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Structural Change in Labor Supply and Cross-Country Differences in Hours Worked

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Abstract

This paper studies how structural change in labor supply along the development spectrum shapes cross-country differences in hours worked. We emphasize two main forces: sectoral reallocation from self-employment to wage work, and declining fixed costs of wage work. We show that these forces are crucial for understanding how the extensive margin (the employment rate) and intensive margin (hours per worker) of aggregate hours worked vary with income per capita. To do so we build and estimate a quantitative model of labor supply featuring a traditional self-employment sector and a modern wage-employment sector. When estimated to match cross-country data, the model predicts that sectoral reallocation explains more than half of the total hours decrease at lower levels of development. Declining fixed costs drive the rise in employment rates at higher levels of income per capita, and imply higher hours in the future, in contrast to the lower hours resulting from income effects and expansions in tax-and-transfer systems.

JEL Codes: E24, H31, J21, J22, L16, O11
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1 Introduction

Patterns of hours worked vary substantially with average income levels. Both time-series evidence and cross-country data point to a pattern of lower hours per adult in economies with higher income per capita (Ramey and Francis, 2009; Bick, Fuchs-Schündeln, and Lagakos, 2018; Boppart and Krusell, 2020). Underlying this decrease are stark differences in the behavior of the extensive margin (employment rates) and intensive margins (hours per worker) of aggregate hours worked over the development spectrum. Employment rates decrease sharply from low to middle-income levels, and then rise between middle- and high-income levels. Hours per worker increase between poor and middle-income countries, and then decline sharply between middle- and high-income countries. In other words, employment rates are convex and hours per worker are concave in income per capita.

The literature has focused on two broad explanations for why aggregate hours worked vary across countries. The first is preferences in which income effects dominate substitution effects in the long run, leading desired hours to fall in response to permanent increases in wages (see Boppart and Krusell, 2020, and the references therein). The second is differences in tax-and-transfer systems, which are the leading explanation of why adults work fewer hours in Europe than in the United States (see e.g. Prescott, 2004; Rogerson, 2008; Ohanian, Raffo, and Rogerson, 2008; McDaniel, 2011; Bick and Fuchs-Schündeln, 2018). The fact that richer countries have more extensive tax-and-transfer systems than poorer countries on average (Besley and Persson, 2014) suggests that tax system differences may also help explain why adults in richer countries tend to work less. Yet, neither explanation seems well equipped to explain the convex behavior of employment rates and concave patterns of hours per worker with income per capita. If strong income effects and more distortionary tax systems reduce incentives to supply labor as income levels rise, why would employment rates fall strongly and then later rise with development, while hours per worker rise and then fall strongly?

In this paper we study a new explanation of why average hours worked vary across countries, which we refer to as *structural change in labor supply*. We emphasize two main forces. The first is the sectoral reallocation from self-employment to wage work that has long been studied in development economics (Kuznets, 1966; Gollin, 2008). A key difference between self-employment and wage work is that wage work usually entails job search and travel costs, which are modeled as "fixed costs" by a large literature (see e.g. Keane, 2011; Rogerson and Wallenius, 2013). Our insight is that movements into market wage work, with its higher fixed costs, must then reduce labor supply along the extensive margin. At the same time, this sectoral reallocation raises hours per worker, which are higher in wage work than in self-employment. As a second force, we allow fixed costs of work to change over the development spectrum, potentially capturing better transportation infrastructure and improved working conditions with development. To the extent that fixed costs fall as GDP per capita grows, this may increase labor supply along the extensive margin.

We formalize these features in a two-sector model with heterogeneous households and an intensive and extensive margin of labor supply. Sectoral reallocation from self-employment to market wage work is modeled as movements from a "traditional sector," with no fixed costs of labor supply but decreasing returns to hours worked, into a modern sector, with fixed costs but constant returns to hours worked. Decreasing returns to hours worked in the traditional sector are meant to capture seasonal variation in labor productivity in agriculture or the small scale of farms or family businesses (Paxson, 1993; Adamopoulos and Restuccia, 2014). To capture cross-country variation in the time or utility costs of wage work, we introduce a wedge in the fixed costs of working that varies with the level of development.

The model also features the two standard channels studied in the literature: income effects in labor supply that dominate substitution effects, and distortionary tax-and-transfer systems. Preferences follow the MaCurdy (1981) specification, which is a special case of the preferences of Boppart and Krusell (2020), and used by other analyses of aggregate labor supply (e.g. Heathcote, Storesletten, and Violante, 2014). Tax-and-transfer systems follow the literature by featuring progressive labor income taxes, consumption taxes and lump-sum transfers. We allow all of these features of the tax system to vary with an economy's income level and discipline them using the database of gross income distributions and associated statutory labor income tax assembled by Egger, Nigai, and Strecker (2019) for a wide range of countries of all income levels. We show that these data imply increasing progressivity and increasing labor income taxation between middle-income and rich countries.

We estimate the model to match patterns of labor supply in the average poor and average rich country in the database of Bick et al. (2018). The estimated model does well in replicating the convex pattern of employment rates and concave pattern of hours per worker across countries of *all* income levels. Sectoral reallocation in the lower half of the development spectrum leads to rapidly decreasing employment rates, but slightly increasing hours per worker. By contrast, the decreasing fixed costs of work in the modern sector serve to raise employment rates in the richer countries. In counterfactual simulations, we show that allowing fixed costs of work to change by development, as well as having them apply only in the modern sector, are crucial features to match the two margins of labor supply. We further investigate what factors the decreasing fixed costs could capture, and provide evidence that commuting time and hazardous conditions at work are decreasing in development, while independence at work is increasing in development.

We then use the estimated model to quantify the relative role of the driving forces in the decrease in hours per adult. The model predicts that income effects and sectoral reallocation are the dominant and equally important forces behind the overall decrease in hours in the bottom half of the world income distribution. For higher income levels the role of sectoral reallocation is greatly reduced, while the income effects plays an even stronger role. In addition, taxes and transfers gain in importance as a driver of the hours decrease as countries grow richer. Declining fixed costs of work become a strong countervailing force to the decrease in hours in the upper half of the development spectrum.

We conclude by illustrating our model's implications for the future of hours worked. Many since Keynes (1930) have argued that hours worked will continue to fall in the future as strong income effects make individuals reluctant to supply labor, or as tax-and-transfer systems continue to expand. Our study suggests that if economies continue to witness decreases in the fixed costs of work—such as provided by internet platforms or through the recently observed increase in work from home—it is possible that hours will not fall as one might expect; they may even rise. As an illustration, continuing our observed trends out into the future would lead to roughly *constant* average hours worked for the next sixty years, meaning that decreasing fixed costs largely offset the decreases in hours implied by income effects and expanded tax systems. This exercise highlights the importance of distinguishing between structural change in labor supply and the latter forces as determinants of cross-country differences in hours worked.[1]

Our paper builds on a growing literature that tries to understand the patterns of structural change that underlie the process of economic growth and development. Most of this literature has focused on the movement of workers from agriculture into industry and then services (see e.g. Buera and Kaboski, 2012; Herrendorf, Rogerson, and Valentinyi, 2014; Storesletten, Zhao, and Zilibotti, 2019; Alder, Boppart, and Müller, 2021). Dividing the economy into these three sectors is not important for our arguments, though, and in practice much of the work within these three sectors is subsistence self-employment in poor countries (Gollin, 2008). The movement of workers from subsistence self-employment to market work is one of the most salient features of development, though it has not been incorporated so far into the literature about the determinants of aggregate hours worked. Ngai and Pissarides (2008) and Bridgman, Duernecker, and Herrendorf (2018) distinguish between market and non-market work, though neither paper tries to account for extensive and intensive margins of aggregate labor supply.[2]

2 Patterns of Labor Supply Across Countries

In this section, we review the main aggregate facts of labor supply across countries, which come from Bick et al. (2018), focusing on the extensive and intensive margins of labor supply and how they vary with income per capita. We then present some new evidence on average hours per worker by sector.

The data underlying the facts presented in the figures and tables of this section come from

[1] In the very long run hours fall in our model so long as productivity and wages continue to grow, since fixed costs cannot fall below zero and our preferences feature income effects that dominate substitution effects.

[2] The same is true of Vandenbroucke (2009) and Kopytov, Roussanov, and Taschereau-Dumouchel (2021), who focus on the decrease in the relative price of leisure goods over time, and Restuccia and Vandenbroucke (2013) and Cervelatti and Sunde (2013), who focus more on the effect of the rise in life expectancy on hours worked.

labor force surveys from 48 countries worldwide, as detailed in Bick et al. (2018). We use the core countries from that study, which have data that are best internationally comparable, but omit Laos, since it lacks data on education. Most of the surveys in low-income countries studied by Bick et al. (2018) ask respondents separately about employment and hours of work at wage jobs, non-agricultural self-employment and agricultural self-employment. Therefore, we consider an employed person to be one that is employed in any of the three categories, and compute hours worked for that individual as the sum of hours at the three categories.

Figure 1A shows the key fact of decreasing hours worked per adult (15 years or older) over the development spectrum. The vertical lines divide countries into those belonging to the poorest, middle, or richest tercile of the world income distribution according to the Penn World Tables. Hours per adult decrease by 9.1 hours between the average poor and rich country, with most of the decrease between poor and middle-income countries.

Underlying the aggregate hours worked data are the extensive and intensive margins of labor supply. Figure 1B plots the employment rates (the extensive margin) against GDP per adult. Employment rates fall strongly between low- and middle-income countries, but then slightly increase towards the high-income countries. Taking averages across country-income groups, employment rates fall by 22.1 percentage points from the low- to middle-income countries, and then rise by 2.2 percentage points between the middle- and high-income countries. In Appendix Figure A.1 we show that while women have lower employment rates than men on average, both genders exhibit remarkably similar patterns across the distribution of income per capita, with declines at low income levels and increases afterwards. Thus, in the cross-country data, the uptick in employment rates is not particular to women, as has been posited by Goldin (1995) and others, but a more general feature of how labor supply evolves with development.[3]

[3]Note that this feature is not prevalent in the U.S. time-series for male employment rates. According to our calculations for European countries in the European Labour Force Survey with time-series starting latest in 2002, 8 out of 20 feature male employment rates increasing over time with rising GDP per adult levels. When treating the time-series observations for these countries and the United States as separate data points, the pattern of increasing male employment rate with rising GDP per adult levels prevails. A detailed analysis of the heterogeneous time series patterns of employment rates and hours per worked in advanced economies would be interesting, but is beyond the scope of the current paper.

Figure 1C plots hours per worker (the intensive margin) across countries. Unlike employment rates, hours per worker show a slight *increase* between low- and middle-income countries, but then fall substantially by 5.5 hours between middle- and high-income countries. Again, this concave pattern of hours per worker is evident for both men and women, with changes of remarkably similar magnitude across different levels of income per capita, see Appendix Figure A.1. Furthermore, Appendix Figures A.2 and A.3 show that the patterns of labor supply are not only the same for both genders, but also for different age groups. Given systematic differences in education attendance and prevalence of public old-age security systems, the employment rate differences between poor and rich countries are larger for young and old individuals compared to the core working age population (ages 25-54).

We turn next to sectoral facts, where we distinguish between a sector characterized by subsistence self-employment (traditional sector) and one characterized by wage employment (modern sector). Our proxy for individuals working in the traditional sector is self-employed individuals with low education and unpaid family workers with low education. This is a close proxy for working in subsistence self-employment, and something we can measure in a comparable way across the countries in our data.[4]

Figure 2A shows the share of all workers working in the traditional sector: In the poor countries, almost two-thirds of workers (64 percent) work in the traditional sector. This share rapidly decreases to 19 percent in the middle-income countries, and to only 6 percent in the high-income countries. Thus, over the development process, there is a marked structural change in labor supply, as workers move from subsistence self-employment to wage work. This pattern is well known. What has not been studied systematically is hours worked for traditional-sector and modern-sector workers. Figures 2B and 2C show the corresponding cross-country patterns. Traditional-sector hours are slightly increasing by development, being 3.8 hours lower in poor than in rich countries. By contrast, modern sector hours are strongly decreasing by development: they are 11.3 hours

[4]If an individual works positive hours both in wage and self-employment, we assign the sector based on the most hours worked. For a subset of countries, we also have information on the number of employees. Classifying only self-employed individuals with low education and without any employees as being in the traditional sector has a negligible impact on the statistics presented in this section.

higher in poor than in rich countries. As a result, for the poor and middle-income countries hours are markedly lower in the traditional than in the modern sector, namely by 10.9 and 5.8 weekly hours, respectively. Only for the rich countries are hours higher in the traditional sector, with a difference of 4.2 hours.

Taking the patterns of sectoral hours worked per worker and sectoral shares of workers together, it becomes clear that the modest increase in weekly hours worked per worker between low- and middle-income countries does not arise because of an increase in sectoral hours worked per worker, but is due to a compositional effect: hours are markedly lower in the traditional than in the modern sector in both low- and middle-income countries, and the substantial decrease in the share working in the traditional sector between low- and middle-income countries thus causes the small increase in average hours worked per worker. The small increase in hours per worker in the traditional sector marginally adds to this increase. Thus, the initial fairly flat part in hours worked per worker over development is driven by this compositional effect. The decreasing part between middle- and high-income countries, by contrast, is driven by the strong decrease of 7.3 hours per worker in the modern sector between these two country income groups, with the large majority of individuals working in the modern sector in both country income groups. Note that these patterns are again robust for both genders and different age groups; see Appendix Tables A.1 to A.5.[5]

3 Model of Labor Supply and Structural Change

We now build and analyze a model of structural change in labor supply. The model features extensive and intensive margins of labor supply and two sectors: a traditional self-employment sector and a modern wage sector. Given that the empirical patterns in question are similar for both genders and across age groups, we abstract from modeling age and gender. The model also includes two more standard determinants of labor supply: preferences in which income effects

[5] One potentially relevant factor for the decrease in hours per worker in the modern sector is the regulation of work hours. The World Bank's Doing Business Report provides country-level data on two main types of hours regulation used in practice, namely legal limits on the number of hours that can be worked per day, and legal limits on the number of days that can be worked per week. Neither series is correlated with GDP per capita, however, as Figure A.4 in the Appendix shows. Thus, while differential regulation of hours may well be important for explaining variation in hours across countries of similar income levels, it is not a prime candidate for explaining why individuals in richer countries work less on average than those in poorer countries.

potentially dominate substitution effects, and distortionary tax-and-transfer systems.

3.1 Environment

Households and Individuals. There is a continuum of households of mass one in each country, and a continuum of individuals of mass one in each household. We allow for risk sharing within households, and no insurance across households (as in Heathcote et al., 2014). Households differ in their modern sector productivity z with $\log z \sim N(0, \sigma_z^2)$. This is broadly consistent with the views of Caselli and Coleman (2001) and Porzio and Santangelo (2019), who posit that human capital matters mainly in non-agricultural work. Individuals within a household differ only in their individual fixed disutility of work $\eta \in \mathbb{R}_+$, where η is continuously distributed with the CDF $F(\eta)$ and the PDF $f(\eta)$. This individual fixed disutility of work is multiplied with a sector-specific disutility of work $\bar{u}_S$, where S represents the sector. We assume the standard utility function of an individual considered in Heathcote et al. (2014) but augment it by including the disutility of work:

$$u(c,h;S,\eta) = \frac{c^{1-\gamma}}{1-\gamma} - \alpha \frac{h^{1+\frac{1}{\phi}}}{1+\frac{1}{\phi}} - \bar{u}_S \eta I_{h>0}, \tag{1}$$

where c and h are individual consumption and hours worked, and $I_{h>0}$ is an indicator equal to 1 if the individual works. In what follows, variables c and h refer to the individual level, and C and H to the household level. Each household is headed by a household head who maximizes the sum of the utility of all household members with equal weight.

Two Sectors of Production. The household can decide to work either in the traditional (T) or in the modern sector (M). The modern sector features a constant returns to scale technology with aggregate labor productivity A_M. Household income in the modern sector is thus equal to the hourly wage w multiplied by household market productivity z and household hours H, i.e. $Y_m = wzH$.

The traditional sector, by contrast, features a decreasing-returns-to-scale technology, and household income in the traditional sector equals $Y_T = A_T H^\rho$ with $0 < \rho < 1$, where A_T is the traditional sector labor productivity. The decreasing returns to scale technology provides a parsimonious way of capturing the small scale of family farms or businesses in the developing world (Adamopoulos and Restuccia, 2014), the seasonality in agricultural production (Paxson, 1993), and the lack of well-functioning land or capital markets to increase scale (see e.g. Jayachandran, 2006, or Karlan et al., 2014). Thus, the marginal product of labor is decreasing in labor supply for those in the traditional sector, and the household is the residual claimant on all profits earned in the traditional sector.

Working in the modern sector is associated with positive fixed costs $\bar{u}_M > 0$, while accessing the traditional sector is not associated with a fixed cost, i.e. $\bar{u}_T = 0$. Moreover, labor income in the traditional sector remains untaxed, due to limited tax enforceability in this sector (see Jensen, 2019).

3.2 Equilibrium Analysis

Household's Problem. The household head faces a two-stage maximization problem. In the first stage, she chooses household hours H, consumption C, and the sector of employment S. In a second stage, given household hours and consumption, she chooses individual hours h and consumption c. We solve the maximization problem by backward induction. Given (C, H, S), the second stage maximization problem amounts to

$$\begin{aligned} \max_{\{c(\cdot),h(\cdot)\}} \quad & \int u\left(c(\eta), h(\eta); S, \eta\right) dF(\eta) \\ \text{s.t.} \quad & \int c(\eta) dF(\eta) = C \\ & \int h(\eta) dF(\eta) = H. \end{aligned} \tag{2}$$

The first-order condition for consumption implies perfect consumption risk sharing within the household, i.e. $c(\eta) = C$ for all η. Also, due to the separability of disutility arising from working at the extensive and intensive margin, there is no variation within the household in optimal hours worked conditional on working. The optimal hours are then $h(\eta) = h^* > 0$ for $\eta \leq \eta^*$ and $h(\eta) = 0$ otherwise.

