. These initial estimates exemplify the status-quo adopted by the study.

The contribution of women to the modern sector is USD 436.4 million or 10.8 percent of GDP while women represent 32.7 percent of its workforce with an average yearly wage of USD 1,582 (Table 3). In contrast, men's total contribution to the modern sector is 119 percent higher than the female contribution and amounts to USD 957.6 million or 23.65 percent of GDP. Men represent 67.3 percent of the workforce allocated to the modern sector and have average yearly wage of USD 1,686.

Table 3. Labor Market Statistics for Baseline Scenario

3. Decomposition by Labor Supply	
3.1. Total LF	1,905,372
3.2. Female LF	888,824
of which, modern (in %)	20.69%
of which, traditional (in %)	79.31%
3.3. Male LF	1,016,547
of which, modern (in %)	37.25%
of which, traditional (in %)	62.75%
4. Decomposition by Earnings	
4.1. Modern-sector wage	$1,652
4.2. Modern-sector, female wage	$1,582
4.3. Modern-sector, male wage	$1,686
4.4. Traditional-sector wage	$1,030
4.5. Traditional-sector, female wage	$919
4.6. Traditional-sector, male wage	$1,153

Source: *Authors' simulation* based on expanded version of CKW 2017 model.

The contribution of women to the traditional sector is USD 647.9 million or 16 percent of GDP. The traditional sector employs 70.5 percent of the workforce in Liberia[17]. With an average annual wage of USD 1,030, the traditional sector generates 34.1 percent of total GDP. Women represent 52.5 percent of the traditional sector workforce and have an average annual wage of USD 919. In contrast, the contribution of men to the traditional sector is USD 957.6 million or 18.7 percent of GDP. Men represent 47.5 percent of the workforce in the traditional sector and have average yearly wage of USD 1,153. Women's lower pay in both sectors, and their greater employment in the traditional sector underpins their smaller contribution to GDP than men's. That said, women generate about one-quarter of Liberia's output. Their contributions would be even greater if gender gaps to productivity were smaller.

5.2 Women's Potential Contribution to GDP if Gender Gaps Narrow

Closing the education gender gap would increase Liberia's GDP by 8.4 percent (Figure 1). In Liberia, the female workforce aged 20-65 years old has an estimated educational attainment of 3.22 years on average, in comparison to almost a doubled male attainment of 6.03 years on average.[18] Increasing women's mean education by 2.8 years to eliminate the

[17] A lack of consensus on the definition of the formal and informal sectors lead to significant differences in the point estimate for the modern/traditional shares of the workforce. For Liberia, the share of the labor force in the formal sector ranges from 13 percent (Johanssen da Silva, 2021) to 30 percent (ILO, 2020).
[18] To allows for the 5-year cohort projections, the Barro & Lee 2013 data were used. The value is slightly lower than the more recently measured (2016 HEIS) estimates presented in the introduction section.

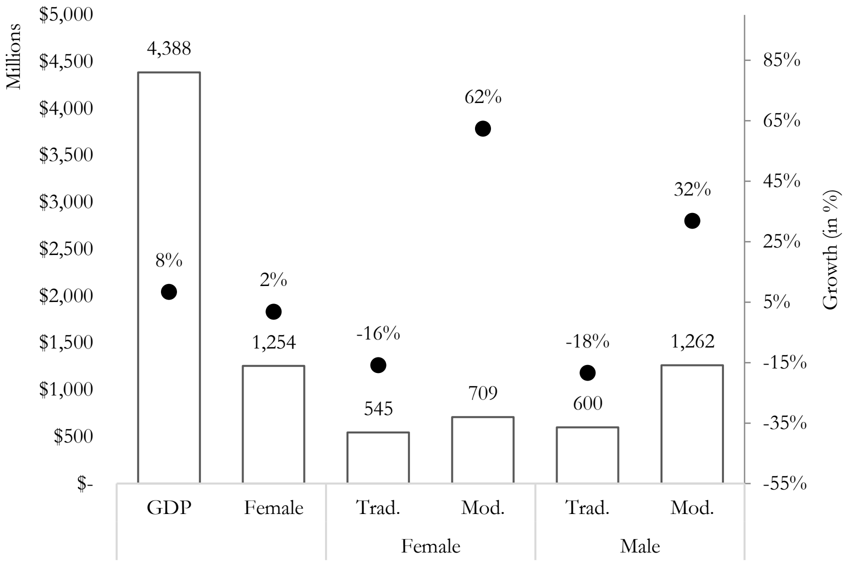
gender education gap would increase women's output by an estimated USD 338 million, making women's total contribution to GDP equivalent to USD 1.25 billion or 28.6 percent of GDP (up from 26.8 percent under the status quo). This would increase total GDP by 8.3 percent just for closing the gender education gap.

The growth due to the closure of the education gender gap is driven by a variety of changes. Wages increase by 0.3 percent across the gender-disaggregated sub-sectors. However, the variation in the sectoral composition of the economy by gender contributes most to the growth in women's output. The modern-sector output of women increases by 62.4 percent and reaches USD 708.8 million as the entire share of the workforce in the modern sector would increase from 29.5 percent to 41.7 percent. At the same time, women's participation in the traditional sector would decline, with their contribution to traditional output declining by 15.9 percent from the status quo scenario.

The dividend would be less, but still considerable, if the gender gap in education resembled the average found in sub-Saharan Africa (SSA). The expansion of education is perceived as substantial but also as a major fault line in the region due to its uneven development across sections of the populations and especially between men and women (Baten, de Haas, Kempter, & Meier zu Selhause, 2021). Liberia is not an exception and performs worse than some of its neighbors. Whereas women in SSA have 77 percent of the years of education achieved by men[19] (Barro & Lee, 2013), such share stands at 41 percent for Liberia. By reaching the level found in SSA, the Liberian GDP would increase to USD 4.25 billion and the aggregate, per-capita and per-worker output would experience a growth of 5 percent. In countries that are a part of the OECD instead, the gender hierarchy in educational achievement has recently reversed, where more (young) women than ever are attaining formal education (OECD, 2015). If the women-to-men divergence found in the OECD would be adopted in Liberia, the growth would amount to 8.65 percent. As a further sensitivity assessment, the return to education is then calibrated to a low-bound value of 4.2 percent and a high-bound value of 12.5 percent which are the minimum and the maximum found in African countries studied by Peet, Günther and Fawzi (2015). The findings signify the extent to which the full-closure estimate at the educational level is volatile to such changes. In comparison to a growth of 8.3 percent seen a the full-closure, the economy would have the potential to grow by 3.1 percent and 10.8 percent with low- and high-bound return to education, respectively.

Figure 1: Selected macro-economic changes due to complete convergences of the education gender gap (in USD, growth in %)

[19] The sample adopted is the one for which countries were available in the latest estimates of the dataset and excluded: Comoros, Djibouti, Eritrea, Ethiopia, Madagascar, Mayotte, Réunion, Somalia, Angola, Chad, Sao Tome and Principe, Western Sahara, Burkina Faso, Cape Verde, Côte d'Ivoire, Guinea, Nigeria.