The household head's problem therefore reduces to determining a threshold level η^*: all household members with a disutility of work below this threshold level work the same positive hours

$h^* = \frac{H}{F(\eta^*)}$, and all household members with a disutility above this threshold level do not work. Given household hours H, hours worked per working household member are decreasing in the share of household members working, i.e., $\frac{dh^*}{d\eta^*} < 0$.

Substituting the optimal decisions into the objective function of the problem (2) gives the household utility:

$$U(C,H,S) \equiv \frac{C^{1-\gamma}}{1-\gamma} - \alpha \frac{H^{1+\frac{1}{\phi}}}{1+\frac{1}{\phi}} (F(\eta^*))^{-\frac{1}{\phi}} - \bar{u}_S \int_0^{\eta^*} \eta dF, \tag{3}$$

which looks different from the individual utility (1), mirroring the result in Constantinides (1982). After substituting the optimal consumption c and hours $h(\eta)$ described above, the first-order condition of the second stage problem (2) with respect to η^* is:

$$\alpha \frac{{h^*}^{1+\frac{1}{\phi}}}{1+\frac{1}{\phi}} f(\eta^*) + \bar{u}_S \eta^* f(\eta^*) = -\alpha {h^*}^{\frac{1}{\phi}} F(\eta^*) \frac{dh^*}{d\eta^*}. \tag{4}$$

The first term on the left-hand side of Equation (4) is the disutility from working h^* hours for the new workers of mass $f(\eta^*)$ that start working when the optimal threshold level η^* is marginally changed. The second term adds to this the fixed utility costs incurred by these workers. These marginal utility losses of the new workers are equated at the optimum with the marginal utility gains the already existing workers of mass $F(\eta^*)$ enjoy because of the decrease in their hours worked, which is expressed on the right-hand side. Equation (4) thus implicitly defines the optimal threshold level η^* as a function of household hours $H = h^* F(\eta^*)$.

Assuming that the individual fixed utility cost of working is uniformly distributed with $\eta \sim U(0,1)$ and thus $F(\eta) = \eta$, we can solve η^* in closed form:

$$\eta^* = \min\left\{ \left(\frac{1}{\bar{u}_S} \frac{\alpha}{1+\phi} H^{1+\frac{1}{\phi}} \right)^{\frac{\phi}{1+2\phi}}, 1 \right\}. \tag{5}$$

This equation illustrates the trade-off that the household head faces between intensive and extensive margins of labor supply. If the household head chooses the traditional sector, she will make all household members work, i.e., $\eta^* = 1$, as the fixed cost of working in that sector is zero, $\bar{u}_T = 0$. If she instead chooses the modern sector where $\bar{u}_M > 0$, she will make only the members with low individual fixed cost η work, i.e., $\eta^* < 1$, unless household hours H are sufficiently high (see Appendix B for the upper bound of H that gives an interior solution). As H increases, the household head sends more workers by choosing a higher η^* in order to keep individual hours ($h^* = H/\eta^*$) relatively low. This force interacts with the curvature of labor supply ϕ in Equation (5).

In the first stage, the household head solves the following maximization problem:

$$\begin{aligned} \max_{C,H,S\in\{T,M\}} \quad & U(C,H,S) \\ \text{s.t.} \quad & (1+\tau_c)C = Y_S - \mathscr{T}_S(Y_S) + \Upsilon, \end{aligned} \tag{6}$$

where $Y_M = wzH$, $Y_T = A_T H^{\rho}$, τ_c is a linear consumption tax, $\mathscr{T}_S(Y_S)$ are non-linear income taxes, and Υ are lump-sum transfers. We denote the solution to the household's problem by $\{C(z), H(z), S(z)\}_{z\in\mathbb{R}_{++}}$.

Government Budget. The government budget is balanced in equilibrium:

$$G + \Upsilon = \sum_{S=T,M} \left[\int \left(\mathscr{T}_S(Y(z)) + \tau_c C(z) \right) 1_{\{S(z)=S\}} dF_z \right], \tag{7}$$

where G is government spending that does not affect the utility of households.

Equilibrium. A stationary equilibrium consists of a set of decision rules $\{c(\eta), h(\eta)\}$ and $\{C(z), H(z), S(z), \eta^*(z)\}$, a wage rate w, and the government policies $\{\tau_c, \mathscr{T}_T(\cdot), \mathscr{T}_M(\cdot), G, \Upsilon\}$ such that: (1) given the price and policies, the decision rules solve households' problems (2) and (6); (ii) the wage satisfies $w = A_M$, (iii) the labor market clears, and (iv) the government budget constraint (7) is satisfied.

3.3 The Process of Development

We solve the model for each level of development and two sets of variables differ exogenously by development: (i) the aggregate productivity levels in the modern and traditional sector A_M

and A_T; and (ii) the size of the tax-and-transfer system $(\tau_c, \mathscr{T}_T(\cdot), \mathscr{T}_M(\cdot), G, \Upsilon)$. Furthermore, we also introduce a wedge ω for the fixed cost of working in the modern sector. In particular, we assume that the fixed costs of working are given by $\omega \times \bar{u}_M$, with ω also varying systematically with development. Anticipating our estimation results, this wedge is needed to match the data successfully.

4 Model Estimation

This section describes how we estimate the model to minimize the distance between ten moments of the data from the high- and low-income countries and their model counterparts. We show how the model's preference parameters, fixed costs of modern work and production functions are identified by the sectoral employment shares and patterns of hours worked in the data. Overall, we find that the model does well in matching the convex pattern of employment rates in income per capita, and the concave pattern of hours per worker, over the full development spectrum.

4.1 Tax-and-Transfer Systems

To parameterize the model, we need to discipline the size of tax-and-transfer systems across countries. For this model input, we generate novel empirical evidence for how the degree of tax progressivity, the importance of labor income taxes, and the share of social benefits change over the full development spectrum. To do this, we draw on two different data sets, and use available information for as many countries as possible for each input.

Our main data source is Egger et al. (2019), who assemble a comprehensive database of statutory tax codes across countries. To do so, they draw on official data from the IMF, the World Bank, the OECD, other government sources from individual countries, and data on taxation by private companies. To operationalize these data for use in our quantitative analysis, we assume the functional form for a progressive tax system used by Bénabou (2002) and Heathcote et al. (2014), with net income $\tilde{y}$ being given by

$$\tilde{y} = y - \mathscr{T}(y) = y - \left(y - \lambda y^{1-\tau}\right) = \lambda y^{1-\tau}, \tag{8}$$

where λ is informative about the level of taxation and τ about the progressivity. For $\tau = 0$, $1 - \lambda$ represents a proportional tax on income, whereas for $\tau = 1$, net income is independent of gross income. We estimate τ for each country based on the data set compiled by Egger et al. (2019). Specifically, for each country we combine data on the average gross income at each percentile of the income distribution and the implied net income, where the latter is calculated for a single individual without children, and using statutory tax codes excluding any transfers that are not incorporated directly into the tax system. Taking logs of Equation (8), we estimate τ for each country from a regression of log net earnings on log gross earnings.[6] We then set λ such that the equilibrium share of government revenue coming from labor income taxes corresponds to the one in the data, which we also obtain from Egger et al. (2019).[7]

We set the consumption tax rate such that the equilibrium government revenue to GDP ratio equals its data counterpart in the Egger et al. (2019) data, assuming a balanced budget. Thus, consumption taxes in our parameterization implicitly also contain revenues coming from tariffs or corporate taxes, assuming that all these revenues are raised as linear taxes on households. Finally, we redistribute only a fraction of government revenues to households. Specifically, we set Υ relative to the aggregate output equal to the share of social benefits over GDP, which we obtain from the IMF government statistics.[8]

Figure A.5 plots the resulting components of the tax-and-transfer system that we use as an input into the model. We apply a piecewise linear interpolation of the averages for all variables over countries belonging to the poorest, middle, and richest terciles of the world income distribution,

[6] Chang, Chang, and Kim (2018) and Holter, Krueger, and Stepanchuk (2019) also estimate the degree of tax progressivity for OECD countries using Equation (8). For the same set of countries, Figure A.6 shows that our measure of tax progressivity lines up more closely with Holter, Krueger, and Stepanchuk (2019) than with Chang, Chang, and Kim (2018). As in Holter, Krueger, and Stepanchuk (2019) the calculation of net incomes in Egger et al. (2019) which we use for our estimates of progressivity relies on statutory tax codes, whereas Chang, Chang, and Kim (2018) rely on reported gross and net incomes from household surveys and also include transfers not incorporated directly into the tax system.

[7] We take the sample of 62 countries with information on the share of government revenues coming from labor income taxes also for the estimation of the progressivity parameter, i.e. the sample of countries is consistent for the different fiscal inputs coming from Egger et al. (2019).

[8] These social benefits include the provision of medical services, unemployment compensation, and social security pensions. We think of these as direct transfers to households, and treat all other government expenditure as either not affecting household utility, or alternatively as an added utility shifter that does not affect household choices.

as measured by GDP per adult in the Penn World Tables. The estimate of progressivity is slightly U-shaped, exhibiting a slight decrease from low- to middle-income countries and a substantial increase from middle- to high-income countries. The share of government revenue coming from labor income taxes is small and almost flat from low- to middle-income countries, but sharply increases from middle- to high-income countries. The size of government transfers relative to GDP increases from the poor to middle-income countries and then somewhat stronger from the middle to the richest countries. Similarly, the estimate of government revenue increases over the development spectrum, with a sharp increase from the middle to the richest countries.

These government revenues relative to GDP can be interpreted as the overall burden of taxes. Taking this perspective, in the poorest tercile countries in our data, taxes are on average around 15 percent of GDP. In the richest tercile, in contrast, taxes are about 33 percent of GDP. Thus, by this metric, the tax burden is about 2.2 times as high in the richest countries as in the poorest. Since these taxes are distortionary, and because redistribution of taxes is perceived as outside income by the households, this will translate qualitatively into lower hours worked in richer countries in our model.

4.2 Individual Labor Productivity

Individual labor productivities, capturing permanent differences across households, are assumed to be log-normally distributed with mean 1. To estimate the variance of the distribution, we exploit the panel component of the Current Population Survey (CPS). We estimate a panel fixed effects regression of log income per hour, following Lagakos and Waugh (2013), and take the variance of the individual fixed effects (0.224) to be the variance of the (log) permanent productivity differences in our model.

4.3 Estimation

We jointly estimate the remaining ten model parameters to replicate ten key moments from the data. We construct all our estimation targets for the "average poor country" and "average rich country," leaving the middle of the world income distribution un-targeted. The moments we target are: (1 and 2) the average employment rates in the poor and rich countries; (3 to 6) average hours per worker in the traditional and modern sectors in the poor and rich countries; (7 and 8) the traditional sector employment shares in the poor and rich countries; (9 and 10) the average GDP per adult in the poor and rich countries.

The parameters to estimate are $\Theta = \{\gamma, \alpha, \phi, \bar{u}_M, \omega, \rho, A_T^P, A_T^R, A_M^P, A_M^P\}$. These represent the curvature parameter on consumption in preferences (γ), the weight (α) and curvature parameter (ϕ) on hours worked in preferences, the fixed costs of market work in the average poor country ($\bar{u}_M$), the wedge in fixed costs between rich and poor countries (ω), the returns-to-scale parameter in the traditional sector (ρ), the traditional-sector productivity terms in the average poor country (A_T^P) and average rich country (A_T^R), and the modern-sector productivity term in the average poor country (A_M^P) and rich country (A_M^R). We estimate Θ by minimizing the percent differences between model and data moments with sectoral hours being weighted by their respective sectoral share.[9]

Table 1 reports the targeted moments in the model and data, including bootstrapped 95 percent confidence intervals for the data moments. Overall, the estimated model does quite well in matching the data. The only moment with a sizable difference is hours per worker in rich countries in the traditional sector, which are slightly higher in the data in rich than in poor countries.

Table 2 reports the estimated parameters and bootstrapped 95 percent confidence intervals. The estimated curvature on consumption, γ, is 1.21, and its confidence interval lies entirely above one, implying income effects that dominate substitution effects and hence hours falling with productivity (see Appendix B). This is consistent with the literature on income effects driving hours worked decreases, though that literature has not agreed on a specific range for this parameter value. Our estimate is also broadly in line with that of Heathcote et al. (2014), who estimate dominant income effects in labor supply using a panel of U.S. households covering the last several decades. The estimated curvature on labor supply, ϕ, is 0.51, and its confidence interval of 0.45 to 0.58 lies within a range of commonly used values at the individual level (see the intensive-margin estimates

[9]To help illustrate how the targeted moments help identify the model parameters, Appendix Table A.6 reports the derivative of each targeted moment with respect to each parameter. At a broad level, the table shows that targeting sectoral-level moments, rather than just aggregate moments, is useful in identifying the model. For example the fixed costs of labor supply are informed not just by employment rates but by sectoral employment shares.

surveyed in Blundell and MaCurdy, 1999, and Keane, 2011).

The fixed costs of labor supply in the modern sector $\bar{u}_M$ are estimated to be 0.39. The confidence interval for $\bar{u}_M^P$ is fairly wide, reflecting the relatively larger variance in traditional sector shares in the poorer countries. The wedge applied to the fixed costs in the average high-income country is 0.45, meaning substantially larger fixed costs in the poorer economy. The magnitudes of the model's estimated fixed costs are consistent with previous estimates in the literature. For example, expressing the final fixed costs, i.e. $\omega \times \bar{u}_M^P$, in units of time, workers in the modern sector of rich countries would be willing to work 26 percent more hours to avoid these fixed costs of work. This translates into 458 hours per year. The equivalent number for poor counties is 588 hours per year. The value for rich countries is well within the wide range of estimates of reported fixed costs by French (2019) in his study of labor supply and health shocks in the United States.

The returns to scale parameter in the traditional sector, ρ, is estimated to be 0.85, consistent with decreasing returns in household labor supply there. The confidence interval for ρ is fairly wide, but we can reject constant returns to scale.

The productivity parameters are easiest to interpret when considering them relative to each other. Poor countries are 19 percent as productive as rich countries in their traditional sectors $\left(A_T^P/A_T^R\right)$, and 8 percent as productive in the modern sector $\left(A_M^P/A_M^R\right)$. For poor countries the traditional sector is 56 percent as productive as the market sector, whereas for rich countries it is only 24 percent as productive. The larger productivity differences in the modern sector than in the traditional sector as well as the larger between-sector productivity difference in richer countries are both drivers of sectoral reallocation in the model, and are broadly consistent with the literature on skill-biased technology differences across countries (Caselli and Coleman, 2006; Malmberg, 2020).

4.4 Model Fit

In this section, we discuss the model fit relative to key non-targeted moments, in particular the shapes of the different variables over the entire development spectrum. While we target labor supply facts in the average poor and rich country, the facts for all other countries—in particular the entire middle of the world income distribution—are not targeted.

To construct country-specific model values for all variables, we proceed as follows. First, we assume the logarithm of aggregate traditional sector productivity $\log(A_T)$ and the wedge for the fixed cost of working in the modern sector ω both change linearly in $\log(A_M)$. Second, we assume all fiscal inputs (i.e., tax progressivity, the share of government revenue coming from labor income taxes, the ratio of government revenue to GDP, and the share of government consumption) change piecewise linearly in $\log(A_M)$. For each level of A_M, we then solve for optimal allocations.

Figure 3 compares the model predictions (blue line) against the data (small red dots). The large red dots denote the averages by country groups in the data, and the stars mark the subset of targeted moments. Panel (a) in the upper left corner shows that hours per adult decrease at a similar rate in the model as in the data. In fact, average hours per adult in the middle-income countries are replicated almost exactly by the model. Panel (b) then focuses on the share of workers in the traditional sector: as in the data, this share decreases rapidly between poor- and middle-income countries, and approaches zero in the richest countries. The lower two panels (c) and (d) show that the model replicates the different behavior of the two margins of hours per adult. Employment rates are decreasing strongly between low- and middle-income countries, with a modest increase for the richest countries, while hours per worker are similar between low- and middle-income countries on average, and substantially lower in the richer countries. Thus, while the model does not perfectly match the shapes, it generates both the convex decrease in the employment rates, including the uptick in the richest countries, and the concave decrease in hours per worker over the development spectrum.

The success behind generating the different shapes of the two margins of labor supply stems from structural change, i.e. households moving from the traditional to the modern sector over the development spectrum, and decreasing fixed costs of work in the modern sector. Because of the absence of fixed costs in the traditional sector, the employment rate in the traditional sector is always 1 in the model. By contrast, the employment rate in the modern sector is significantly below 1, but increasing in development due to the decrease in the fixed cost of working there via the wedge ω. The strong decrease in the traditional sector share from 64 percent to less than 20 percent between low- and middle-income countries generates the decrease in the employment rate between these two country groups. In both middle- and high-income countries, by contrast, the large majority of households work in the modern sector, and the decrease in the fixed cost in this sector generates the mild increase in the employment rate.

Besides the sectoral share, sectoral hours are important for aggregate hours per worker. Due to the absence of fixed cost of working and the decreasing returns to scale in the traditional sector, model-predicted hours per worker in the modern sector are higher than in the traditional sector over the full development spectrum (see Appendix Figure A.7). In both sectors, hours are decreasing with development, only at a slightly faster rate in the modern sector. The sectoral reallocation out of the traditional sector generates the flat hours per worker in the aggregate between poor and middle-income countries. The fall-off between the middle- and high-income countries then largely mimics the decrease in hours per worker in the modern sector.

Two further non-targeted moments of importance are the ratios of earnings and consumption for households working in the modern vs. traditional sector. This is most informative in the poor countries, where the majority of households work in the traditional sector. In the model, households in the average poor country in the modern sector have 2.0 times higher earnings and 1.9 times higher consumption than households in the traditional sector. This is in line with evidence that households working in non-agriculture have 2.1 times higher earnings and 1.7 times higher consumption than households in agriculture in poor countries (Gollin, Lagakos, and Waugh, 2014).

5 Investigating the Mechanisms of Structural Change

Structural change in labor supply has two channels in our model: sectoral reallocation from the traditional to the modern sector, and declining fixed costs of work with development. In this section, we investigate the importance of these two channels in matching the cross-country data. First, we estimate a model in which fixed costs only apply in the modern sector, but are not allowed to change by development. Second, we estimate a model in which we assume that the same fixed costs of work apply in the traditional sector as in the modern sector. These exercises help illustrate which features of our model are necessary to match the facts at hand.

In the first re-estimation exercise, we impose that the fixed costs of work in the modern sector stay constant by development. This implies that we have one less parameter to estimate, namely ω. Consequently, we also use one less estimation target, and target average hours per worker in the rich countries, rather than hours in each sector.

The results are presented in Figure 4, and estimated parameter values are reported in Appendix Table A.8. The model matches the decreasing traditional sector share well, and to some degree hours worked per adult. However, it overestimates the decrease in the employment rate by almost 7.9 percentage points, or 40 percent in relative terms, and fails to predict the uptick in employment for the richest countries. The strong decrease in employment arises because the counteracting force of decreasing fixed costs of work with development is now missing. Consequently, the income effects have to be smaller now than in the baseline model, and in fact the estimation of γ implies that income and substitution effects basically cancel each other out, resulting in nearly flat hours per worker in the upper end of the development spectrum, when almost all workers are in the modern sector. Hours per adult are still matched well because the sectoral reallocation into the modern sector, together with increasing taxes and transfers, are strong enough to generate the decrease in hours per adult, given the absence of decreasing fixed costs of work as a counteracting force.

The second counterfactual exercise we conduct is one in which we assume that the fixed costs of work apply equally to both sectors, rather than just the modern sector. This setup leaves the number of parameters and moments unchanged from the baseline exercise in the re-estimation. Figure 6 shows the resulting model predictions; the estimated parameters are in Appendix Table A.9. This model with fixed costs of work both sector falls somewhat short in matching the traditional sector share and hours per adult in poor countries (stemming from both margins). Most noticeably, though, it counterfactually predicts that employment rates fall at a slower pace between poor- and middle-income countries and faster pace between middle- and high-income countries. That is, in contrast to the convexity displayed in the data, employment rates are concave in the model.

These two counterfactual exercises make it clear that fixed costs changing with development and applying only to the modern sector are two crucial features to match the data over the full development spectrum. In the appendix, we show that a model without any traditional sector can also not replicate the differential shapes of the two margins of labor supply over the development spectrum (see Appendix Figure A.9). In contrast we find that assuming constant returns to scale in the traditional sector (Appendix Figure A.10) or assuming full taxation in the traditional sector (Appendix Figure A.11) makes only a modest difference in matching the data, suggesting these are not the most important features in understanding the hours patterns in question.

The counterfactual experiments in this section highlight the role of lower fixed costs of working in richer countries as implied by our estimated wedge. Yet, ω is simply backed out by the moment matching exercise rather than being directly measured in the data. What does the decrease of ω in development capture? Arguably the most natural candidate is commuting time. Figure 5A shows that commuting time is higher in low-income countries than in rich countries by about 30 minutes per day. Assuming 5 days of work per week and 48 weeks per year, this would amount to a difference of about 120 hours per year. This is close to the difference of how many hours more workers in the modern sector in poor countries would be willing to work to avoid the fixed cost of working compared to workers in the modern sector in rich countries (588 vs. 458 hours, see the discussion in Section 4.3).

Is the observed higher commuting time for wage workers in poor countries quantitatively important enough to take the place of the wedge in our estimated model? The answer turns out to be no. Appendix Figure A.8 shows that a version of the model including commuting time along the intensive margin in the modern sector while abstracting from the wedge yields employment rates that are more or less linear in GDP per capita, rather than convex, and hours per worker that are not as concave as in the data. We conclude that the wedge must reflect other factors in addition to commuting time differences across countries.

In Figure 5 and Table A.7, we provide some suggestive evidence on what could be behind the decreasing fixed cost of working. Figures 5B and 5C draw on data from the Work Orientation

Module from the International Social Survey Programme (ISSP). Figure 5B shows that the share of workers employed in the modern sector according to our definition who either strongly agree or agree with the statement that they can work independently (as opposed to neither agree or disagree, disagree, or strongly disagree) is significantly positively correlated with development. This is important because the literature has documented that happiness and independence at work are positively correlated, see e.g. Benz and Frey (2004). Figure 5C relies also on subjective data, but is possibly more objective than the assessment of job independence. In particular, it shows that the share of workers in the modern sector reporting that they always or often (as opposed to sometimes, hardly ever, or never) work in dangerous conditions is strongly decreasing in GDP per adult. As a related objective measure, Figure 5D shows a significant decrease in fatal occupational injuries per 100,000 workers with GDP per adult. Thus, the lower fixed costs of working in richer countries could capture safer working conditions there. Table A.7 shows the correlation of more variables from the ISSP with GDP per adult. Next to the two variables shown in Figure 5, the share of modern sector workers finding their job interesting is significantly positively correlated with development, and the shares doing hard physical work or being exhausted from work are significantly negatively correlated with development.

Taken together, these variables are broadly supportive of the notion that the fixed costs of working in the modern sector are decreasing in development. Yet it is not obvious how much of these less attractive work conditions in poorer countries reflect a fixed, as opposed to variable, cost of supplying labor. Furthermore, it is an open question how much these conditions matter to workers in utility terms, making it hard to quantify their importance in explaining our wedge, ω. We leave these important issues for future work.

6 Decomposing the Driving Forces of the Decrease in Hours

We now analyze the quantitative importance of the different driving forces in explaining the decrease in hours worked per adult between poor and rich countries. We start with the estimated baseline model for the average poor country, then set one component after the other to the level of the average rich country in a cumulative fashion, and calculate the marginal change in hours by adding that specific component. To give a concrete example, we first change the productivity level in both sectors to the level of the rich countries, afterwards we additionally set the tax-and-transfer system to the level of the rich country, and finally let the fixed costs in the modern sector fall to the level of the average rich country. In all these three decomposition steps, we do not allow for sectoral reallocation: households are required to continue working in the same sector they optimally chose given the poor countries' environment, but they can optimally adjust their hours. The role of sectoral reallocation is assessed in the last step by allowing households to choose their sector. We conduct the decomposition exercise in a cumulative way, since the effect of sectoral reallocation between poor and rich countries on hours worked is ultimately the residual. However, this approach implies that the marginal effects of the first three steps, i.e. by how much hours per adult change when turning on a specific feature, depend on the order in which they are turned on, and there exist six possible orderings. Rather than reporting the results from each ordering, Panel A in Table 3 reports the average effect across all orderings.

Row 1 of Panel A in Table 3 shows the hours difference between the average poor and rich country predicted by the full model (9.9 hours), and the subsequent rows show the effect attributed to each model feature separately. The higher productivities in the modern and traditional sectors in rich than in poor countries predict on average a decrease of 5.7 hours, accounting for 57.6 percent of the overall predicted hours gap. The model thus predicts that on average more than half of the observed decrease in hours worked per adult between poor and rich countries can be attributed to an income effect, which is the most important driving factor of the decrease. The second most important driver of the decrease in hours per adult between poor and rich countries is one of our two features of structural change in labor supply, namely sectoral reallocation, i.e. the move from the traditional into the modern sector of production over the course of the development process. Sectoral reallocation accounts for 43.4 percent of the total hours decrease. Higher taxes and transfers have a more modest effect and predict on average an hours decrease of only 2.3 hours, accounting for a quarter (23.2 percent) of the total hours gap.

Finally, the second feature of structural change in labor supply, lower fixed costs of working in the modern sector in rich countries, alone predicts *higher* hours in rich countries, resulting on average in a negative difference of 2.4 hours between poor and rich countries. Thus, while the decreasing fixed costs of work are an important model feature to explain the convex shape of the employment rate and the concave shape of hours per worker, they do not contribute to explaining the overall decrease in hours. On the contrary, based on the decreasing fixed costs alone, hours in rich countries would be higher than in poor countries.

Table 3 also shows the results of the same decomposition exercise, but focusing on the hours decrease between poor and middle-income countries (Panel B) or between middle-income and rich countries (Panel C), respectively. Hours per adult decrease by 6.3 hours at the lower end and 3.6 hours at the upper end of the development spectrum, which affects the explanatory power of the model components in terms of percentages. The role of income effects is increasing between the lower and the upper half of the development spectrum, which stems from the fact that aggregate labor productivities change more between middle-income and rich countries than between poor and middle-income countries. As Figure A.5 shows, taxes and transfers do not change much between poor and middle-income countries, and consequently also play a minor role in explaining the decrease in hours at this development stage. In contrast, they are an important driver of the hours decrease in the upper half of the development spectrum: there, they explain 44.4 percent of the decrease, reflecting the large increase in taxes and transfers at this stage of development. The findings of the model are thus also in line with the literature that establishes taxes as an important driver of hours differences between different rich countries and in the development of hours in the rich countries over the last half-century (see e.g Prescott, 2004 and Ohanian et al., 2008).

Turning to the two forces of structural change in labor supply, sectoral reallocation is a very important driver of the hours decrease at the lower end of the development spectrum, where households move rapidly from the traditional into the modern sector. Its importance mimics the one of income effects at this stage of the development process: both explain slightly more than half of the total hours decrease. However, sectoral reallocation loses importance as a driver of the hours decrease in the upper half of the development spectrum, because already in the middle-income countries more than 80 percent of the workers work in the modern sector. The opposite holds true for the counteracting role of decreasing fixed costs: this role is muted at the lower end of the development spectrum, but then becomes stronger at the upper end, since the fixed costs only apply when households work in the modern sector. Decreasing fixed costs alone would on average predict 1.2 higher hours in rich than in middle-income countries, rather than 3.6 fewer.

7 Hours Worked in the Future

Will people continue to work less in the future, as economies continue to grow? Prognosticators since Keynes (1930) have posited that, indeed, strong income effects will lead households to demand more leisure, and work less, as labor productivity continues to rise (see Ohanian, 2008, and the references therein). The elegant preference specification of Boppart and Krusell (2020) captures the secular decline in hours with productivity growth through just this force, and predicts continued reductions in labor supply going forward. Many observers have rung the alarm over automation eliminating jobs in the future, and academic evidence does suggest a negative link between recent adoption of robots and employment, at least in the short run (see e.g. Acemoglu and Restrepo, 2020). Future increases in tax rates, and more generous transfer systems, provide additional incentives to reduce labor supply, and cross-country evidence suggests that tax-and-transfer systems will continue to expand as countries grow richer.

Our analysis suggests that declining fixed costs of work may be an important channel moving in the opposite direction, potentially stabilizing or even raising average hours worked in the future. To illustrate this point, Figure 7 computes the model's predictions for economies with income levels up to $128,000 (in 2011 International Dollars in PPP). Assuming a growth rate of GDP per adult of 2 percent per year, it will take the average rich country in our data 61 years to reach this level. For the United States, this would correspond to roughly a doubling of GDP per adult.

The model predictions in Figure 7 extrapolate from our cross-country data, meaning that they assume the same relationship between GDP per adult, the size of tax-and-transfer systems, and fixed costs of work as in our main analysis. The model's predictions for hours worked, and the two margins of aggregate labor supply, are driven therefore by higher productivity levels, higher tax rates and larger transfers, and lower fixed costs of work. The figure also includes a breakdown akin to our decomposition exercise, namely asking what would happen if only productivity continued to increase, if both productivity and taxes and transfers increased, or if additionally fixed costs continued to decrease. Since sectoral reallocation hardly plays any role anymore at this stage of development, we do not separately consider the role of sectoral reallocation.

The black dotted line in Figure 7A shows that if only productivity would continue to increase, average hours per adult would fall by 3.6 hours per work relative to the average rich country today. This is similar to what Keynes (1930) and others had in mind, with income effects dominating substitution effects in preferences. Adding the impact of an expanding tax-and-transfer system would lead to a reduction of another 2.8 hours per week (the green dashed line). Thus, the model without structural change would predict sizeable decreases in hours worked in the future, consistent with the standard views.

The solid blue line in Figure 7A shows that once declining fixed costs are added back into the model, average hours are basically unchanged compared to the average rich country today. The decreasing fixed costs are thus such a strong countervailing force that they completely offset the two other forces leading hours to fall. Figures 7B and 7C show the breakdown for the two margins. Increasing productivity and higher taxes both reduce employment and hours per worker, whereas the decreasing fixed costs operate in opposite directions on the two margins. As more people are drawn into employment, average hours per worker are reduced. In other words, decreasing fixed costs point to a world where more people work in the future, but where each supplies fewer hours. Since the employment rate is bounded, at some point this counteracting force will lose importance.

Obviously, it is unclear what the future will hold for productivity growth, tax rates, and fixed costs of market work. The goal of this section is to show that a future with less work is not a foregone conclusion. Recent advancements in gig-work like Uber or Lyft probably have reduced—and will continue to reduce—the cost of working, as did the surge in working from home amid the COVID-19 pandemic (see, e.g. Bick et al., 2021). To the extent that the fixed costs of working continue to fall, average hours worked could remain similar to current levels or even grow. This point underscores the importance of distinguishing between the drivers of hours worked across countries, and in particular in separating income effects in labor supply from the changing nature of labor supply as countries develop, as we have emphasized.

8 Conclusion

This paper explores a new source of variation in hours worked across countries, which we call *structural change in labor supply*. We emphasize two forces that accompany development: sectoral reallocation from self-employment to market wage work, and declining fixed costs of market work. The first leads employment rates to fall, and hours per worker to rise, as households transition into work arrangements characterized by high fixed costs but constant, rather than decreasing, marginal products of labor. The second leads employment rates to rise as more and more individuals enter the labor market to take advantage of jobs with lower fixed costs.

When estimated, the model is largely successful in matching the concave pattern of hours per worker in GDP per capita, and the convex pattern of employment rates. Variants of our model that ignore the transition from self-employment to market work, and the decline in fixed costs of work with development, make counterfactual predictions for these intensive and extensive margins of aggregate labor supply.

Our study offers a new perspective on the future of hours worked relative to existing studies, which focus on income effects in labor supply, automation, and expanding tax-and-transfer systems. These channels point to a future of ever lower labor supply as productivity rises, new technologies are developed, and the "welfare state" continues to expand. Our model shows that declining fixed costs are an offsetting force that can increase employment rates in the coming decades.

This paper is hardly the last word on cross-country patterns of hours worked and employment, and additional research on this topic would be valuable. Future studies could explore the role of rising schooling levels and declining fertility with development (Restuccia and Vandenbroucke, 2014; Chatterjee and Vogl, 2018; Delventhal et al., 2019), the mechanization of home production (Greenwood et al., 2005), and the rising value of leisure goods, among other forces. More detailed analyses of hours and employment patterns for women and men would also be welcome, as would further studies of the underlying drivers of changes in fixed costs of work with development.