In Liberia, while the participation in the labor-market is substantial for both men and women, the growth at which such rate increases for women recently stagnated. The female share of the overall workforce increased solely by 0.66 percentage points between 2010 and 2019 and remains below 48 percent (UN Women, 2021). The disparity is likely not explained by educational or training engagement as the share of female youth neither in employment nor in education or training (NEET) was nearly double that of male youth in 2014, at 29 percent and 16.6 percent respectively (ILO, 2017).

Generally, women of working age (20-65) have high activity rates, with an average labor force participation rate of 77.8 percent, as compared to 88.6 percent for men.[20] Yet if we close such 10.7 percentage point difference, the workforce is estimated to grow from 1.90 million to 2.04 million and GDP would increase by 2.3 percent (Figure 2). Ultimately, the economy is estimated to reach USD 4.14 billion and the contribution of women would rise to USD 1.13 billion from USD 1.08 billion. The influx of workers into the labor-market would not be equally absorbed, instead displacing female and male workers between sectors to differing degrees. The share of workers in the traditional sector increases from 70.5 percent to 73.9 percent and the share of workers in the modern sector decreases from 29.5 percent to 26 percent. Notably, the share of female in the modern sector increases from 32.7 to 40 percent while its male share decreases from 67.3 to 60 percent. The convergence on labor force participation is not estimated to the OECD level and to the sub-Saharan Africa

[20] These point estimates were drawn from ILO 2010, constructed to allow for 5-year cohort averages.

level since rates in Liberia are only marginally lower than the former region and better than the latter region[21].

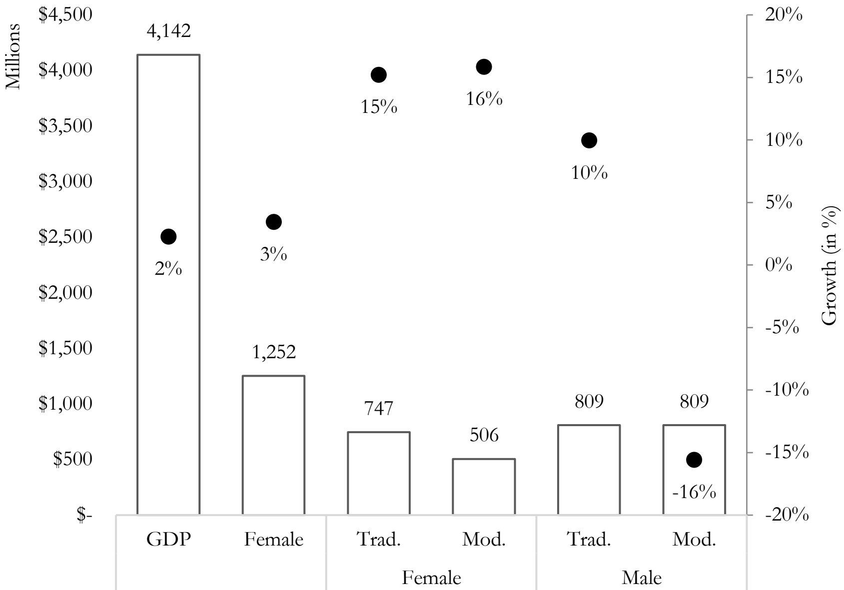


Figure 2. Selected macro-economic changes due to complete convergence in the LFPR gender gap (in USD, growth in %)

Fertility rates equal to the net reproduction rate of 1.0 will increase GDP by 3.1 percent (Figure 3). Overall, Liberian women have 4.47 children over the course of their reproductive years.[22] We initially investigate to what extent a fertility rate that is equal to an instant-replacement level alters the economic contribution of women and the aggregate output in the economy. The variant sets the fertility parameter to 2.35, a quantity necessary to ensure a net reproduction rate of 1.0 starting in the 2015-2020 period. The economy of Liberia is estimated to experience a 3.1 percent growth if fertility were equal to its instant-replacement rate (Figure 3). Per worker output is estimated to grow by 1.59 percent.

The growth due to lower fertility rates is driven by a variety of changes. The average years of education is predicted to grow from 4.6 to 5.0 while we expect the entire supply of labor to increase by 28,600 workers. The variation in output due to lower fertility rates is

[21] The average female/male ratio on participation rates is 85% in Liberia according to the model, 87% in OECD and 77% in sub-Saharan Africa according to ILO (2020) on countries available and latest estimates.
[22] This figure is drawn from the World Population Prospects, which estimates population size, in five- year increments, over the century. These rates are slightly higher than the estimates derived from the recently released DHS 2019/2020, reported earlier in the paper. This number decreased from 6.8 in 1970-1975 and it is projected to reach 3.9 in 2025-2030 (United Nations, 2015). There is significant variation in the average fertility rate across regions, education levels, and wealth quintiles (DHS 2019/2020).

further driven by an increased allocation of the workforce to the modern sector and more representation of women within it. The modern sector is estimated to expand its share from 29.5 percent to 32.5 percent which leads to a modern sector output growth of 18.3 percent for women and 8.8 percent for men.

The dividend would be less, but still economically meaningful, if the fertility rate in Liberia were equal to the regional average (4.1 children per woman) in 2015-2020. A reduction of an average of 0.37 children per women in Liberia would lead to an economic expansion that amounts to 0.57 percent in GDP and 0.28 percent in the economic contribution of women. Alternately, applying the number of children per women found in OECD countries in the same years[23] is estimated to make GDP surpass the returns given by a net reproduction rate and reach a growth of 3.71 percent in comparison to our baseline or attain USD 5 billion.

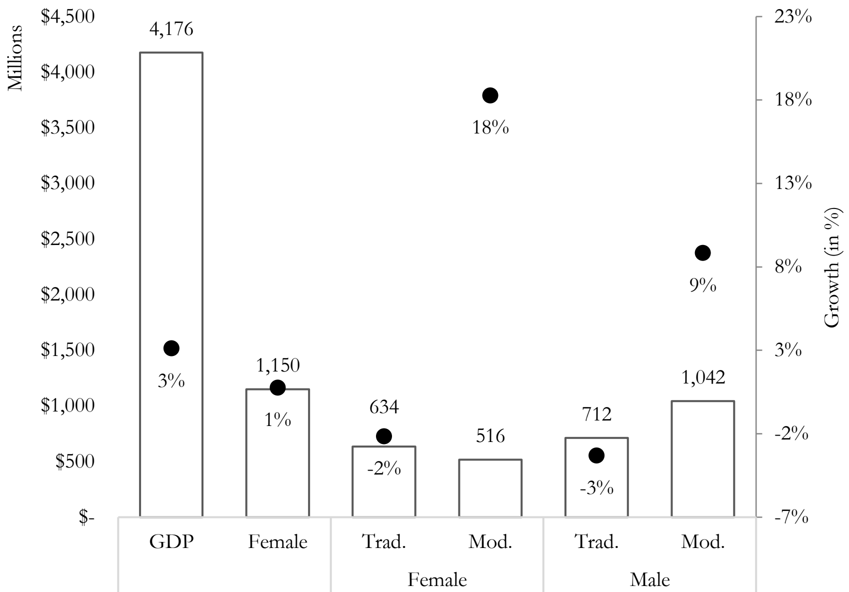


Figure 3. Selected macro-economic changes due reduction of fertility rates to instant-replacement rates (in USD, growth in %)

Closing the gender pay gap within sector would increase GDP by 4.8 percent (Figure 4). Liberia is not an exception to the global disparity that exist between male and female remuneration at work and especially in sub-Saharan Africa (UN Women, 2016). Whereas some of such disparity can be explained by observable attributes of the female workforce such as attainment in education, the gender pay-gap is also reflective of wage discrimination

[23] The value adopted is 1.95 and sourced from the UN Population estimates given that the same source is used for Liberia and SSA estimates, yet this differs from recent estimates given by the OECD which put the average in 2019 to 1.6 children per woman (OECD, 2021).

between men and women. In Liberia, male workers earn 6.55 percent more than women in the modern sector and 25.5 percent more than women in the traditional sector. We calibrate the average male and female wages to USD 1,686 in the modern sector and to USD 1,153 in the traditional sector. The value of traditional sector production is predicted to increase by 11.9 percent and of modern sector production by 2.1 percent if women and men earned the same within sector. Women's total contribution to GDP would rise to USD 1.28 billion and therefore grow from 26.8 percent to 30.1 percent.