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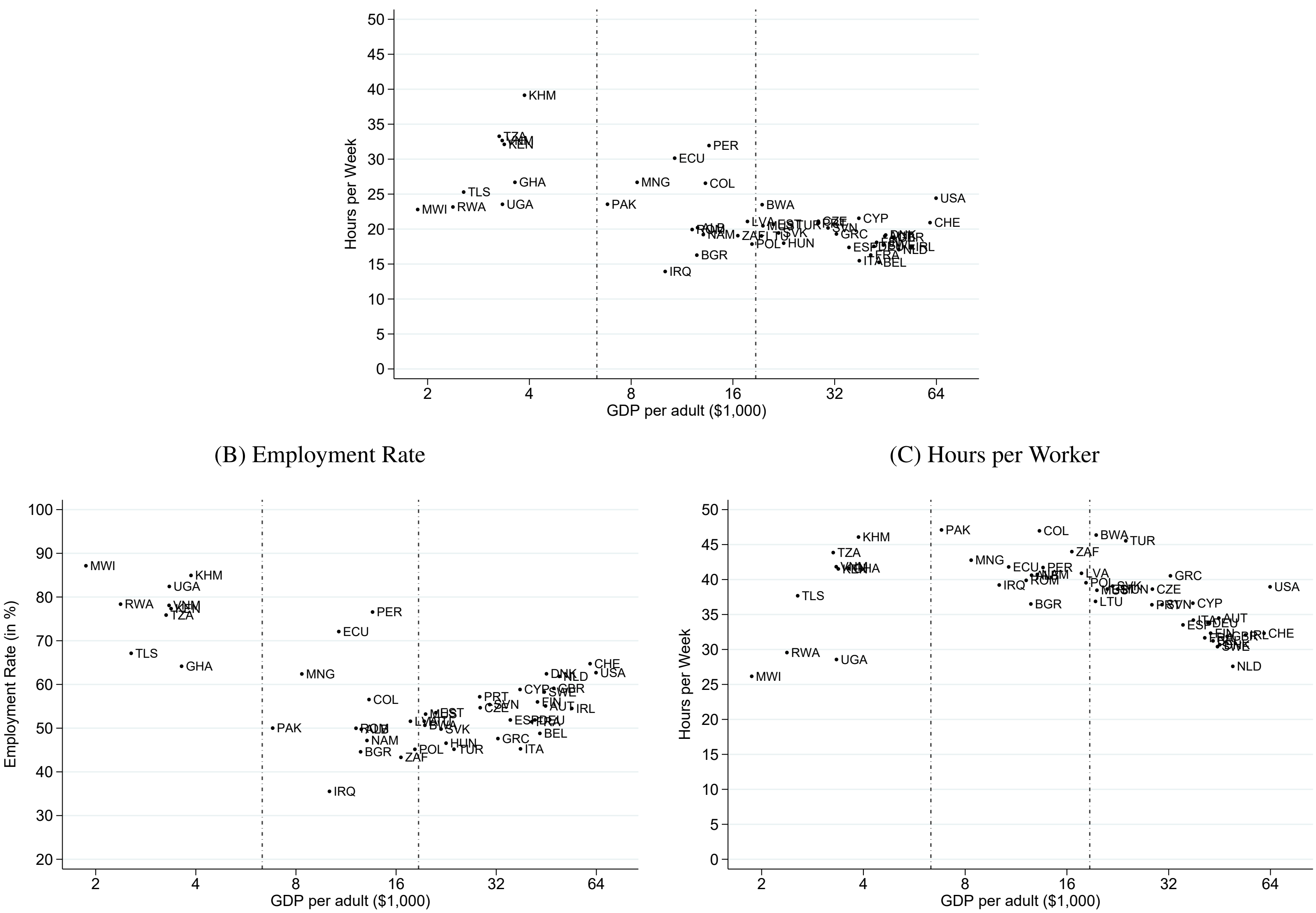
9 Figures

Figure 1: Hours per Adult and Employment Rates Across Countries

(A) Hours Worked per Adult

(B) Employment Rate

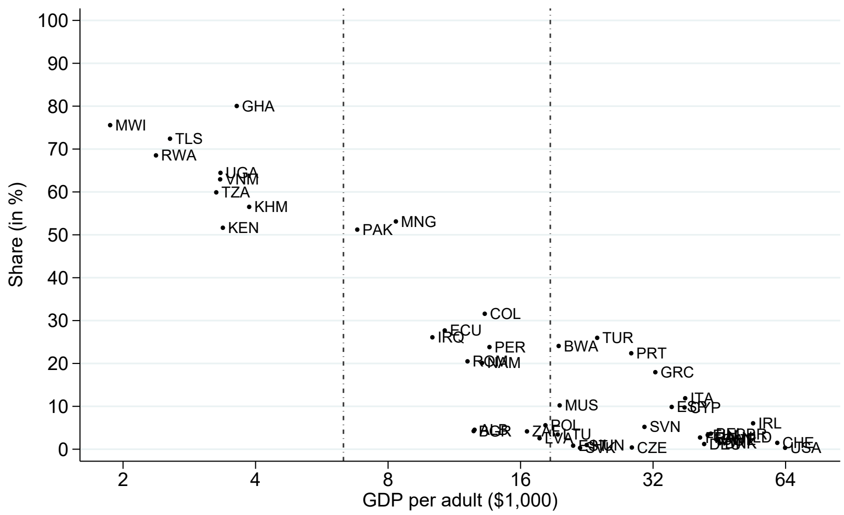
(C) Hours per Worker



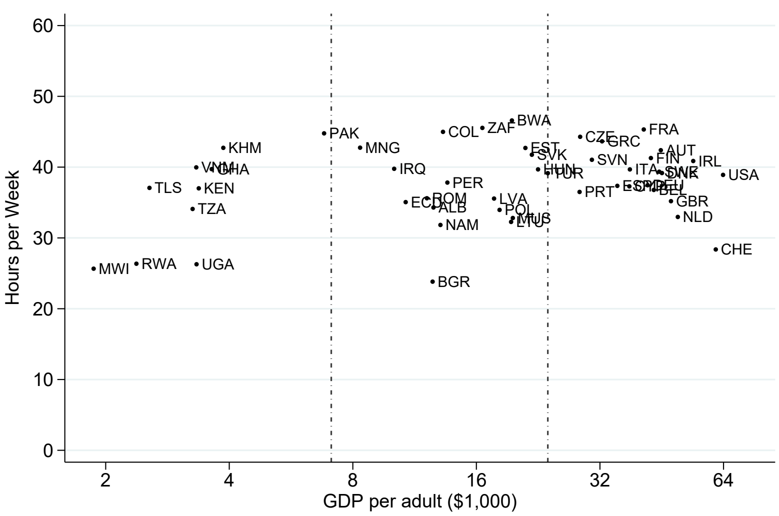
Note: This figure plots average weekly hours worked, employment rates, and hours per worker per adult by GDP per adult in thousands of international dollars. The vertical lines represent the division between low- and middle-income countries, and between middle- and high-income countries. Data source: Bick et al. (2018).

Figure 2: Sectoral Facts Across Countries

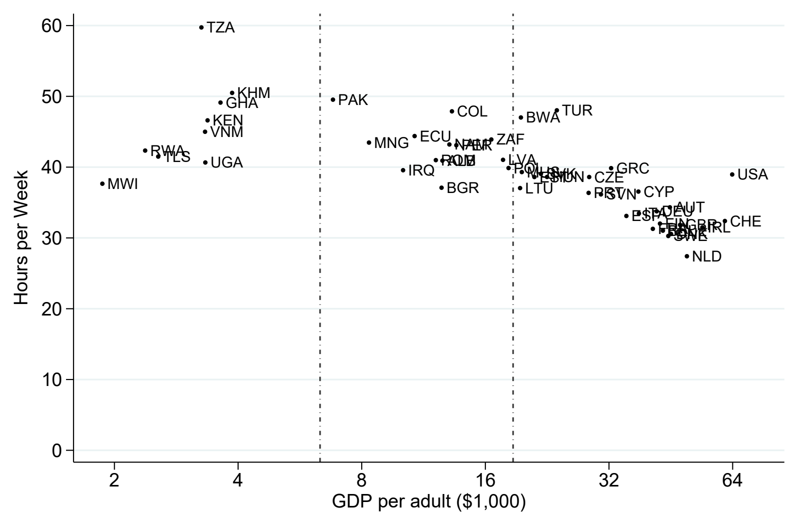
(A) Traditional Sector Share



(B) Hours per Worker Traditional Sector

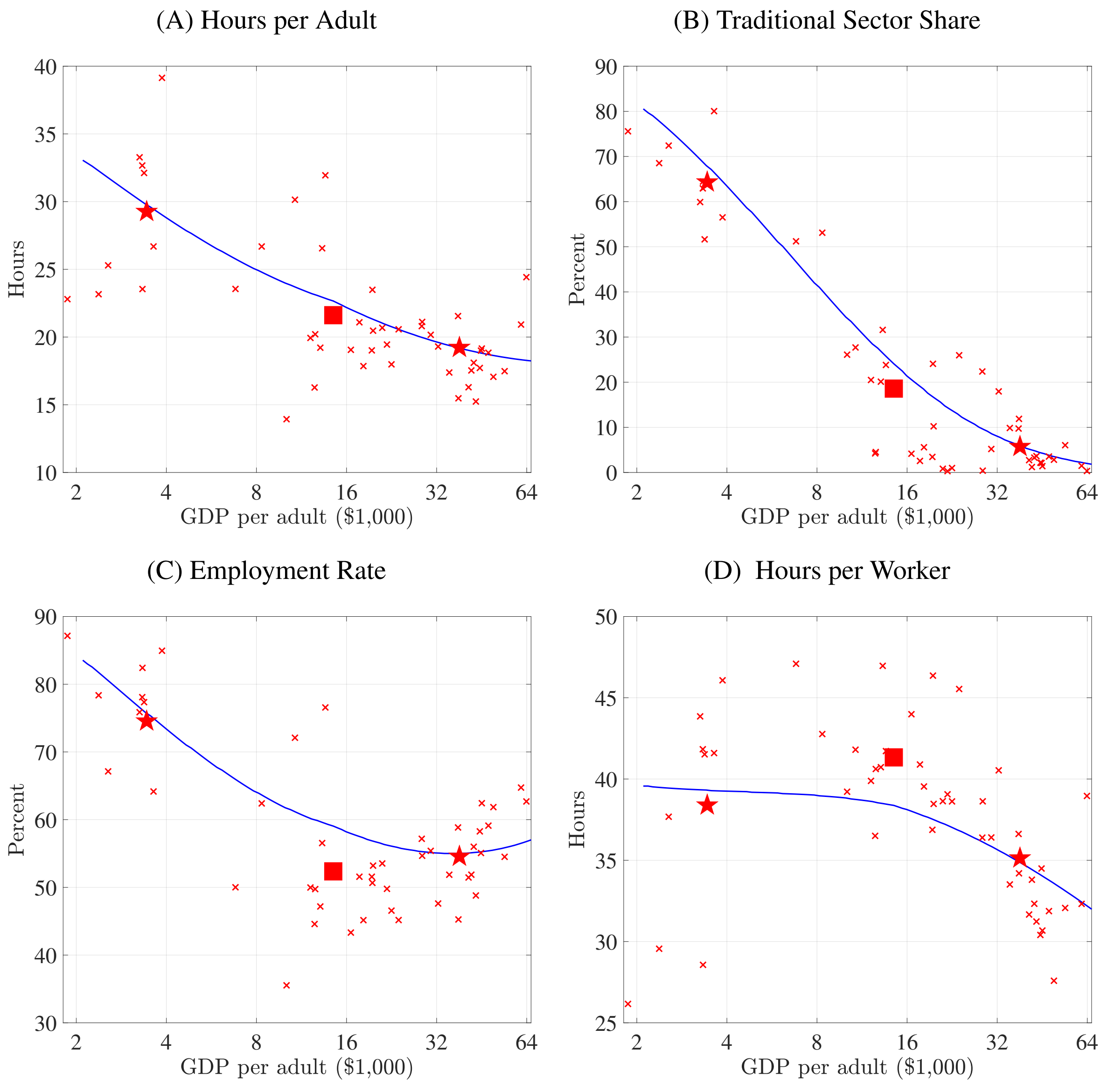


(C) Hours per Worker Modern Sector



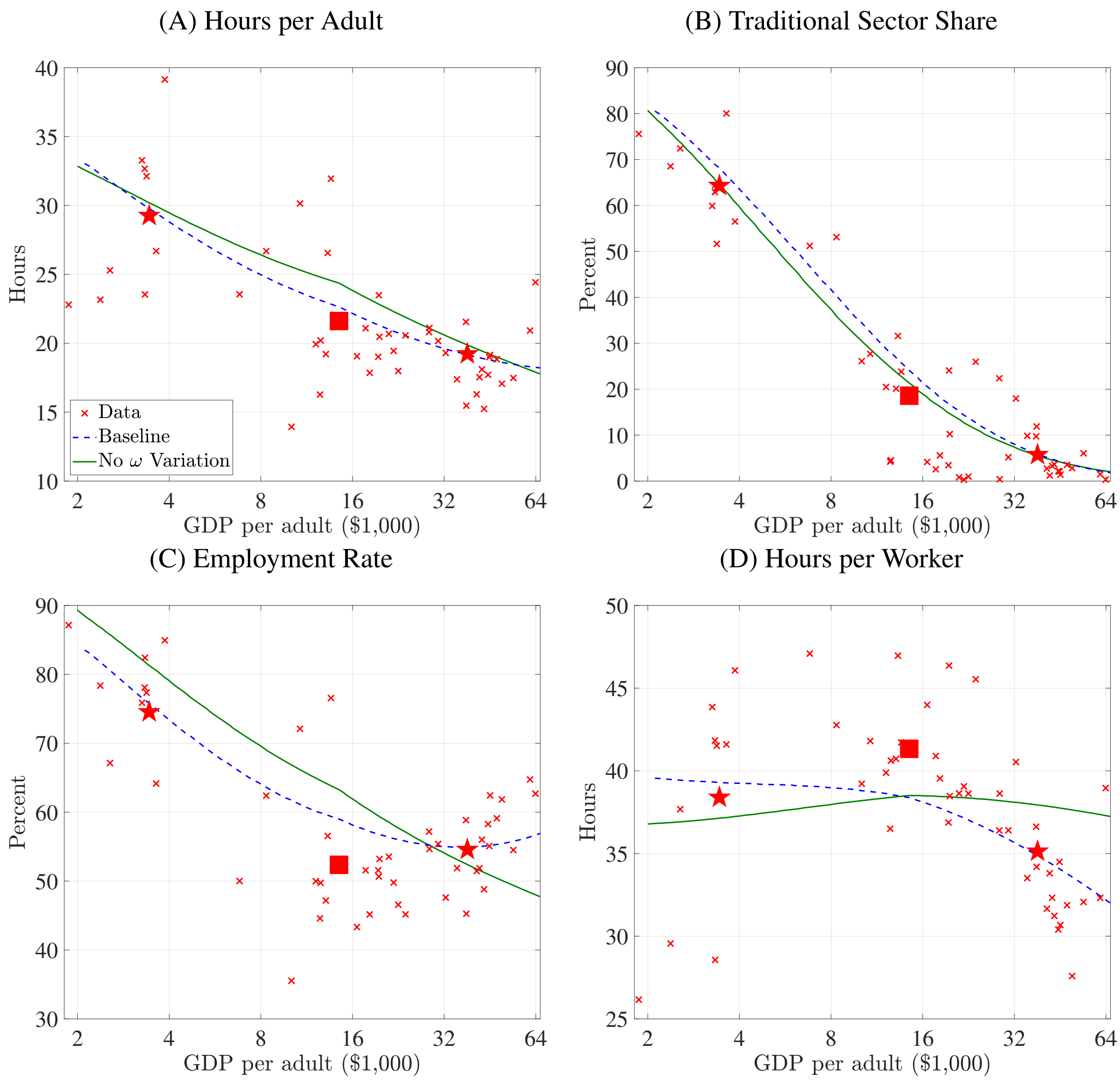
Note: This figure plots the share of employment in the traditional sector (Panel a), the average hours per worker in the traditional sector (Panel b), and the average hours per worker in the modern sector (Panel c). The vertical lines represent the division between low- and middle-income countries, and between middle- and high-income countries. Data source: Bick et al. (2018)

Figure 3: Estimated Model



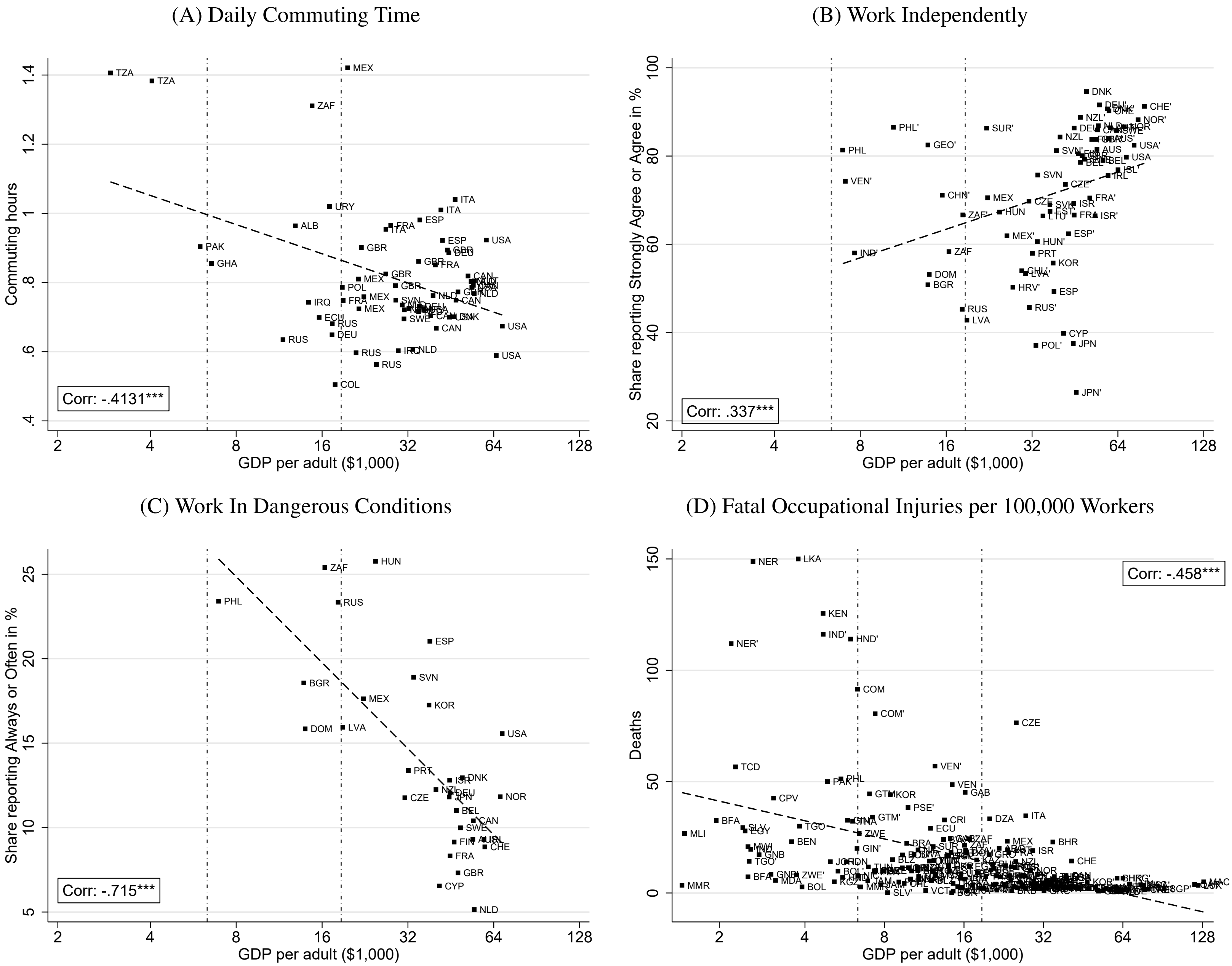
Note: This figure plots average hours per adult, employment rates, hours per worker and the traditional sector share of employment in the data and in the estimated model. Stars represent calibration targets, and squares represent un-targeted means of the low-, middle- or high-income country groups.