While female-to-male earnings are similar between Liberia and sub-Saharan Africa[24], and thus such benchmarking convergence is not estimated, the pay-gap between men and women is found to be 11.6 percent for employees in OECD countries (OECD, 2022). If we would have to calibrate the average gender pay-gap found in the modern sector in Liberia from 25.5 percent to 11.6 percent, the aggregate output would grow to USD 4.13 billion or by 1.99 percent. The contribution of the female-modern sector would be the only one affected and grow by 12.5 percent.

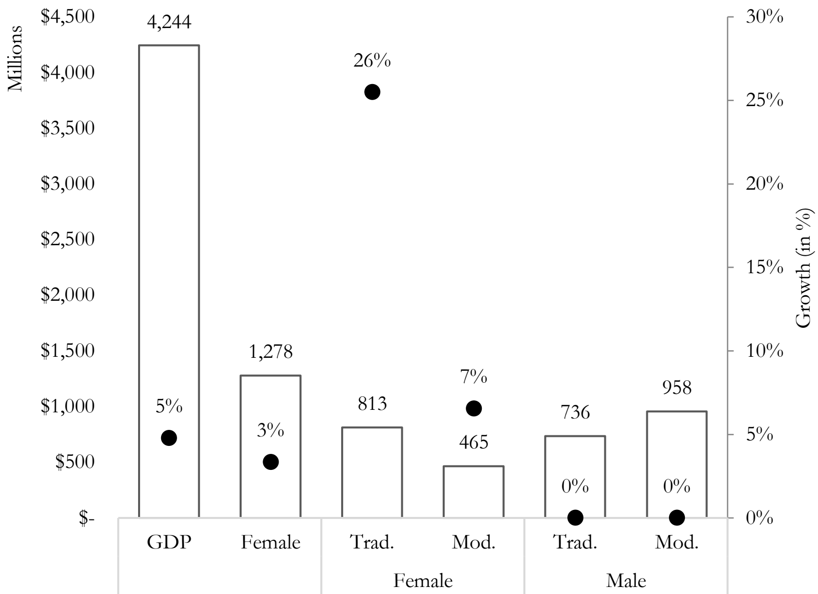


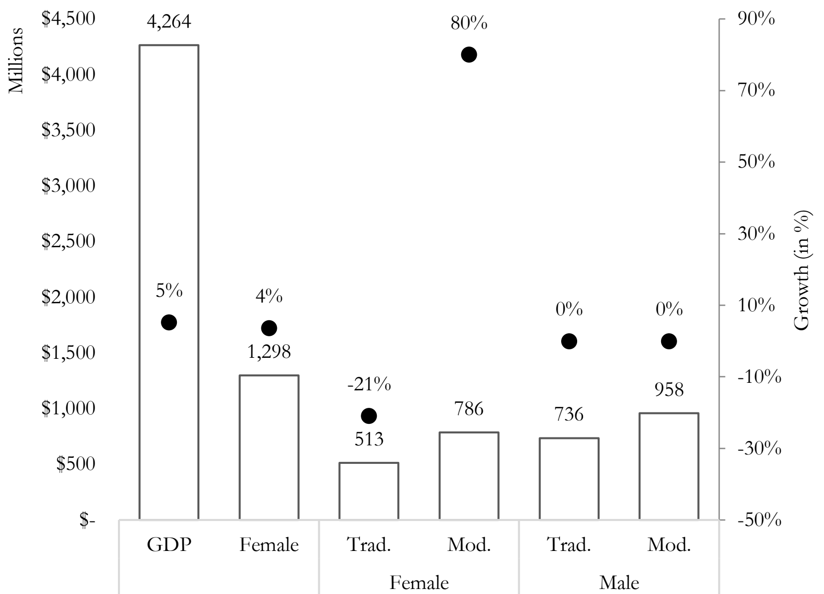
Figure 4. Selected macro-economic changes due to complete convergence of the gender-pay gap (in USD, growth in %)

If men and women are equally represented in each sector, GDP would increase by 5.3 percent or to USD 4.26 billion (Figure 5). The underrepresentation of women in the high-productive sector is substantial, as outlined in section 5.1. Equalizing the gender

[24] We find the modern-sector pay gap to be 6.5% in Liberia and 6% in SSA, and the traditional-sector pay gap to be 25.5% in Liberia and 28% in SSA, with the gaps in SSA proxied by informal-sector gaps (UN Women, 2016).

distribution within sectors would decrease the share of women in the traditional sector from 61 percent to 46.65 percent and increase the share of women in the modern sector from 39 percent to 53.3 percent. The number of women contributing to modern-sector production would increase from 184 thousand to 331 thousand while the number of men would remain unchanged. Women's total contribution to GDP would be USD 1.29 billion or 30.45 percent of GDP and 43.4 percent of the aggregate production of labor.

The lack of data has hindered the estimation of sectoral convergence to the level found within the OECD region. The sectoral convergence to the sub-Saharan Africa level is also not estimated since the region has virtually equal levels in comparison to the ones found in Liberia[25]. Yet, allowing for modern and traditional sector wages to shift in response to an inflow of women to the modern sector leads to a smaller estimated increase in GDP, of 2.48 percent, as compared to estimates when wage appreciation and depreciation is not accounted for. We parametrize the adjustment with the averaged elasticities of factor demand (Behar, 2004)[26]. In the aggregate, the modern-sector wage is predicted to decrease from USD 1,652 to USD 1,485 and the traditional-sector wage is predicted to increase from USD 1,030 to USD 1,084. The modern sector remains more productive than the traditional sector by about 18 percent. Overall, the aggregate output, per-capita output and per-worker output are projected to increase and reach USD 4.15 billion, USD 820 and USD 2,178, respectively.



[25] The share of women in the traditional sector is 79.3% in Liberia and 78.9% in SSA, the latter proxied by informal-sector shares ILO (2022).

[26] With a 1 percent increase/decrease in the share of a given sector, the respective wage decreases/increase by 0.35 percent.

Figure 5. Selected macro-economic changes due to complete convergence of gender-sector gap (in USD, growth in %)

The value of non-tradable production is estimated at USD 780 million – equivalent to nearly 16.1 percent of GDP – with women responsible for 68 percent of the total value. The role of women outside the labor market is well established and acknowledged. In Liberia, it characterizes environments where households cannot afford external support and creates a condition of *time poverty* which constraint women from pursuing their personal or labor-market aspirations and thus preventing economic engagement (UN Women, 2021).

In the first parametrization, the female population aged 15+ is estimated to allocate 8.1 percent of their time to non-tradable activities (or 1.95 hours a day) compared to 3.9 percent (or 0.93 hours a day) allocated by men. The estimated opportunity cost of the non-tradable production is USD 530.2 million for women compared to USD 250.3 million for men. If non-tradable production were included in aggregate production calculations, GDP would be 19.3 percent higher, reaching USD 4.83 billion. Women's contribution to GDP would be USD 1.61 billion if their non-tradable production were accounted for, as compared to USD 1.08 million when only measuring market-based output. The full accounting would increase women's contribution to total output to 33.4 percent to GDP (compared to 26.8 percent without accounting for non-tradable production).

The total value of non-tradable production would not differ if we equalize the intra-household allocation of time between men and women. Despite this logic and according to this thought-experiment, the contribution of women would yet exceed men's as the female population aged 15+ is larger than the male population aged 15+. Under this variant, the contribution of the female population would be USD 392 million (or 50.2 percent) compared to USD 388 million (or 49.8 percent) of men. In a different estimate, we would expect the wage rate to be depreciated if the traditional sector absorbs the jobs represented by the non-tradable sector. We thus translate the number of daily hours devoted to non-tradable production into the number of workers that they represent[27]. The additional workforce absorbed by the traditional sector brings its wage down by 14.4 percent and by using this calibration, the non-tradable sector would be valued at USD 551.5 million instead of USD 780 million.

5.3 Women's Potential Contribution to GDP with Multiple Convergence

GDP would increase by 11.5 percent or reaching USD 4.51 billion (Figure 6) if labor-relevant gender gaps are simultaneously closed. A structured transition of women to the high-productive sector of employment as well as increasing their participation in the labor market

[27] The number of workers is 543 thousand and it is estimated by dividing the total amount of hours devoted by the population to non-tradable production by 8 which is the standard number of hours devoted to a job in a day.

and wage differentials greatly exemplify the economic potential of the country. The analysis continues by considering the effect of equalizing the gender gaps in labor-force participation, wages and sub-sectors shares. The supply of labor would grow from 1.90 million to 2.04 million workers and the contribution of women would be USD 1.62 billion, or 36 percent of GDP and 50.1 percent of the aggregate production of labor. A 9.2 percent growth and 11.1 percent growth from the initial estimates, respectively.

The sectoral and gender decomposition indicates that most of the expansion would be driven by an increased allocation of the workforce to modern sector production which would grow by 86 percent for women alone. The aggregate output would grow by 9.6 percent (instead of 11.5 percent) if we would allow wages to change due to the displacement of the additional jobs created between sectors. Given the tight link between labor market earnings and poverty, the closure of the three labor-relevant gaps would reduce poverty by 8.4 percent and reach a headcount of 40.7 percent.[28]

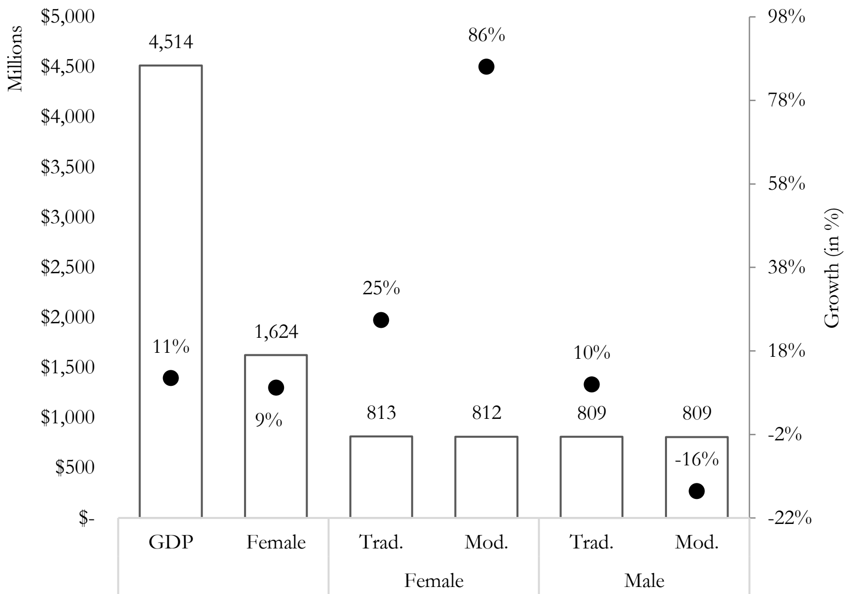


Figure 6. Selected macro-economic changes due simultaneous convergence of labor-relevant gender gaps (in USD, growth in %)

A complete convergence of gender gaps is estimated to results in a 23.6 percent increase in GDP (Figure 7). Given the endogenous relationships between the sub-modules developed, it is not appropriate to simply sum the effects of the individual convergences.

[28] Poverty in Liberia is widespread and 44 percent of the population lived under the international poverty line of $1.90 per day in 2016 (World Bank, 2021).

The model calculates that Liberia's GDP would be USD 5.01 billion if all convergences would occur simultaneously. This specification maximizes the potential of women across the inputs of production in the model as their contribution would be 1.87 billion or 37.4 percent of GDP and 50.2 percent of the aggregate production of labor. A 10.6 percent growth and 11.1 percent growth from the initial estimates, respectively. The modern sector would generate 49.2 percent of the economic wealth and women would contribute 50.1 percent of it. The average wage of women would grow by 7.3 percent in the modern sector and 26.4 percent in the traditional sector. The average wage of men would grow too, by 0.7 percent in both sectors of production. Similar to the above-described relationship between GDP and poverty, the increase in aggregate output led by simultaneously closing the gender gaps modelled would allow poverty to reduce by 17.4 percent and reach a poverty headcount of 36.7 percent from the initial 44.4 percent.

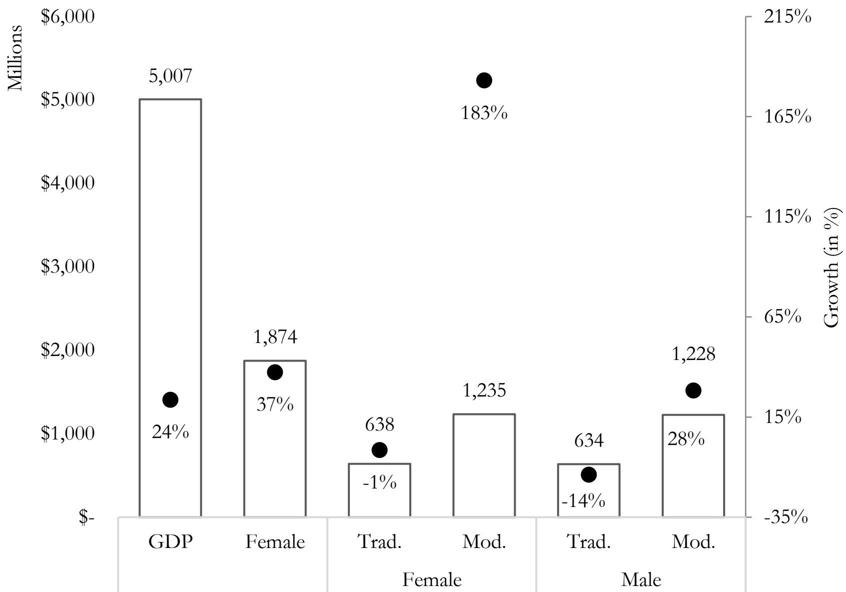


Figure 7. Selected macro-economic changes due simultaneous convergence of all gender gaps (in USD, growth in %)