Figure 4: Model with Constant Fixed Costs Across Countries



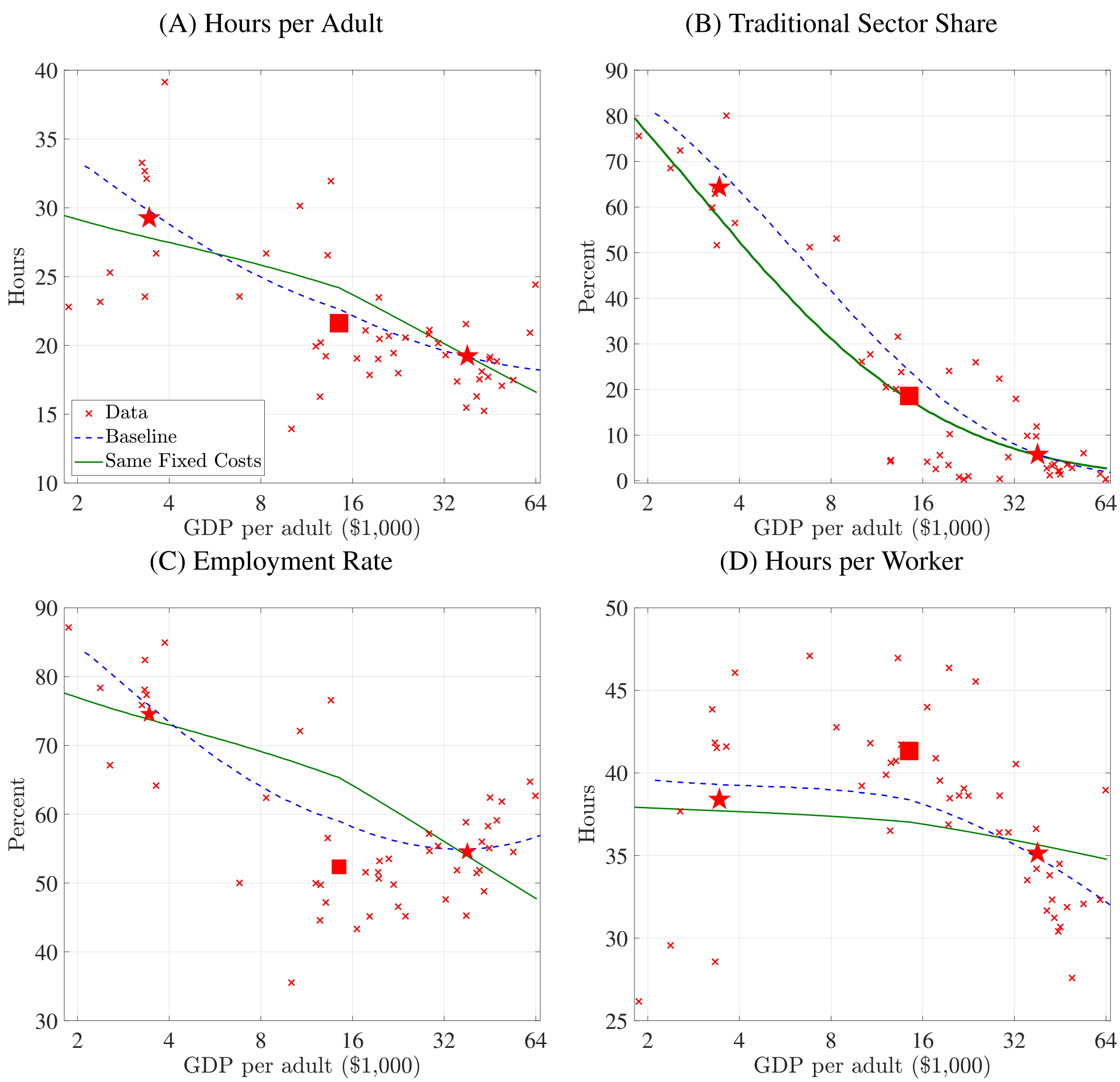
Note: This figure plots average hours per adult, employment rates, hours per worker and the traditional sector share of employment in the data and in a re-estimation of the model that restricts the fixed costs of working to be identical across countries, and present only in the modern sector. Stars represent calibration targets, and squares represent un-targeted means of the low-, middle- or high-income country groups. The dashed line reproduces the predictions from the main estimation of the model.

Figure 5: Possible Driving Forces of Decreasing Fixed Cost of Working



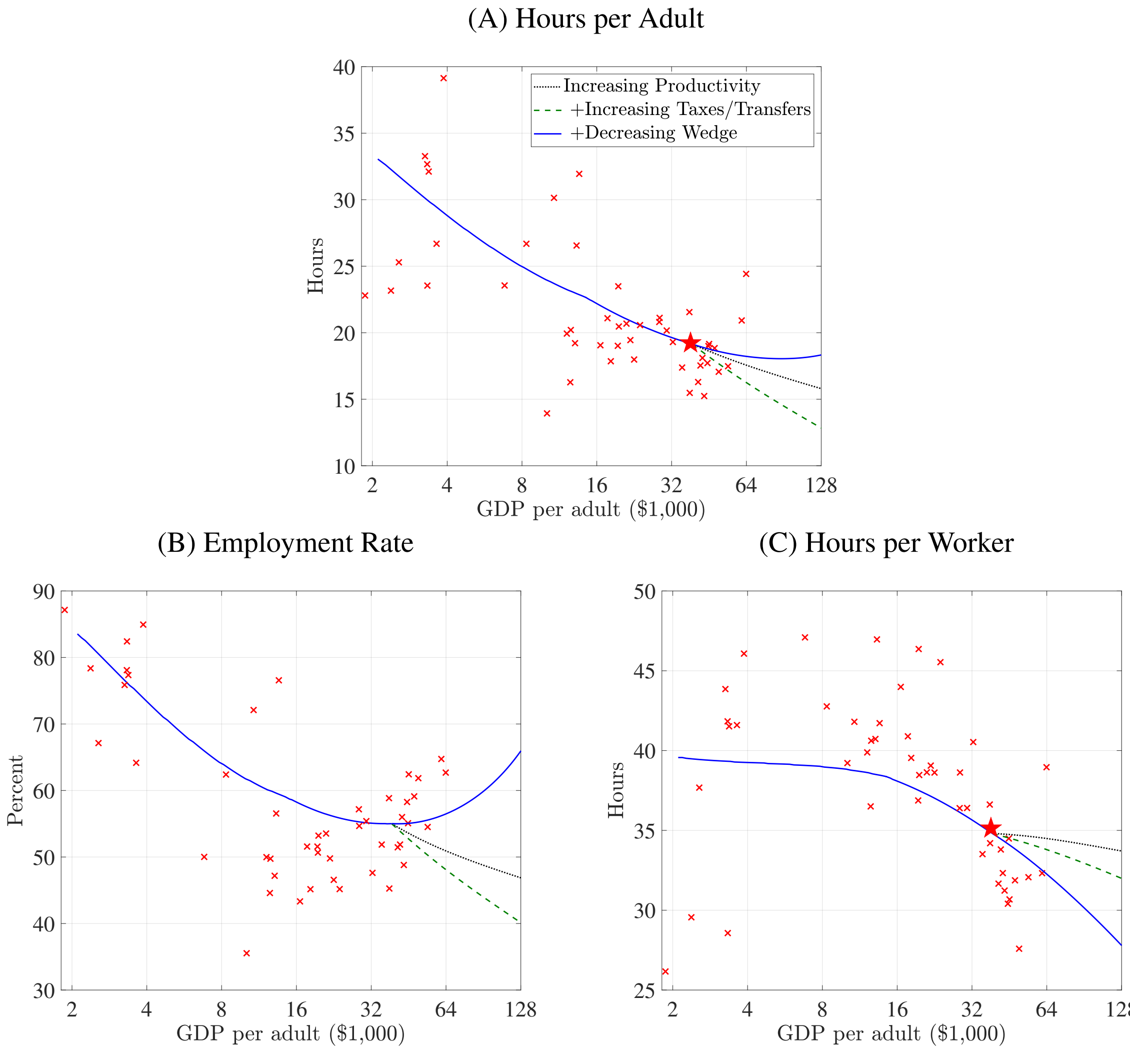
Sources: Figure 5A: Average daily commuting time on weekdays for all employed individuals in the modern sector aged 15-64 based on the data from Bridgman et al. (2018). Figure 5B and Figure 5C: International Social Survey Programme (ISSP), Work Orientation Module, employed individuals in the modern sector aged 18-64. Figure 5B draws on 2005 and 2015 surveys and states the share reporting to Strongly Agree or Agree with the statement “I can work independently”; the other answer options are: Neither agree nor disagree, Disagree, Strongly disagree. A ’ indicates observations from the 2015 survey. Figure 5C draws on 2005 survey and states the share reporting Always or Often in response to the question “How often do you work in dangerous conditions?”; the other answer options are: Sometimes, Hardly ever, Never. Figure 5D: International Labor Organization. For expositional purposes, we trim the actual number of deaths of 245 per 100,000 workers for LKA at 150 per 100,000 workers. For each country, we show (if available) two observations referring to the first three years and last three years (indicated with ’ in the figure) of the time-series. Appendix Table A.16 lists the years used for each country.

Figure 6: Model with Fixed Costs of Working in Both Sectors



Note: This figure plots average hours per adult, employment rates, hours per worker and the traditional sector share of employment in the data and in a re-estimation of the model that restricts the fixed costs of working to be the same in both sectors. Stars represent calibration targets, and squares represent un-targeted means of the low-, middle- or high-income country groups. The dashed line reproduces the predictions from the main estimation of the model.

Figure 7: Declining Fixed Costs and the Future of Hours Worked



Note: This figure plots the model's predicted average hours per adult, employment rates and hours per worker for higher income levels. The star represents the average rich country in the data.

10 Tables

Table 1: Moments Targeted in the Estimation

Moments	Data	Model
Employment Rate, Poor	74.5 (68.0, 81.1)	73.9
Employment Rate, Rich	54.6 (52.5, 56.7)	55.0
Hours per Worker, Traditional Sector, Poor	35.4 (35.2, 35.5)	36.0
Hours per Worker, Modern Sector, Poor	46.3 (46.1, 46.5)	45.3
Hours per Worker, Traditional Sector, Rich	39.2 (37.5, 40.9)	27.3
Hours per Worker, Modern Sector, Rich	35.0 (33.3, 36.7)	35.3
Traditional Sector Employment Share, Poor	64.3 (58.5, 70.1)	64.5
Traditional Sector Employment Share, Rich	5.7 (3.1, 8.4)	5.7
ln GDP per Adult, Poor	8.1 (7.9, 8.3)	8.3
ln GDP per Adult, Rich	10.5 (10.4, 10.7)	10.6

Note: This table reports the moments targeted in the estimation and their values in the data and in the model. The range reported below each data moment is its bootstrapped 95 percent confidence interval, computed by re-sampling with replacement from the cross-country database of Bick et al (2018).

Table 2: Parameter Estimates and Confidence Intervals

Parameter	Description	Estimate (Confidence Interval)
γ	Curvature of consumption in preferences	1.21 (1.13, 1.29)
α	Weight of labor supply in preferences ($\times 10^{-6}$)	3.6 (2.1, 5.6)
ϕ	Curvature of labor supply in preferences	0.51 (0.45, 0.58)
$\bar{u}_M$	Fixed cost of labor supply	0.39 (0.20, 0.79)
ω	Wedge on fixed-costs in rich countries	0.45 (0.31, 0.60)
ρ	Returns to scale in traditional sector	0.85 (0.65, 0.99)
A_T^P	Traditional sector productivity, poor countries	118.3 (73.2, 194.6)
A_T^R	Traditional sector productivity, rich countries	623.6 (444.5, 1043.8)
A_M^P	Modern sector productivity, poor countries	210.1 (143.9, 269.7)
A_M^P	Modern sector productivity, rich countries	2574.8 (1917.5, 3384.5)

Note: This table reports the estimated parameters. The confidence interval is the 2.5th and 97.5th percentiles of 500 bootstrapped parameter estimates. Levels of modern and traditional sector productivity are not directly comparable unless $\rho = 1$. Fixed costs of labor supply apply only to the modern sector.

Table 3: Decomposing Differences in Average Hours Worked by Income Level

	(A) Poor-Rich		(B) Poor-Middle		(C) Middle-Rich	
	Hours	% Explained	Hours	% Explained	Hours	% Explained
Model	9.9	100.0	6.3	100.0	3.6	100.0
Higher Productivity	5.7	57.6	3.3	52.4	2.5	69.4
Higher Taxes & Transfers	2.3	23.2	0.7	11.1	1.6	44.4
Structural Change in Labor Supply						
Lower Fixed Costs	−2.4	−24.2	−1.2	−19.0	−1.2	−33.3
Sectoral Reallocation	4.3	43.4	3.5	55.6	0.8	22.2

Note: This table shows the marginal change in hours when, starting from the estimated baseline model for the average poor country, one model component after the other is set to the level of the average rich (Panel A) or middle-income country (Panel B), or when, starting from the estimated baseline model for the average middle-income country, one model component after the other is set to the level of the average rich country (Panel C). The first column of each panel shows the change in hours, and the second column of each panel the percent explained of the total hours change. The table shows the mean of six possible decomposition exercises that change the ordering of the steps. Appendix Table A.10 also reports the minimum and maximum effects among the different orderings.

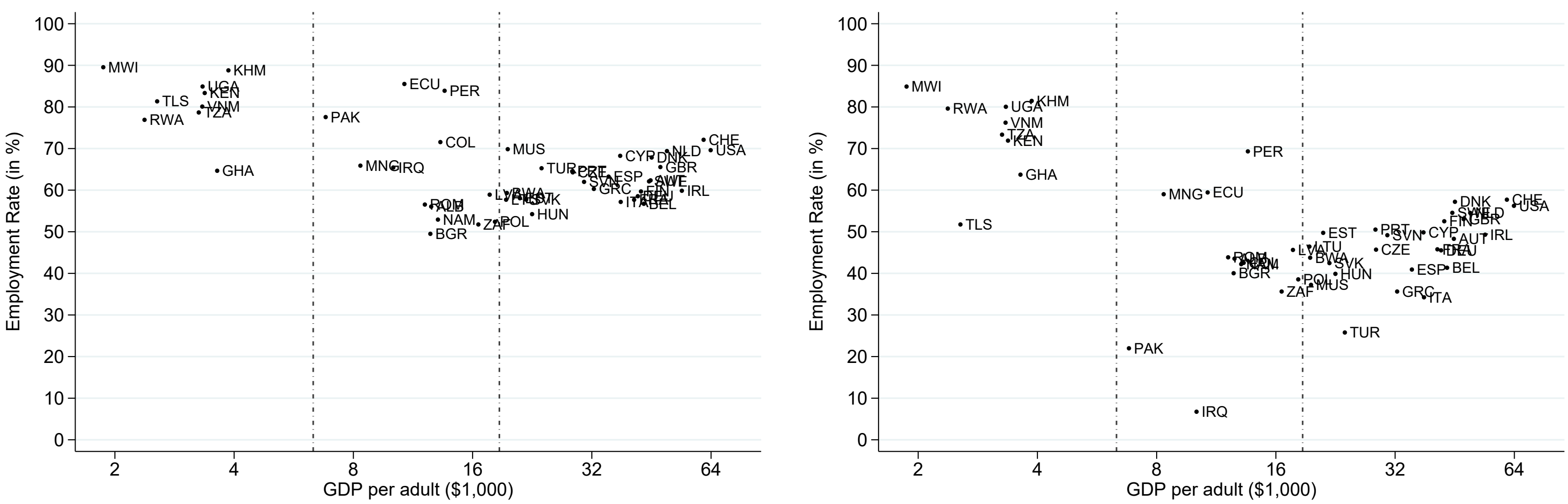
Appendix (For Online Publication Only)