If we would allow wages to depreciate due to the displacement of workers between sectors in our simultaneous convergence model, the growth would be 22.1 percent instead 23.6 percent. When adding non-tradable production to the full gender convergence GDP estimates results in a GDP equal to USD 5.89 billion. With such addition, the wide-ranging value of women would be acknowledged and their potential maximized in the Liberian economy as their contribution to GDP would rise to 41.4 percent while the value added to the labor market would be 52.8 percent.

6 Conclusions

The role of gender equality is a subset of a broader body of scholarship on the relationship between intergroup inequality and growth (Kalecki, 1954). Perhaps most significant in this body of research is the finding of a two-way causality between gender equality and economic growth outcomes. If gender equality is found to be a stimulus to growth, then policies and interventions that promote greater gender equality can contribute to a virtuous cycle of growth. To the extent that greater gender equality is a stimulus to growth and development, targeted policies and interventions that promote gender equality can produce Pareto-improving outcomes, with women as a group and society as a whole benefiting from equality-induced gains.

In this study, we show that the current contribution of women to the Liberian economy is under-valued, creating an economic cost to not only women individually but also to society at large. We adapt a macrosimulation model to construct a model of the gender dividend, which quantifies the current economic contributions of women in Liberia. We then identify the potential economic contribution that women would be able to make if there were equality of opportunity and capability by gender across a range of factors that have been identified as determinants of the gender dividend and inputs to economic growth and productivity. We also incorporate into the production estimate the contributions that are made from undertaking housework and domestic chores.

We create a series of estimates by varying the parametrization of the model. We show that the current contribution of women represents 26.8 percent of GDP and 39 percent of the aggregate production of labor. The contribution of women to the modern sector is solely 31.3 percent while the contribution of women to the traditional sector is 46.8 percent.

We show that the potential of women under equality of opportunities is considerable and that their current contribution is undervalued. The captured opportunity cost of the non-tradable production (value of unpaid domestic work) is USD 530 million for women compared to USD 250 million for men. The highest return of single-variable convergences to GDP is given by closing the gap in education (+8.3 percent) and sectoral difference (+5.3 percent). Simultaneously closing gender gaps in labor-relevant domains would lead to an increase in output equivalent to 11.5 percent of GDP. The monetary return would be of 23.7 percent and GDP would reach USD 5 billion if we add to the macrosimulation the assumptions that gaps in education are eliminated and fertility rates are at replacement rate.

The predictions found in this study are comparable to studies that have attempted to estimate the economic losses due to gender inequality on employment and productivity. The 11.5 percent increase in GDP (and GDP-per-capita) that is generated by eradicating labor-relevant inequalities between men and women in our model closely resembles the estimated 8.9 percent increase found in estimates from Niger (World Bank, 2019) and the 19 percent increase in GDP-per-capita found in a multi-country study on employment and productivity (Pennings, 2022). On the other hand, our estimate of an 8.3 percent increase in output per capita from closing the gender gap in education is almost three times larger than the increase found by Devadas & Kim (2020) even though our studies estimate similar average losses from the difference in labor force participation rates between men and women; the Devadas & Kim (2020) study estimated a 1.4 percent loss from gender gaps in labor force participation, which is about 0.9 percentage points lower than the 2.3 percent loss that we estimate for Liberia.

Our approach is not without its limitations, many of which have been discussed throughout this study as well as in prior studies that have also proposed macrosimulation models for inference. A key constraint of our model is in its limited ability to infer general equilibrium effects that are not explicitly incorporated through our identified channels of interest. An example of this limitation can be observed in our conceptualization of the labor market in which labor supply allocations across sectors by gender may in turn have dynamic impacts on wages by gender and by sector, to the extent that wages in the formal sector may fall over time as more skilled women enter the labor market and are allocated to that sector. While there may be value added to modeling these relationships more realistically, we recognize that the inclusion of more realistic dynamics will increase complexity while simultaneously reducing tractability and transparency of the findings. Our model may therefore be more useful for providing insights of the underlying relationships and interactions between factors than for the predictions themselves. To this end, we recommend that our model predictions not be taken as precise measures of the gender dividend but rather be interpreted as illustrative of the potential relative impacts of these factors on key economic outcomes of interest.

Furthermore, we assume that a closure of gender gaps occurs instantaneously in the starting period and the effects of this convergence are immediately reflected in subsequent periods. A more realistic approach, however, may be to model convergence in the factor over multiple periods, which may more accurately reflect the realities of implementing exogenous policies and interventions that are phased in over time. This approach would need to specify the conditions under which convergence occurs over time, which would require either empirical evidence or assumptions about convergence velocity, acceleration, and functional form, among others.

Our study findings highlight a range of potential economic and social benefits that can be accrued from closing gender gaps and achieving a gender dividend. However, we recognize that the policies, programs, and interventions that are needed to close these gaps are not costless, and their implementation would require significant investments and coordinated efforts from a wide range of actors and stakeholders across a wide number of sectors. The inclusion of costs would put our estimates of gender gap closures in perspective, yet formally modeling the costs of these investments is beyond the scope of this study.

Taken together, our approach to conceptualizing and estimating the gender dividend provides empirical evidence to reinforce the need for a unified policy agenda that actively advances the empowerment of women. This goal has implications for global development at large but also, and more importantly, serves to promote the rights and well-being of women as equal and productive members of society.

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8 Appendixes

8.1 Appendix 1: Data Sources

Data Type	Source
Baseline population by age and sex, 2010	World Population Prospects
Baseline age-specific fertility rates, 2010-2100	World Population Prospects
Years of education by 5 year age-sex groups, 2010	Barro & Lee, 2013
Adult height by 5 year age-sex groups,	Liberia DHS, 2013
Labor force participation by 5 year age-sex groups, 2010	ILO
Sector- and gender-disaggregated earnings	HIES 2014
Hours devoted to domestic chores and housework	UN Women, 2019
Hours devoted to collecting firewood or fetching water	HIES 2014
Output, 2005	WDI
Output, 2010	WDI
Oil Output, 2010	WDI
Capital stock, 2010	WDI
Agricultural land, 2010	WDI
Proportion of GDP between sectors, 2010	Abid, 2016
Proportion of labor between sectors, 2010	ILO

8.2 Appendix 2: Departures from CKW 2017

8.2.1 Non-Tradable Production

It is assumed that there is no overlap between (1) hours devoted to domestic chores and housework and (2) hours devoted to collecting firewood (or charcoal) or fetching water.