A Appendix Figures and Tables

Figure A.1: Employment Rates and Hours per Worker Across Countries by Gender

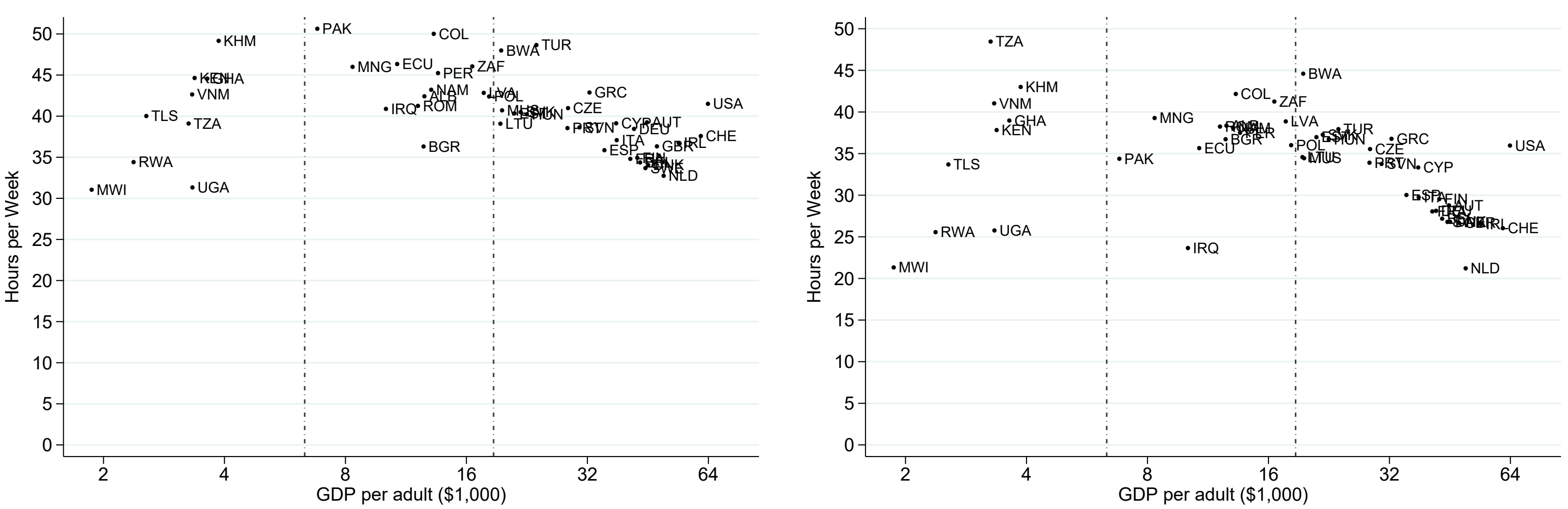
Panel A: Employment Rates

Men | Women



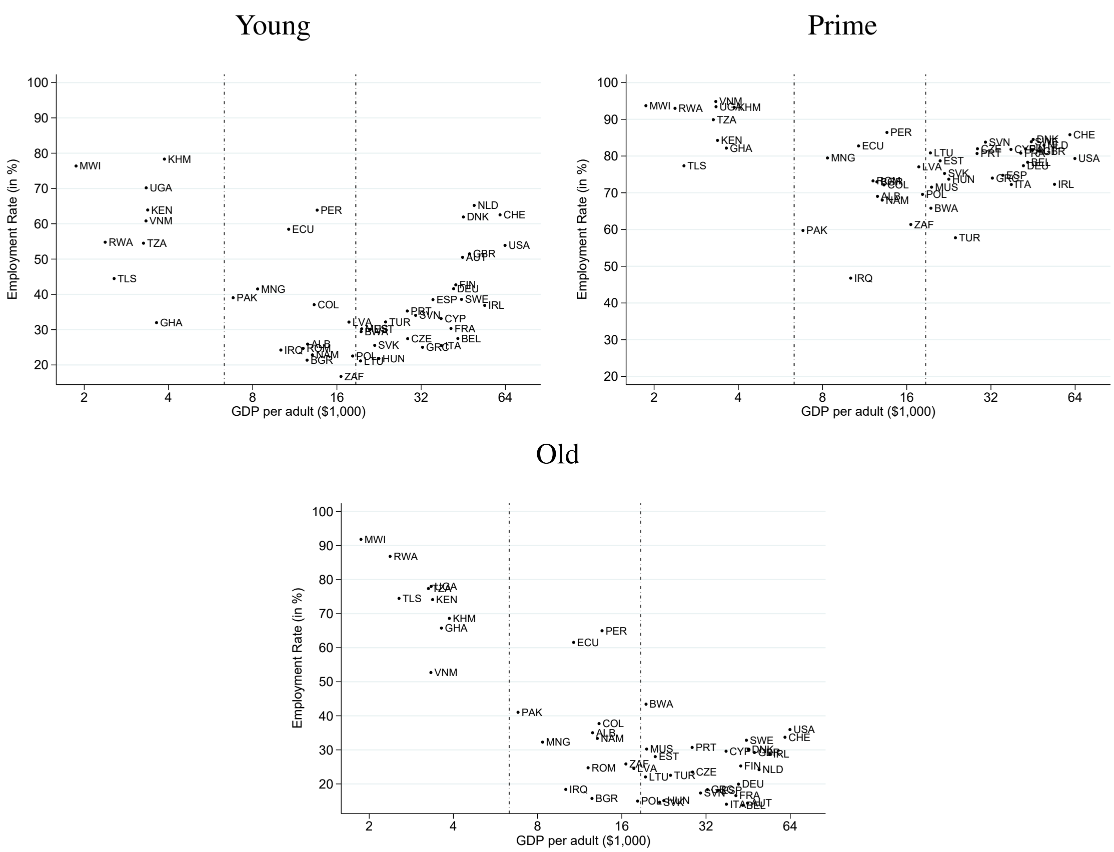
Panel B: Hours per Worker

Men | Women



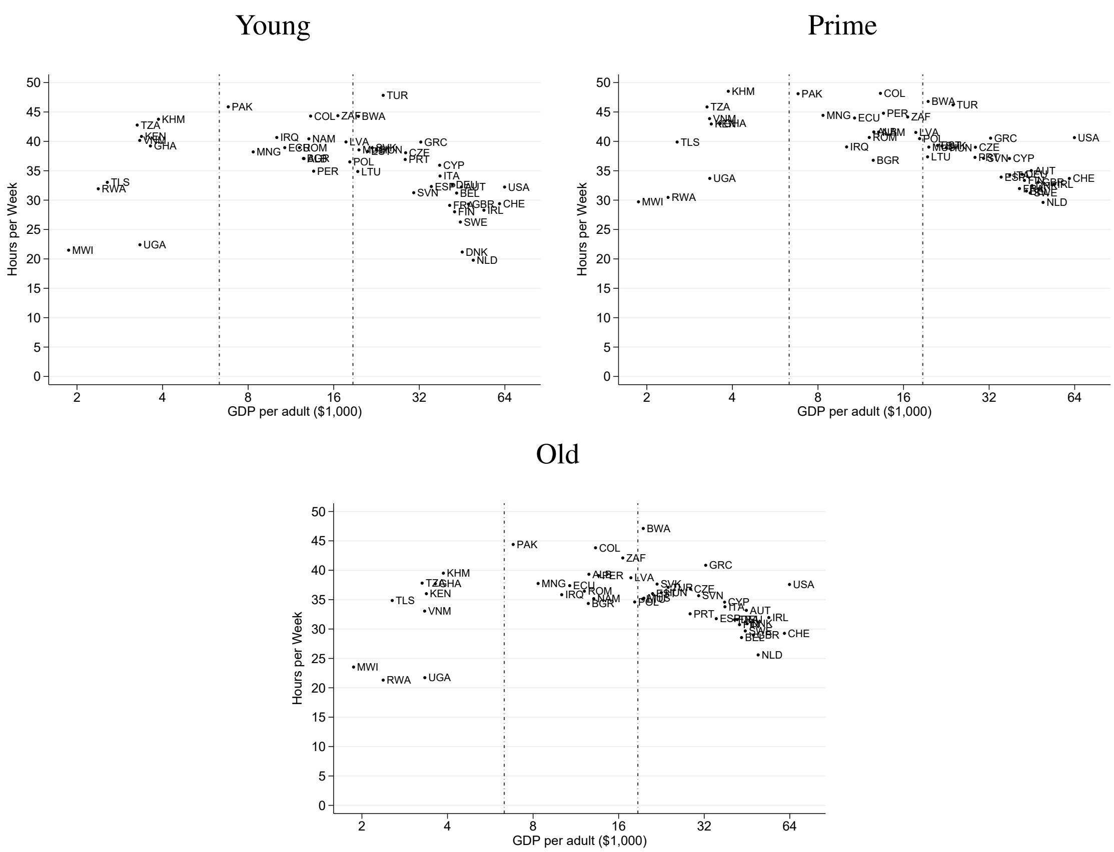
Note: This figure plots employment rates (in Panel A) and hours per worker (in Panel B) by GDP per adult in thousands of international dollars. The vertical lines represent the division between low- and middle-income countries, and between middle- and high-income countries. The left-hand panels are for men, and the right-hand panels are for women. Data source: Bick et al. (2018).

Figure A.2: Employment Rates Across Countries by Age



Note: This figure plots employment rates by GDP per adult in thousands of international dollars. The vertical lines represent the division between low- and middle-income countries, and between middle- and high-income countries. The upper panel is for individuals aged 15-24, the lower left-hand panel for individuals aged 25-54, and the lower right-hand panel for individuals aged 55 or older. Data source: Bick et al. (2018).

Figure A.3: Hours per Worker Across Countries by Age



Note: This figure plots hours per worker by GDP per adult in thousands of international dollars. The vertical lines represent the division between low- and middle-income countries, and between middle- and high-income countries. The upper panel is for individuals aged 15-24, the lower left-hand panel for individuals aged 25-54, and the lower right-hand panel for individuals aged 55 or older. Data source: Bick et al. (2018).

Table A.1: Sectoral Hours Worked and Sectoral Shares: Men Only

	Country Income Group		
	Low	Middle	High
Traditional Sec. Hours	37.2	39.1	42.0
Modern Sec. Hours	47.4	44.4	38.0
Traditional Sec. Share	54.9	17.3	6.4

Table A.2: Sectoral Hours Worked and Sectoral Shares: Women Only

	Country Income Group		
	Low	Middle	High
Traditional Sec. Hours	33.1	33.0	33.8
Modern Sec. Hours	43.0	38.2	31.4
Traditional Sec. Share	75.7	20.8	4.8

Table A.3: Sectoral Hours Worked and Sectoral Shares: Young Only (15-24)

	Country Income Group		
	Low	Middle	High
Traditional Sec. Hours	32.8	33.0	31.1
Modern Sec. Hours	44.9	40.8	32.9
Traditional Sec. Share	59.9	15.2	2.3

Table A.4: Sectoral Hours Worked and Sectoral Shares: Prime-Aged Only (25-54)

	Country Income Group		
	Low	Middle	High
Traditional Sec. Hours	37.4	38.8	41.9
Modern Sec. Hours	47.1	43.0	35.6
Traditional Sec. Share	62.0	15.8	4.4

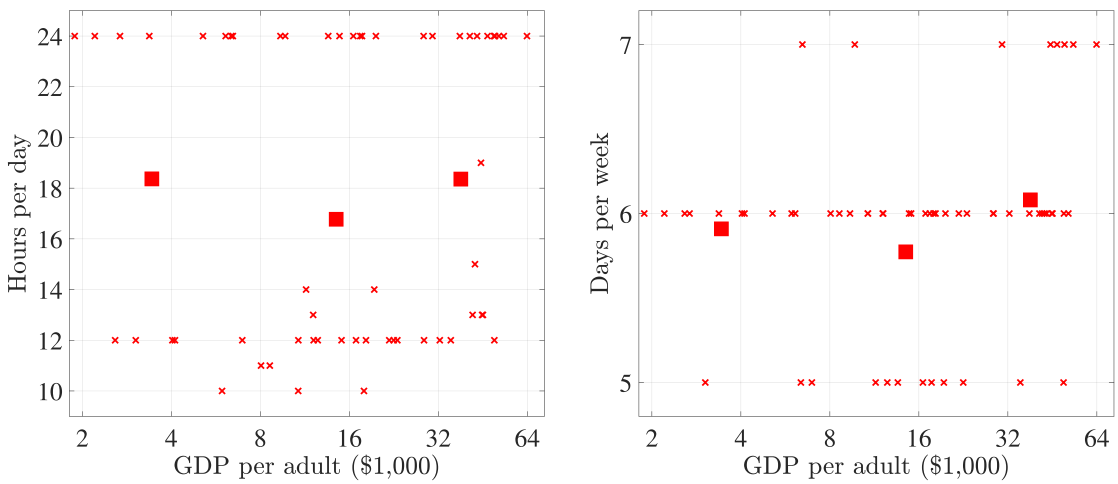
Table A.5: Sectoral Hours Worked and Sectoral Shares: Old Only (55+)

	Country Income Group		
	Low	Middle	High
Traditional Sec. Hours	31.5	34.2	36.2
Modern Sec. Hours	43.4	40.3	33.3
Traditional Sec. Share	82.4	40.5	16.2

Figure A.4: Cross-Country Differences in Hours Regulation

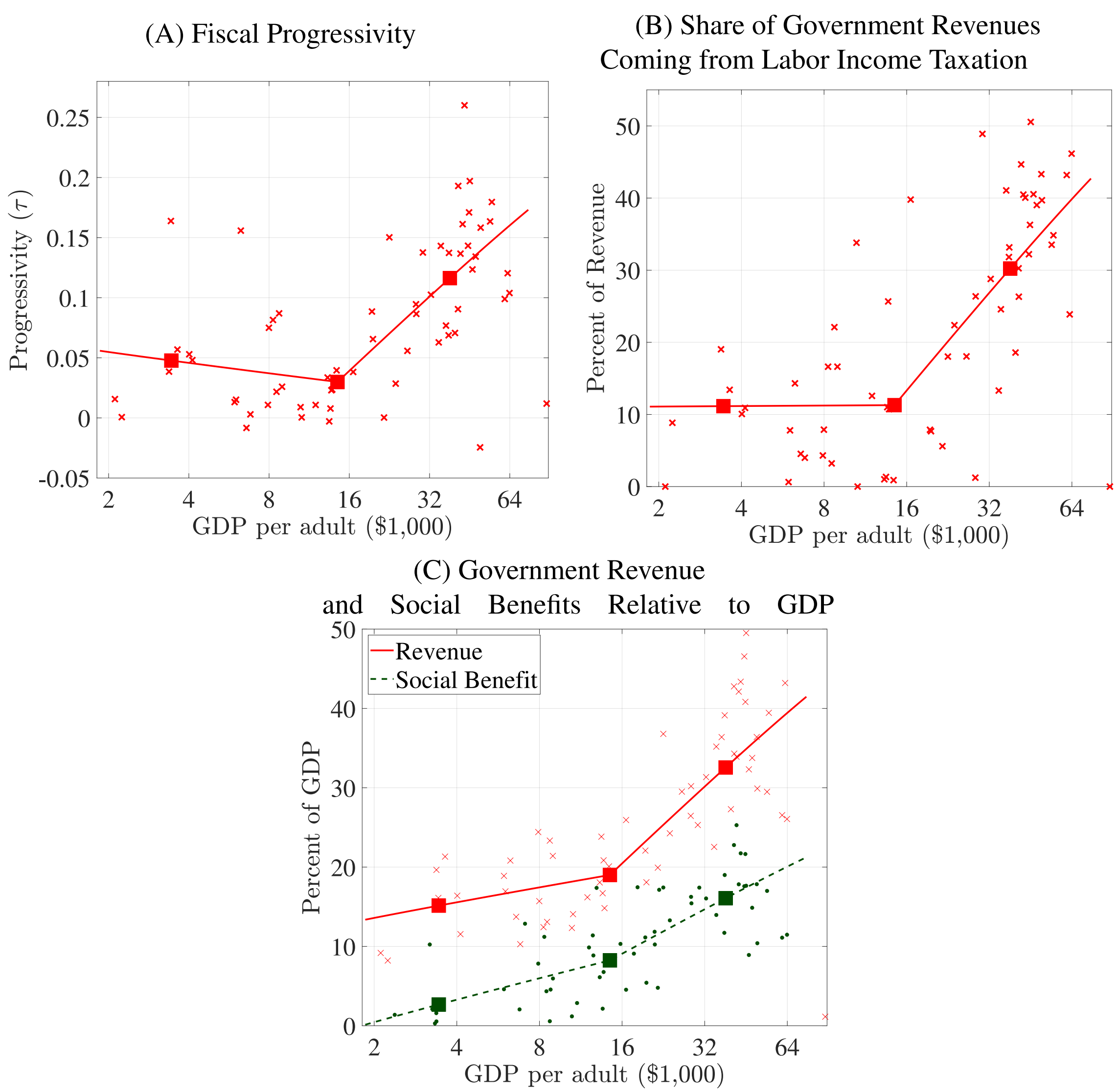
(A) Legal Limits on Hours per Day

(B) Legal Limits on Days per Week



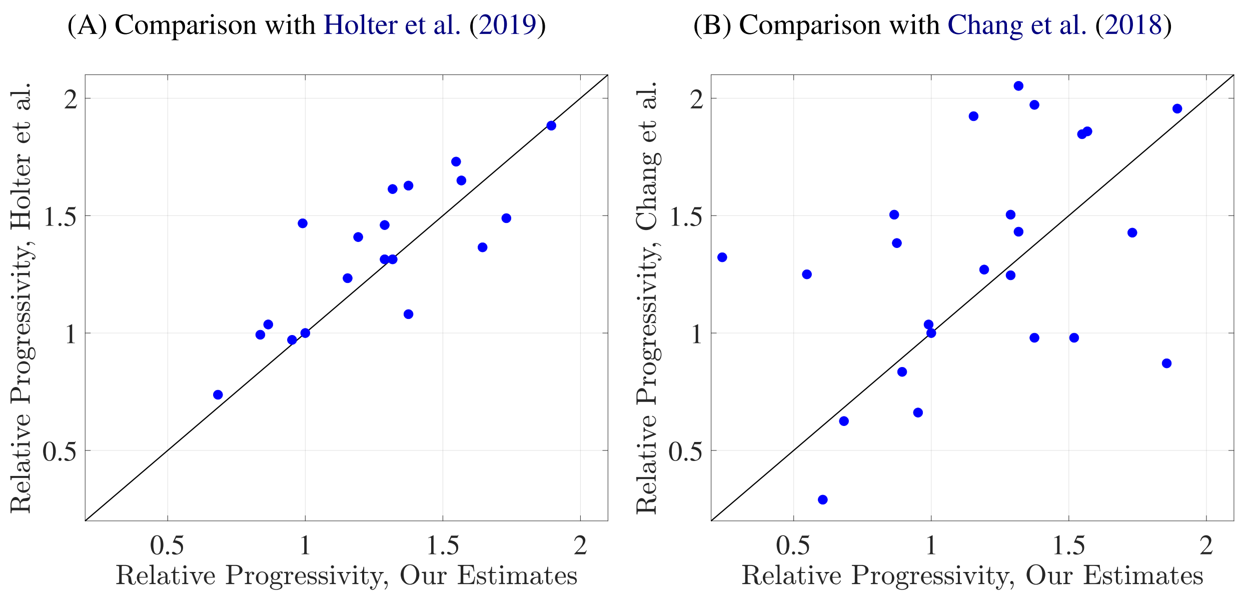
Source: Doing Business 2005, World Bank. Note: The small dots represent each country with available data, and the large dots the averages by country-income group. Legal limits on maximum hours worked per day, depicted in panel (a), may be defined either as mandatory maximum regular and overtime working hours per day or by mandatory minimum rest hours per day. If nothing is specified in the law, 24 hours are used. Legal limits on the maximum number of work days per week, depicted in panel (b), may be defined either by a number of mandatory rest days per week or by a mandatory minimum of consecutive hours of rest. If nothing is specified, seven days are used.

Figure A.5: Cross-Country Differences in the Tax-and-Transfer System



Note: The small dots represent each country in our sample, and the large dots the averages by country-income group. The lines show the piecewise linear interpolation.

Figure A.6: Comparison of Progressivity Estimates



Note: This figure plots our estimates of country-specific progressivity relative to the one for the United States against those in Holter et al. (2019) (Panel a) and in Chang et al. (2018) (Panel b). The estimates shown in panel a are directly taken from table 1 in Holter et al. (2019), and those shown in panel b are constructed using table 3 in Chang et al. (2018).

Table A.6: Derivative of Moments to Parameters

Moment	γ	ϕ	$\bar{u}_M$	ω	ρ	α	A_T^P	A_M^P	A_T^R	A_M^R
Employment Rate, Poor	0.5	-0.1	0.0	0.0	1.4	0.0	0.5	-0.3	0.0	0.0
Employment Rate, Rich	-2.4	-0.2	-0.2	-0.2	0.2	0.0	0.0	0.0	0.1	-0.1
Hours / Worker, Traditional, Poor	-2.9	2.3	0.0	0.0	0.2	-0.3	-0.1	-0.0	0.0	0.0
Hours / Worker, Modern, Poor	-1.5	2.5	0.2	0.0	-0.1	-0.3	-0.0	-0.0	0.0	0.0
Hours / Worker, Traditional, Rich	-2.9	2.0	0.0	0.0	0.6	-0.3	0.0	0.0	0.1	-0.1
Hours / Worker, Modern, Rich	-1.8	2.4	0.2	0.2	0.0	-0.3	0.0	0.0	0.0	-0.0
log GDP p.a., Poor	-5.6	2.0	-0.3	0.0	0.3	-0.3	0.1	0.8	0.0	0.0
log GDP p.a., Rich	-7.4	2.0	-0.3	-0.3	-0.0	-0.3	0.0	0.0	-0.0	0.9
Traditional Share, Poor	3.9	0.1	0.4	0.0	2.6	-0.0	0.9	-0.6	0.0	0.0
Traditional Share, Rich	1.6	-0.1	0.1	0.1	0.9	-0.0	0.0	0.0	0.3	-0.2

Note: This table reports the derivatives of each moment with respect to each parameter. The numbers in the table are the percentage point changes in all variables expressed in percentage points (the employment rates and traditional in the rich and poor countries plus the GDP per adult ratio), and the percent changes in the variables measured in hours per week (hours per worker in the rich country and poor countries by sector.

Table A.7: Correlation between Job Perception/Attributes & GDP per Adult

Variable	Correlation
Job is secure	0.01
Job is interesting	0.35***
Work independently	0.34***
Can help other people	−0.01
Job useful to society	−0.30
Hard physical work	−0.45***
Work is stressful	0.09
Exhausted from work	−0.51***
Work in dangerous conditions	−0.72***
Job Satisfaction	0.13

Source: International Social Survey Programme (ISSP), Work Orientation Module, employed individuals in the modern sector aged 18-64. *Top panel*: 2005 and 2015 surveys; states the share reporting to Strongly Agree or Agree with the statement; the other answer options are: Neither agree nor disagree, Disagree, Strongly disagree. *Middle panel*: 2005 survey; states the share reporting Always or Often as frequency for condition; the other answer options are: Sometimes, Hardly ever, Never. *Bottom panel*: 2005 and 2015 surveys; states the share reporting to be Completely satisfied, Very satisfied, or Fairly satisfied in their job; the other answer options are: Neither satisfied nor dissatisfied, Fairly dissatisfied, Very dissatisfied, or Completely dissatisfied.

Figure A.7: Baseline Model Fit: Hours per Worker by Sector

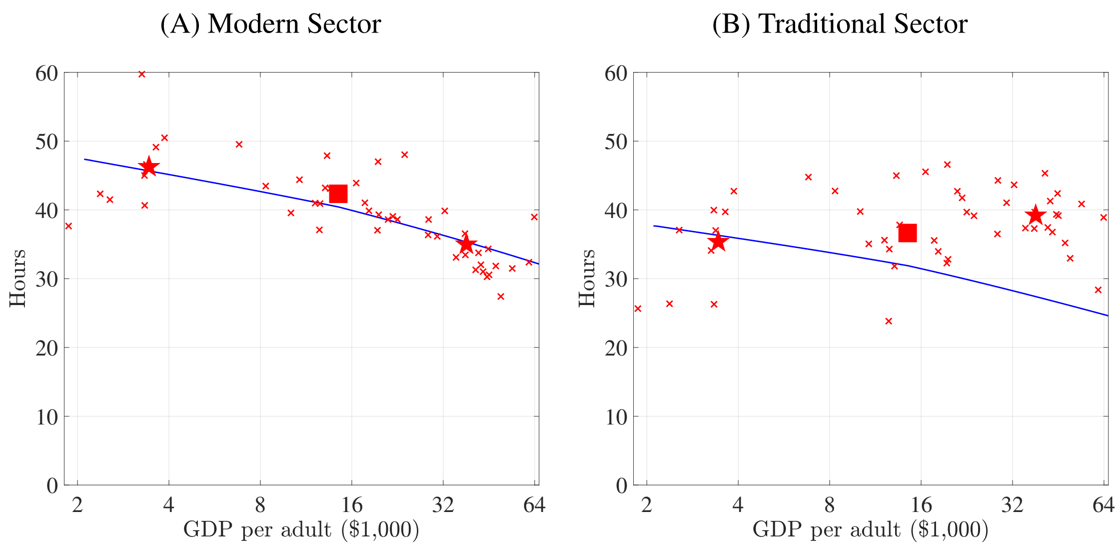


Table A.8: Estimated Parameters: Constant Fixed Costs of Working in Modern Sector

Model	γ	α	ϕ	$\bar{u}_M$	ω^R	ρ	A_T^P	A_T^R	A_M^P	A_M^R
Baseline	1.22	0.36×10^{-5}	0.51	0.39	0.45	0.85	118.31	623.58	210.09	2574.79
$\omega^R = 1$	1.05	2.33×10^{-5}	0.53	1.10	*	1.00	69.57	326.14	181.14	2329.00

Table A.9: Estimated Parameters: Fixed Costs in Both Sectors

Model	γ	α	ϕ	$\bar{u}_M$	ω^R	ρ	A_T^P	A_T^R	A_M^P	A_M^R
Baseline	1.22	0.36×10^{-5}	0.51	0.39	0.45	0.85	118.31	623.58	210.09	2574.79
$\bar{u}_T = \bar{u}_M$	1.27	0.16×10^{-7}	0.30	0.11	1.09	0.55	384.74	3138.12	93.27	2414.89

Table A.10: Decomposing Differences in Average Hours Worked by Income Level

(A) Poor-Rich

	Hours			% Explained		
	Mean	Min	Max	Mean	Min	Max
Model	9.9			100.0		
Higher Productivity	5.7	5.3	6.2	57.6	53.5	62.7
Higher Taxes & Transfers	2.3	2.1	2.5	23.2	21.2	25.3
Lower Fixed Costs	-2.4	-3.1	-1.8	-24.2	-31.3	-18.1
Sectoral Reallocation	4.3	4.3	4.3	43.4	43.4	43.4

(B) Poor-Middle

	Hours			% Explained		
	Mean	Min	Max	Mean	Min	Max
Model	6.3			100.0		
Higher Productivity	3.3	3.1	3.5	52.4	49.2	55.5
Higher Taxes & Transfers	0.7	0.6	0.8	11.1	9.5	12.7
Lower Fixed Costs	-1.2	-1.4	-1.0	-19.0	-22.2	-15.9
Sectoral Reallocation	3.5	3.5	3.5	55.6	55.6	55.6

(C) Middle-Rich

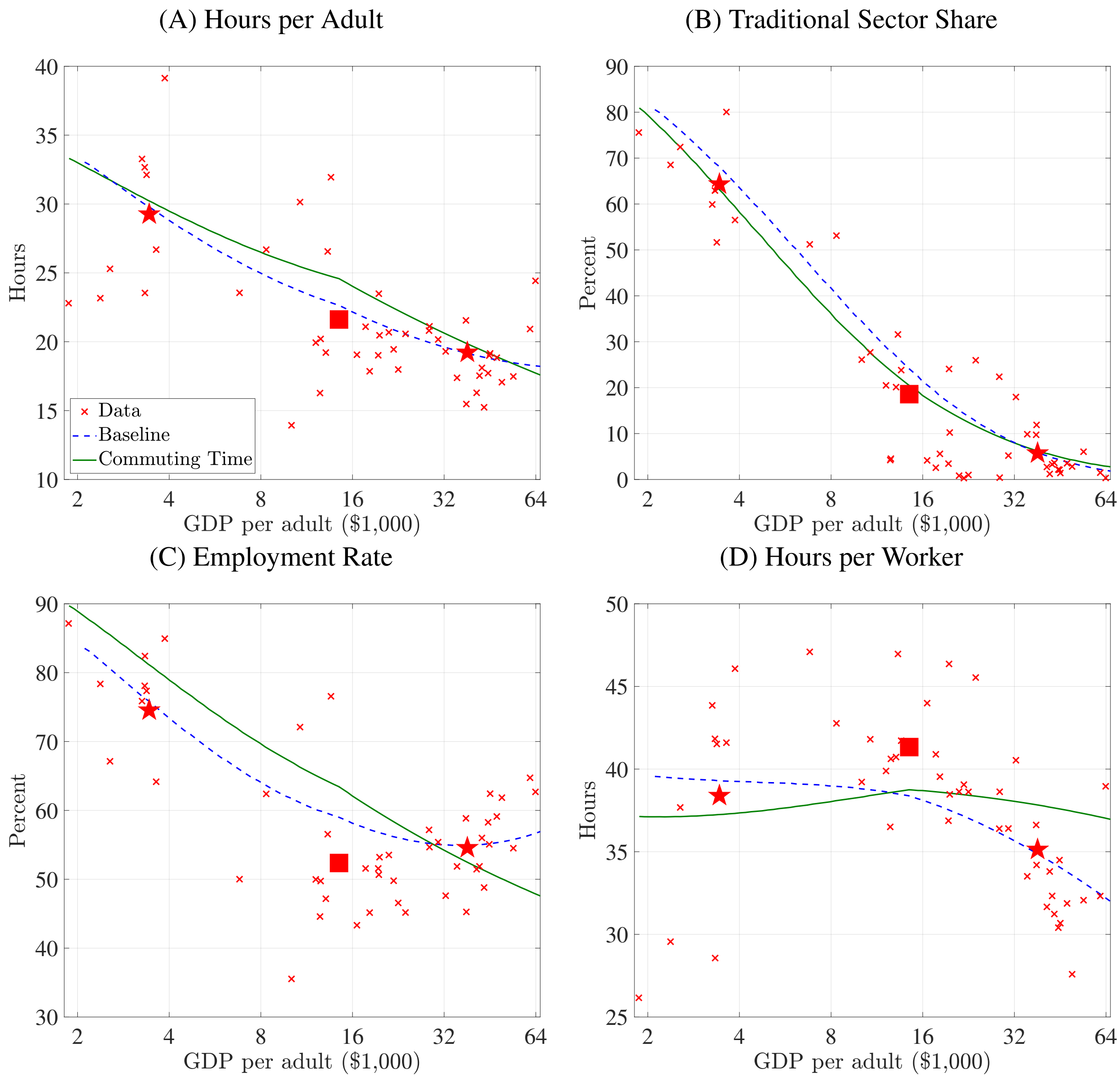
	Hours			% Explained		
	Mean	Min	Max	Mean	Min	Max
Model	3.6			100.0		
Higher Productivity	2.5	2.1	2.8	69.4	58.3	77.8
Higher Taxes & Transfers	1.6	1.4	1.8	44.4	38.9	50.0
Lower Fixed Costs	-1.2	-1.7	-0.8	-33.3	-47.2	-22.2
Sectoral Reallocation	0.8	0.8	0.8	22.2	22.2	22.2

Note: This table shows the mean, minimum, and maximum values of decomposition exercises that change the ordering of the steps. There are six different possible orderings since sectoral reallocation is by definition always the last component. Therefore the mean, min, and max are by construction identical for sectoral reallocation.

Table A.11: Differences in Estimated Model Inputs over the Development Spectrum

	Poor vs. Middle		Middle vs. Rich	
	Diff.	Ratio	Diff.	Ratio
ω	-0.31	0.69	-0.24	0.65
A_M	660.69	4.14	1704.01	2.96
A_T	185.50	2.57	319.78	2.05

Figure A.8: Model Fit with Constant Fixed Cost of Working and Commuting Time in the Modern Sector



Notes: In this version of the model, we set $\omega = 1$ and the disutility from hours worked in (1) is defined over $h + \bar{h} * I_{S=M,h>0}$ instead of h, with the commuting time $\bar{h}$ varying exogenously with development based on Figure 5 and $I_{S=M,h>0}$ being an indicator function.

Table A.12: Calibrated Parameters: Constant Fixed Cost of Working and Commuting Time in the Modern Sector

Model	γ	α	ϕ	$\bar{u}_M$	ω^R	ρ	A_T^P	A_T^R	A_M^P	A_M^R
Baseline	1.22	0.36×10^{-5}	0.51	0.39	0.45	0.85	118.31	623.58	210.09	2574.79
	1.09	3.16×10^{-5}	0.61	0.67	*	0.80	127.14	661.37	176.82	2570.08

Notes: By not letting the fixed cost of working in the modern sector change with the level of development, we drop one target and target hours per worker in the rich countries rather than hours per worker by sector.

Figure A.9: Model Fit without Traditional Sector

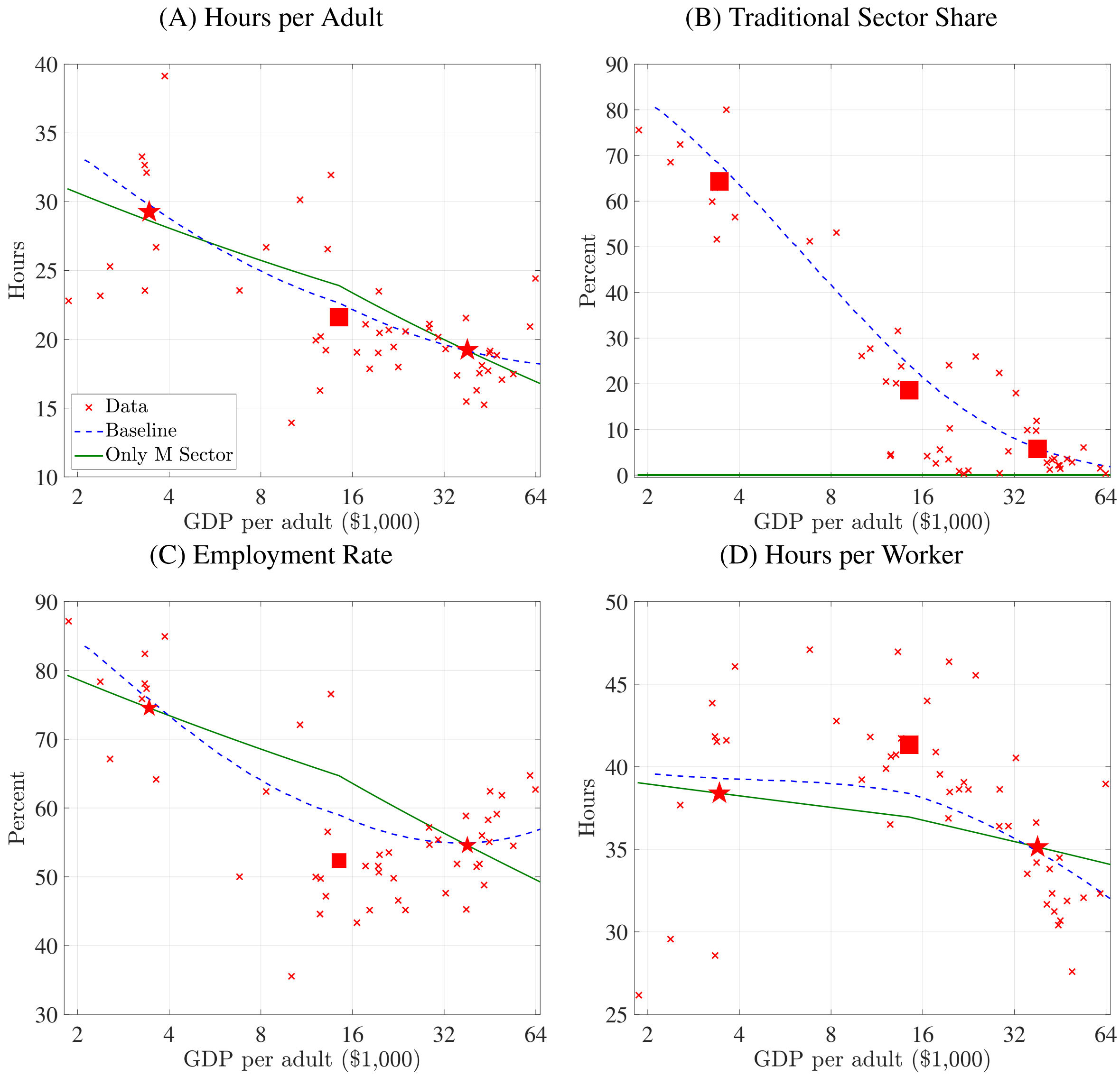


Table A.13: Calibrated Parameters: No Traditional Sector

Model	γ	α	ϕ	$\bar{u}_M$	ω^R	ρ	A_T^P	A_T^R	A_M^P	A_M^R
Baseline	1.22	0.36×10^{-5}	0.51	0.39	0.45	0.85	118.31	623.58	210.09	2574.79
No T Sector	1.14	0.80×10^{-5}	$0.51^{\dagger}$	0.35	1.05	*	*	*	152.51	2475.02

Notes: †By dropping the traditional sector, we are short of one target (hours per worker in the traditional sector in rich countries). We therefore set the curvature parameter of the disutility of work ϕ equal to the benchmark value. * A_T^{rich}, A_T^{poor} and ρ do not apply in the model without traditional sector.