The total daily female contribution through non-tradable production (NTP_{Ft}) is given by:

$$NTP_{Ft} = (POP_{ft} \times h_{f1} \times (\rho_{f1f} + \rho_{f1h}) \times W.inf_{ft}$$

Where POP_{ft} = female population aged 15-100 at time t

h_{f1} = share involved in fetching water/firewood and housework and domestic chores

ρ_{f1f} = hours devoted to fetching water/firewood by $POP_{F1t} \times h_{F1}$

ρ_{F1h} = hours devoted to housework and domestic chores by $POP_{F1t} \times h_{F1}$

$W.inf_{ft}$ = hourly wage at time t in the traditional sector.

1.1.1 Labor Allocation across Sectors by Gender

Our gender-specific labor model requires that modern sector and traditional sector wages, which endogenously adjust by gender $G = \{m, f\}$ and within their respective labor markets, will in turn determine equilibrium male and female labor supply allocations across the two sectors that employ workers. Total male labor supply L_{mt} and total female labor supply L_{ft} are shared across the modern M and traditional A sectors such that

$$L_{mt} = LM_{mt} + LA_{mt} \quad (1)$$

$$L_{ft} = LM_{ft} + LA_{ft} \quad (2)$$

In addition, we have the following labor market-clearing conditions:

$$LM_t = LM_{mt} + LM_{ft} \quad (3)$$

$$LA_t = LA_{mt} + LA_{ft} \quad (4)$$

$$L_t = LM_t + LA_t \quad (5)$$

The wage per worker in the modern sector at time t, wM_t, is set to be equal to the marginal product of labor in the modern sector for an additional worker with average levels of education and health, or in log terms

$$log\ log\ wM_t = log\ log\ \left[(1-\alpha)\frac{YM_t}{LM_t}\right] \quad (6)$$

In contrast, we assume that the traditional sector is less developed and is more labor intensive with little to no capital endowment, thereby resulting in the wage per worker in the traditional sector at time t, wA_t, being determined by the average product, or in log terms:

$$log\ log\ wA_t = log\ log\ \frac{YA_t}{LA_t} \quad (7)$$

Since the wage in the traditional sector is determined at the average and not on the margin, in equilibrium there will be too many workers in the traditional sector. In addition, there may be migration costs or other barriers to entry into modern sector jobs, which are parametrized by the term b, that will contribute to an inefficient allocation of labor across sectors. In equilibrium, workers will migrate between sectors and wages will adjust such that

$$log\ log\ wM_t - log\ log\ b = log\ log\ wA_t \quad (8)$$

Here, b is a constant that is set so as to explain any baseline differential in sector wages and is then held constant over time. Similarly to the equalization of wages across sectors in equilibrium, we also allow for differences in wages within each sector by gender, which effectively captures the sector-specific gender gap in wages. In particular, we specify that wages between men and women in the modern and traditional sectors differ by the terms b_M and b_M, respectively, such that

$$log\ log\ wM_{mt} - log\ b_M = log\ log\ wM_{ft} \quad (9)$$

$$log\ log\ wA_{mt} - log\ b_A = log\ log\ wA_{ft} \quad (10)$$

The terms b_M and b_A are also constants that are calibrated to the initial differences in baseline sectoral wages between men and women and are then held constantly over time.

We also specify that wage (and hence labor supply allocation and migration) across each sector for each gender is determined by

$$log\ log\ wM_{mt} - log\ log\ b^m = log\ log\ wA_{mt} \quad (9)$$

$$log\ log\ wM_{ft}\ -log\ log\ b^{f}\ =log\ log\ wA_{ft} \tag{10}$$

where the gender-specific wage frictions between the modern and traditional sectors, b^{m} for men and b^{f} for women, are specified and calibrated for the aggregate sectors using baseline data on wage differences.

Finally, the sectoral wage is set to be the weighted average of male and female wages in each sector, weighted by the relative fraction of men and women in that sector

$$wM_t = wM_{mt} \cdot \frac{LM_{mt}}{LM_t} + wM_{ft} \cdot \frac{LM_{ft}}{LM_t} \tag{11}$$

$$wA_t = wA_{mt} \cdot \frac{LA_{mt}}{LA_t} + wA_{ft} \cdot \frac{LA_{ft}}{LA_t} \tag{12}$$

Equilibrium Solutions

We calculate our equilibrium conditions in sequence, first solving for aggregate wages and labor supply by sector, and then solving for gender-specific labor distributions and gender-specific wages within each sector. If we replace modern sector and traditional sector aggregate wages with their respective aggregate wage-output equilibrium conditions and substitute modern sector and traditional sector output with their respective production functions, we obtain:

$$Z_t LM_t^{-\alpha} = (L_t - LM_t)^{-\beta}$$

where

$$Z_t = \frac{(1-\alpha) \cdot AM_t K_t^{\alpha} e^{\gamma E_t + \lambda H_t}}{b \cdot AA_t X^{\beta}}$$

For $\alpha = \frac{1}{3}$ and $\beta = \frac{1}{6}$, we can explicitly solve for LM_t as

$$LM_t = \frac{1}{2}\left(Z_t^3 \sqrt{Z_t^6 + 4L_t} - Z_t^6\right)$$

We can verify that $0 \leq LM_t \leq L_t$, and we calibrate the value of b so that initial labor stock in the modern sector, LM_t, matches the data. We then fix b to that value in all subsequent simulations.

We note the following identities:

$$wM_{mt} = wM_{ft} \cdot b_M, b_M > 1$$

$$wA_{mt} = wA_{ft} \cdot b_A, b_A > 1 wM_{mt} = wA_{mt} \cdot b^m, b^m > 1$$

$$wM_{ft} = wA_{ft} \cdot b^f, b^f > 1$$

$$wM_t = wA_t \cdot b, b > 1$$

These relationships imply that in terms of wM_{mt}

$$wM_{ft} = \frac{wM_{mt}}{b_M}$$

$$wA_{mt} = \frac{wM_{mt}}{b^m}$$
$$wA_{ft} = \frac{wA_{mt}}{b_A} = \frac{wM_{mt}}{b_A \cdot b^m}$$

In solving for modern sector wages for males, we first find that:

$$wM_t = wM_{mt} \cdot \frac{LM_{mt}}{LM_t} + \frac{wM_t}{b_M} \cdot \frac{LM_t - LM_{mt}}{LM_t}$$

Therefore

$$wM_t = \left[\frac{(b_M - 1)LM_{mt} + LM_t}{b_M \cdot LM_t}\right] wM_{mt}$$

For traditional sector wages for males, we find that:

$$wA_t = wA_{mt} \cdot \frac{(L_{mt} - LM_{mt})}{L_t - LM_t} + \frac{wA_{mt}}{b_A} \cdot \frac{(L_t - L_{mt} - LM_t + LM_{mt})}{L_t - LM_t}$$
$$wA_t = \frac{wM_{mt}}{b^m} \cdot \frac{(L_{mt} - LM_{mt})}{L_t - LM_t} + \frac{wM_{mt}}{b \cdot b_A} \cdot \frac{(L_t - L_{mt} - LM_t + LM_{mt})}{L_t - LM_t}$$
$$wA_t = \left[\frac{(L_{mt} - LM_{mt})}{b^m(L_t - LM_t)} + \frac{(L_t - L_{mt} - LM_t + LM_{mt})}{b \cdot b_A(L_t - LM_t)}\right] wM_{mt}$$
$$wA_t = \left[\frac{b \cdot b_A \cdot (L_{mt} - LM_{mt}) + b^m(L_t - L_{mt} - LM_t + LM_{mt})}{b \cdot b_A \cdot b^m(L_t - LM_t)}\right] wM_{mt}$$
$$wA_t = \left[\frac{(b \cdot b_A \cdot L_{mt} - b \cdot b_A \cdot LM_{mt}) + (b^m L_t - b^m L_{mt} - b^m LM_t + b^m LM_{mt})}{b \cdot b_A \cdot b^m(L_t - LM_t)}\right] wM_{mt}$$
$$wA_t = \left[\frac{b^m L_t + (b \cdot b_A - b^m)L_{mt} - b^m LM_t + (b^m - b \cdot b_A)LM_{mt}}{b \cdot b_A \cdot b^m(L_t - LM_t)}\right] wM_{mt}$$

We know that $wA_t = \frac{wM_t}{b}$, so

$$\frac{wM_t}{b} = \left[\frac{(b_M - 1)LM_{mt} + LM_t}{b \cdot b_M \cdot LM_t}\right] wM_{mt}$$
$$= \left[\frac{b^m L_t + (b \cdot b_A - b^m)L_{mt} - b^m LM_t + (b^m - b \cdot b_A)LM_{mt}}{b \cdot b_A \cdot b^m(L_t - LM_t)}\right] wM_{mt}$$
$$= wA_t$$

Canceling out the wM_{mt} and b terms:

$$\frac{(b_M - 1)LM_{mt} + LM_t}{b_M \cdot LM_t} = \frac{b^m L_t + (b \cdot b_A - b^m)L_{mt} - b^m LM_t + (b^m - b \cdot b_A)LM_{mt}}{b_A \cdot b^m(L_t - LM_t)}$$

Solving for LM_{mt}:

$$LM_{mt} = \frac{(b_M - b_A)b^m L_t LM_t + (b \cdot b_A - b^m)b_M L_{mt} LM_t - (b_M - b_A)b^m LM_t^2}{(b_M - 1)b_A b^m L_t + b^m b_A LM_t + (b \cdot b_A - b^m - b_A b^m)b_M LM_t}$$

We can confirm that $0 < LM_{mt} < LM_t < L_t$ and can use the solution for LM_{mt} to solve for the other labor supply and wage allocations by sector and gender.

8.3 Appendix 3: Calibration

Rel.	Symbol	Value	Description	Source(s)
1	π	0.02	Effect of fertility on female labor supply	Ashraf et al. (2013)
2	θ_E	0.2	Effect of fertility on childhood education	Joshi & Schultz (2007); Rosenzweig & Wolpin (1980)
3	ψ	-0.15	Effect of women's education on fertility	Osili & Long (2008)
4	θ_H	-0.00067	Effect of fertility on adult height	Giroux (2008); Joshi & Schultz (2013); Kravdal & Kodzi (2011); Stevens et al. (2012); Victora et al. (2008)
5	α	0.33	Capital share of output in modern sector	Hall & Jones (1999)
6	β	0.167	Land share of output in traditional sector	Kawagoe et al. (1985); Williamson (1998, 2002)
7	γ	0.1	Economic returns to schooling	Banerjee & Duflo (2005); Oyelere (2010); Psacharopoulos (1994); Psacharopoulos & Patrinos (2004)
8	λ	0.08	Effect of health on output	Schultz (2002, 2005)
9	δ	0.07	Depreciation rate of capital	Schmitt-Grohe & Uribe (2006)
10	ϕ_1	0.758	Effect of lagged savings on current savings	Bloom et al. (2007)
11	ϕ_2	0.133	Effect of wage rate on savings rate	Bloom et al. (2007)
12	ϕ_3	-0.006	Effect of squared wage rate on savings rate	Bloom et al. (2007)
13	ϕ_4	-0.209	Effect of ratio of old to working age population on savings rate	Bloom et al. (2007)
14	υ	+-0.356	Elasticity of factor demand	Behar (2004)
15	τ	-0.326	GDPpc-to-poverty elasticity	Tuccio & Paci (2016)

8.4 Appendix 4: Estimations by Domain and Sensitivities

Table A4.1 Convergence Estimated by Domain

Category	Model No.	Calibration
Education	1.1	Closure
	1.2	SSA
	1.3	OECD
Fertility	2.1	net-reproduction rate
	2.2	SSA
	2.3	OECD
LFPR	3.1	Closure
Pay-Gap	4.1	Closure
	4.2	OECD
Sectoral	5.1	Closure
	5.2	Closure+
Non-Tradable	6.1	Additive of NTP
LFPR, Pay-Gap and Sectoral	7.1	Closure
	7.2	Closure+
Complete Convergence	7.3	Closure
	7.4	Closure+
	7.5	Additive of NTP

Notes: Closure represents complete convergence of the respective gap. Closure+ represents appreciation/depreciation is applied to wages due to the displacement of workers between sectors. SSA and OECD stands for benchmarking with averages found in sub-Saharan Africa and OECD countries, respectively. Additive represents the additional value added by the non-tradable sector which is summed to the status-quo.

Table A4.2 Sensitivity Tests

Model of Appl.	Description	Value
1.1	Economic returns to schooling	4.2%
1.1	Economic returns to schooling	12.5%
3.1	Effect of fertility on female labor supply	0
6.1	Non-tradable wages	depreciated

Notes: refer to Appendix 4 for the status-quo values of coefficients.

1.1 Appendix 5: Results

Table 5.1. Convergence Estimates for Education and Fertility

		Education			Fertility		
		1.1	1.2	1.3	2.1	2.2	2.3
	Baseline	Closure	SSA	OECD	net-repr.rate	SSA	OECD
1. GDP							
1.1. GDP (in USD)	$4,049,744,636	$4,388,335,127	$4,253,190,626	$4,400,110,268	$4,175,874,219	$4,072,908,921	$4,199,841,582
1.1.1. Growth (in %)		8.36%	5.02%	8.65%	3.11%	0.57%	3.71%
1.2. GDP per capita (in USD)	$800.71	$867.66	$840.94	$869.99	$825.65	$805.29	$830.39
1.2.1. Growth (in %)		8.36%	5.02%	8.65%	3.11%	0.57%	3.71%
1.3. GDP per worker (in USD)	$2,125.44	$2,303.14	$2,232.21	$2,309.32	$2,159.22	$2,125.66	$2,169.19
1.3.1. Growth (in %)		8.36%	5.02%	8.65%	1.59%	0.01%	2.06%
2. Women's Contribution							
2.1. in USD, bil.	$1,084,390,549	$1,253,722,388	$1,184,810,896	$1,259,793,203	$1,150,278,839	$1,102,102,586	$1,159,794,558
2.2. of GDP (in %)	26.78%	28.57%	27.86%	28.63%	27.55%	27.06%	27.62%
2.2.1. Growth (in p.p. %)		1.79%	1.08%	1.85%	0.77%	0.28%	0.84%
2.3. of Labor Output (in %)	39.04%	40.23%	39.74%	40.27%	39.61%	39.35%	39.61%
2.3.1. Growth (in p.p. %)		1.19%	0.70%	1.23%	0.57%	0.31%	0.57%
3. Sectoral Value Added							
3.1. traditional, female (in USD)	$647,951,018	$544,919,521	$587,085,006	$541,193,305	$634,051,255	$650,632,344	$628,268,957
3.1.1. Growth (in %)		-15.90%	-9.39%	-16.48%	-2.15%	0.41%	-3.04%
3.2. modern, female (in USD)	$436,439,531	$708,802,867	$597,725,890	$718,599,899	$516,227,584	$451,470,242	$531,525,601
3.2.1. Growth (in %)		62.41%	36.96%	64.65%	18.28%	3.44%	21.79%
3.3 traditional, male (in USD)	$735,858,976	$600,342,350	$653,652,082	$595,736,673	$711,563,750	$735,955,225	$704,207,490
3.3.1. Growth (in %)		-18.42%	-11.17%	-19.04%	-3.30%	0.01%	-4.30%
3.4. modern, male (in USD)	$957,620,009	$1,262,395,286	$1,142,852,546	$1,272,705,289	$1,042,156,527	$962,976,008	$1,063,964,432
3.4.1. Growth (in %)		31.83%	19.34%	32.90%	8.83%	0.56%	11.11%