Figure A.10: Constant Returns to Scale in Traditional Sector ($\rho = 1$)

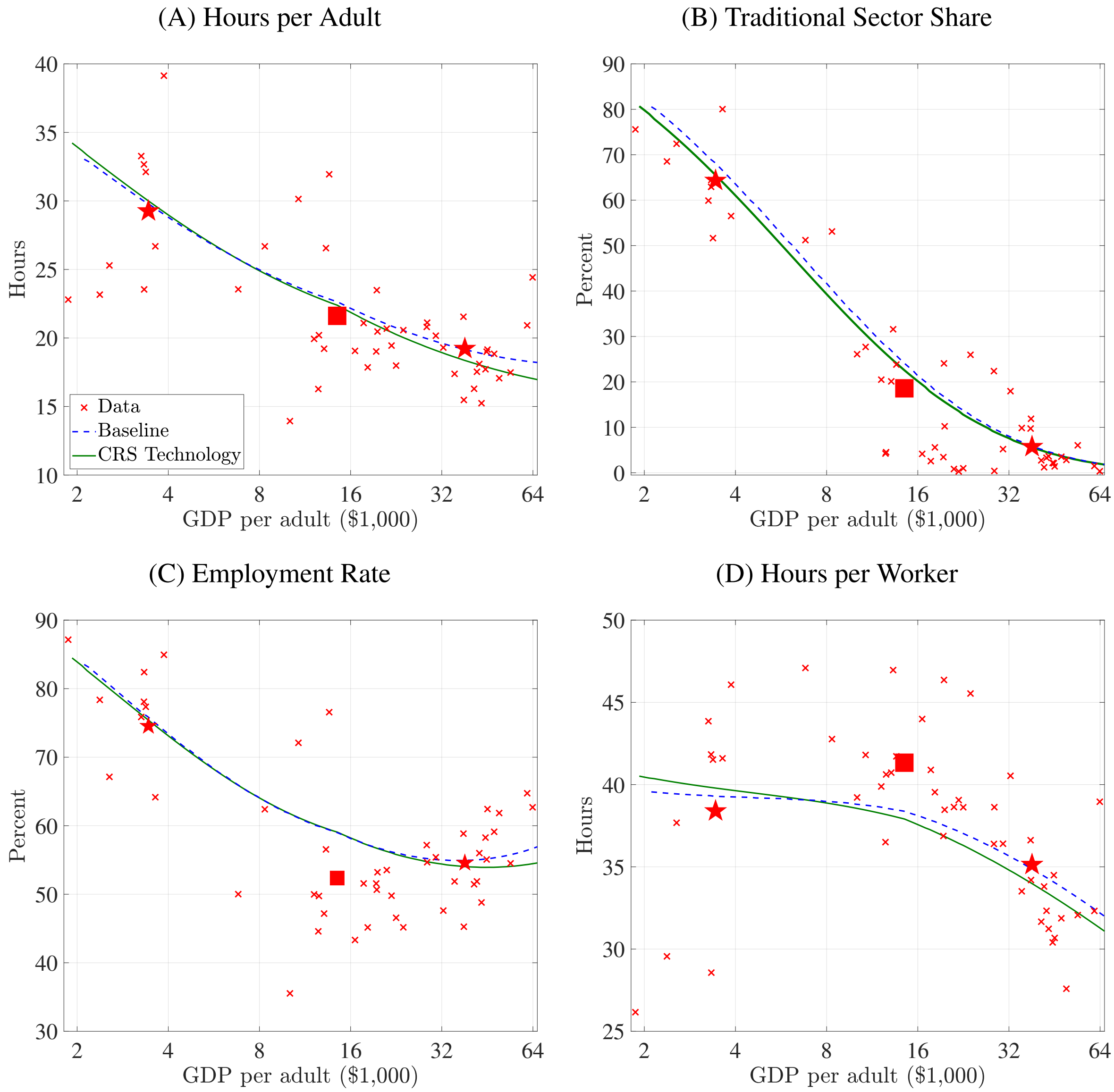


Table A.14: Calibrated Parameters: Constant Returns to Scale in Traditional Sector

Model	γ	α	ϕ	$\bar{u}_M$	ω^R	ρ	A_T^P	A_T^R	A_M^P	A_M^R
Baseline	1.22	0.36×10^{-5}	0.51	0.39	0.45	0.85	118.31	623.58	210.09	2574.79
$\rho = 1$	1.22	1.19×10^{-5}	0.60	0.37	0.48	$1.0^{\dagger}$	63.95	394.66	181.05	2618.35

Notes: †Since we set $\rho = 1$, we drop one target and target hours per worker in the rich countries rather than hours per worker by sector.

Figure A.11: Taxation of Labor Income in Traditional Sector

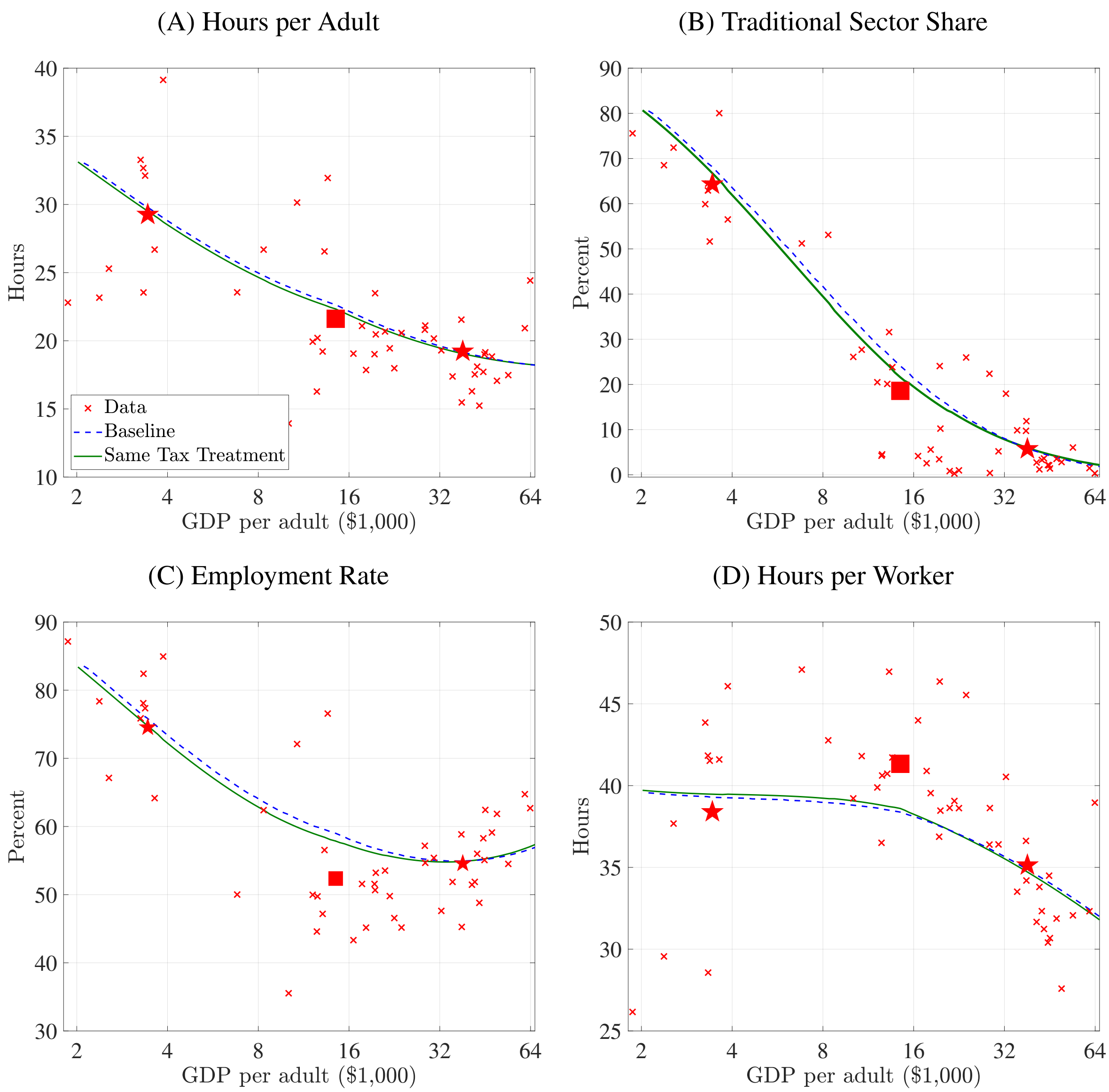


Table A.15: Calibrated Parameters: Taxation of Labor Income in Traditional Sector

Model	γ	α	ϕ	$\bar{u}_M$	ω^R	ρ	A_T^P	A_T^R	A_M^P	A_M^R
Baseline	1.22	0.36×10^{-5}	0.51	0.39	0.45	0.85	118.31	623.58	210.09	2574.79
$\mathscr{T}_T(\cdot) = \mathscr{T}_M(\cdot)$	1.23	0.30×10^{-5}	0.50	0.38	0.43	0.90	93.35	498.57	203.67	2616.86

Table A.16: Selected Years from ILO Database on Occupational Death

	First Observation	Second Observation
ARG	1997-1999	2016-2018
ARM		2013,2018,2019
AUS	1992-1994	2014,2015,2017
AUT	1974-1976	2014-2016
AZE	1992-1994	2017-2019
BEL	1984-1986	2013-2015
BEN	1979-1981	
BFA	1975-1977	1998-2000
BGR	1986-1988	2014,2015,2019
BHR	1979-1981	2006-2008
BLR	1990-1992	2017-2019
BLZ	1983-1985	2011-2012
BOL	1981-1983	1996-1998
BRA	1978-1980	1998-2000
BRB	1976,1977,1979	1993-1995
BRN	1979-1981	1984-1986
BWA	1987-1988	1989-1990
CAN	1985-1987	2011,2013,2014
CHE	1976-1978	2013-2015
CHL	1983-1985	2013,2017,2018
COL	1982-1984	2013-2015
COM	1981-1983	1984-1986
CPV	1980-1982	
CRI	1976-1978	2014-2016
CYP	1977-1979	2013-2015
CZE	1991-1993	2013-2015
DEU	1990-1992	2013-2015
DNK	1983-1985	2013-2015
DOM		2008
DZA	1977-1979	2002-2004
ECU	1983-1985	1992-1994
EGY	1976-1978	2011,2012,2014
ESP	1980-1982	2017-2019
EST	1990-1992	2014-2016
FIN	1976-1978	2013-2015
FRA	1969-1971	2013-2015
GAB	1985-1987	1997-1999
GBR	1979-1981	2013-2015
GEO		2019
GIN	1990-1992	1994-1996

GNB	1982-1984	1989-1991
GRC	1979-1981	2014-2016
GTM	1976-1978	1990-1992
GUY	1999	
HKG	1981-1983	2013-2015
HND	1985,1988	1998
HRV	1990-1992	2014-2016
HUN	1977-1979	2014-2016
IDN	1990-1992	
IND	1971,1976,1977	2005-2007
IRL	1981-1982	2013-2015
ISR	1982-1984	2017-2019
ITA	1979-1980	2013-2015
JAM	1982,1983,1985	1988-1990
JOR	1975-1977	2004-2006
JPN	1979-1981	1988-1990
KAZ	1990-1992	2013,2015,2017
KEN	1978	
KGZ	1990-1992	2008,2013,2015
KOR	1977-1979	2017-2019
LKA	1981-1983	2017-2019
LTU	1995-1997	2013-2015
LUX	1994-1996	2013-2015
LVA	2002-2004	2013-2015
MAC	2006-2008	2014-2016
MDA	1999-2001	2017-2019
MEX	1978-1980	2015-2017
MLI	1981-1982	
MLT	1992-1994	2013-2015
MMR	1993-1995	2017-2019
MNG	2016-2017	2018-2019
MUS	1976-1978	2002,2008
MWI	1976-1978	
MYS	1984-1986	2013,2015,2017
NAM	2000-2001	
NER	1985-1987	1992-1994
NIC	1978-1980	2009-2010
NLD	1975-1977	2013-2015
NOR	1975-1977	2013-2015
NZL	1979-1981	1991-1993
PAK	2001-2002	
PAN	1976-1978	2013,2014,2016
PER	1978-1980	1990,1995,1996

PHL	1976-1978	2009,2011,2013
POL	1975-1977	2013-2015
PRT	1981-1983	2013-2015
PSE		2015
QAT		2016,2018
ROU	1985-1987	2014-2016
RUS	1990-1992	2006-2008
SGP	1976-1978	2013-2015
SLV	1976-1977	2009-2010
SUR	1976-1978	1981,1982,1986
SVK	1990-1992	2014-2016
SVN	1990-1992	2014,2015,2019
SWE	1979-1981	2014-2016
TCD	1987	
TGO	1979-1981	2002-2004
THA	1982-1984	2012-2014
TTO	1973-1975	2004-2006
TUN	1976-1978	2002-2004
TUR	2008-2010	2017-2019
UKR	1990-1992	2017-2019
URY		2018
USA	1976-1978	2017-2019
UZB	2009-2011	2017-2019
VCT	1999-2001	2006-2008
VEN	1988-1990	1995-1997
ZAF	1978-1980	1987-1989
ZWE	1971-1973	2007,2011,2012

Note: Selected years from the International Labor Organization database on occupational death used in Figure 5D. For each country, to the degree available we use two observations referring to the first three years and last three years of the time-series. For some countries, we have only or two years, or the first or last three years are not consecutive years but years close by.

B Solution to the Household Problem (2)

We solve the second stage household problem (2) as follows. Plugging the optimal consumption c and hours $h^*(\eta^*)$ into the objective function, the household head's problem becomes an unconstrained problem:

$$\max_{\eta^*} \quad -\left[\alpha \frac{h^*(\eta^*)^{1+\frac{1}{\phi}}}{1+\frac{1}{\phi}} F(\eta^*) + \bar{u}_S \int_0^{\eta^*} \eta dF\right].$$

Taking the first order condition and applying the chain rule and the Leibniz rule leads to Equation (4). Since $h^*(\eta^*) = \frac{H}{F(\eta^*)}$, we have

$$\alpha \frac{\left(\frac{H}{F(\eta^*)}\right)^{1+\frac{1}{\phi}}}{1+\frac{1}{\phi}} f(\eta^*) + \bar{u}_S \eta^* f(\eta^*) = -\alpha \left(\frac{H}{F(\eta^*)}\right)^{\frac{1}{\phi}} \frac{-H}{F(\eta^*)} f(\eta^*).$$

After straightforward algebra, we get

$$\eta^* F(\eta^*)^{1+\frac{1}{\phi}} = \frac{1}{\bar{u}_S} \frac{\alpha}{1+\phi} H^{1+\frac{1}{\phi}}.$$

Assuming $\eta \sim U(0,1)$ and thus $F(\eta) = \eta$, we obtain a closed form solution (5) for the optimal cutoff η^*. Since η^* must be bounded by one from above, there is a maximum H for an interior solution that is given by

$$H = \left(\bar{u}_S \frac{1+\phi}{\alpha}\right)^{\frac{\phi}{1+\phi}}.$$

We thus have two cases. First, if H is smaller than this threshold, then η^* is given by an interior solution in Equation (5) and the household utility (3) becomes

$$\begin{aligned} U(C,H,S) &= \frac{C^{1-\gamma}}{1-\gamma} - \alpha \frac{H^{1+\frac{1}{\phi}}}{1+\frac{1}{\phi}} \left(\frac{1}{\bar{u}_S} \frac{\alpha}{1+\phi} H^{1+\frac{1}{\phi}}\right)^{\frac{-1}{1+2\phi}} - \frac{\bar{u}_S}{2} \left(\frac{1}{\bar{u}_S} \frac{\alpha}{1+\phi} H^{1+\frac{1}{\phi}}\right)^{\frac{2\phi}{1+2\phi}} \\ &= \frac{C^{1-\gamma}}{1-\gamma} - \left[\alpha \frac{\phi}{1+\phi} \left(\frac{1}{\bar{u}_S} \frac{\alpha}{1+\phi}\right)^{\frac{-1}{1+2\phi}} + \frac{\bar{u}_S}{2} \left(\frac{1}{\bar{u}_S} \frac{\alpha}{1+\phi}\right)^{\frac{2\phi}{1+2\phi}}\right] H^{1+\frac{1}{1+2\phi}}. \end{aligned}$$

Second, if H is larger than the threshold, then $\eta^* = 1$ and the household utility (3) is simply given by

$$U(C,H,S) = \frac{C^{1-\gamma}}{1-\gamma} - \alpha \frac{H^{1+\frac{1}{\phi}}}{1+\frac{1}{\phi}} - \frac{\bar{u}_S}{2}.$$

One can show that hours worked are decreasing in the wage when $\gamma > 1$, meaning that income effects dominate substitution effects in labor supply. For example, in the case of η^* being an interior solution, and assuming no transfers, household hours worked can be written as

$$H = constant \times w^{\frac{-1+\gamma}{-\gamma - \frac{1}{1+2\phi}}}.$$

Thus, if $\gamma > 1$, an increase in the wage rate w leads to a fall in household hours. Moreover, equation (5) implies that individual hours $h^* = H/\eta^*$ are positively related to household hours. Therefore, if $\gamma > 1$, an increase in w results in a fall in hours at the individual level too.