Source: Authors' simulation based on expanded version of CKW 2017 model.

Table 5.2. Convergence Estimates for LFPR, Pay-Gap, Sectoral and Non-Tradable

		LFPR	Pay-Gap		Sectoral	
		3.1	4.1	4.2	5.1	5.2
	Baseline	Closure	Closure	OECD	Closure	Closure+
1. GDP						
1.1. GDP (in USD)	$4,049,744,636	$4,142,044,348	$4,243,588,292	$4,130,475,421	$4,263,837,535	$4,150,064,054
1.1.1. Growth (in %)		2.28%	4.79%	1.99%	5.29%	2.48%
1.2. GDP per capita (in USD)	$800.71	$818.96	$839.04	$816.67	$843.04	$820.55
1.2.1. Growth (in %)		2.28%	4.79%	1.99%	5.29%	2.48%
1.3. GDP per worker (in USD)	$2,125.44	$2,033.18	$2,227.17	$2,167.81	$2,237.80	$2,178.09
1.3.1. Growth (in %)		-4.34%	4.79%	1.99%	5.29%	2.48%
2. Women's Contribution						
2.1. in USD, bil.	$1,084,390,549	$1,252,334,304	$1,278,234,205	$1,165,121,334	$1,298,483,448	$1,245,245,780
2.2. of GDP (in %)	26.78%	30.23%	30.12%	28.21%	30.45%	30.01%
2.2.1. Growth (in p.p. %)		3.46%	3.34%	1.43%	3.68%	3.23%
2.3. of Labor Output (in %)	39.04%	43.63%	43.01%	40.76%	43.40%	43.26%
2.3.1. Growth (in p.p. %)		4.60%	3.98%	1.72%	4.36%	4.23%
3. Sectoral Value Added						
3.1. traditional, female (in USD)	$647,951,018	$746,647,597	$813,208,892	$728,681,803	$512,652,499	$532,672,334
3.1.1. Growth (in %)		15.23%	25.50%	12.46%	-20.88%	-17.79%
3.2. modern, female (in USD)	$436,439,531	$505,686,706	$465,025,312	$436,439,531	$785,830,948	$712,573,446
3.2.1. Growth (in %)		15.87%	6.55%	0.00%	80.05%	63.27%
3.3 traditional, male (in USD)	$735,858,976	$809,219,818	$735,858,976	$735,858,976	$735,858,976	$764,595,353
3.3.1. Growth (in %)		9.97%	0.00%	0.00%	0.00%	3.91%
3.4. modern, male (in USD)	$957,620,009	$808,615,124	$957,620,009	$957,620,009	$957,620,009	$868,347,818
3.4.1. Growth (in %)		-15.56%	0.00%	0.00%	0.00%	-9.32%

Source: Authors' simulation based on expanded version of CKW 2017 model.

Table 5.3. Multiple Convergences Estimates

		LFPR, Pay-Gap and Sectoral		Complete Convergence	
		7.1	7.2	7.3	7.4
	Baseline	Closure	Closure+	Closure	Closure+
1. GDP					
1.1. GDP (in USD)	$4,049,744,636	$4,514,124,396	$4,438,326,790	$5,007,472,629	$4,943,569,613
1.1.1. Growth (in %)		11.47%	9.60%	23.65%	22.07%
1.2. GDP per capita (in USD)	$800.71	$892.53	$877.54	$990.07	$977.44
1.2.1. Growth (in %)		11.47%	9.60%	23.65%	22.07%
1.3. GDP per worker (in USD)	$2,125.44	$2,215.82	$2,178.61	$2,428.51	$2,397.52
1.3.1. Growth (in %)		4.25%	2.50%	14.26%	12.80%
2. Women's Contribution					
2.1. in USD, bil.	$1,084,390,549	$1,624,414,351	$1,586,438,641	$1,873,707,498	$1,841,654,912
2.2. of GDP (in %)	26.78%	35.99%	35.74%	37.42%	37.25%
2.2.1. Growth (in p.p. %)		9.21%	8.97%	10.64%	10.48%
2.3. of Labor Output (in %)	39.04%	50.10%	50.10%	50.16%	50.16%
2.3.1. Growth (in p.p. %)		11.06%	11.06%	11.12%	11.12%
3. Sectoral Value Added					
3.1. traditional, female (in USD)	$647,951,018	$812,510,752	$833,158,308	$638,402,833	$657,565,149
3.1.1. Growth (in %)		25.40%	28.58%	-1.47%	1.48%
3.2. modern, female (in USD)	$436,439,531	$811,903,599	$753,280,333	$1,235,304,665	$1,184,089,763
3.2.1. Growth (in %)		86.03%	72.60%	183.04%	171.31%
3.3 traditional, male (in USD)	$735,858,976	$809,219,818	$829,783,745	$634,376,428	$653,417,887
3.3.1. Growth (in %)		9.97%	12.76%	-13.79%	-11.20%
3.4. modern, male (in USD)	$957,620,009	$808,615,124	$750,229,301	$1,227,513,601	$1,176,621,711
3.4.1. Growth (in %)		-15.56%	-21.66%	28.18%	22.87%

Source: Authors' simulation based on expanded version of CKW 2017 model.

Table 5.4. Non-Tradable Production (NTP) Output

	Status-Quo	Complete Convergence
Total NTP (in USD)	$780,487,162	$880,138,323
As share of GDP, if added (in %)	16.16%	14.93%
GDP, if NTP added (in USD)	$4,830,231,798	$5,887,610,953
Growth (in %)	19.27%	45.38%
Female NTP (in USD)	$530,209,334	$597,905,484
Female share of NTP (in %)	67.93%	67.93%
Male NTP (in USD)	$250,277,828	$282,232,839
Male share of NTP (in %)	32.07%	32.07%

Source: Authors' simulation based on expanded version of CKW 2017 model. *Notes:* NTP stands for Non-Tradable Production. Complete Convergence refer to the value of the non-tradable production if the Model 7.3 would be applied.