Measuring and Explaining International Differences in Hours Worked

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Abstract

How do average hours worked vary with income per capita? To answer this question, we build a new internationally comparable database of hours worked covering countries of all income levels. We document that average hours worked per adult are substantially higher in low-income countries than in high-income countries. This pattern is shaped by differences along both the extensive margin (employment rates) and intensive margin (hours per employed), with the former being quantitatively more important than the latter. Employment rates are decreasing between low- and middle-income countries, while hours per employed are decreasing between middle- and high-income countries. To help explain these facts, we build a model with subsistence consumption requirements in preferences and individual heterogeneity in the cost of supplying labor. An implication of our empirical findings and our model is that welfare differences across countries are substantially larger than suggested by income differences.

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1. Introduction

One of the most basic facts in macroeconomics is that aggregate income per capita varies greatly across countries (Klenow and Rodríguez-Clare, 1997; Hall and Jones, 1999; Caselli, 2005). Much less is known about how aggregate labor input varies across countries. Consider the basic question: are average hours worked higher for adults in high-income countries or for those in low-income countries? Due to data limitations, the economics literature does not have a clear answer to this question. This is unfortunate, because if hours enter directly into preferences, then measures of average hours worked at the country level are a key input to understanding welfare differences across countries (Jones and Klenow, 2011).

In this paper, we create a new database of average hours worked using recent household survey data from 84 countries of all income levels. The surveys we employ are nationally representative and cover workers in all sectors, including the self-employed, which represent the majority of the workforce in low-income countries. We focus most of our analysis on a set of 44 *core countries*, for which international comparability of hours data is as high as possible. In particular, we require that the data from these core countries satisfy three basic criteria. First, the surveys cover the entire calendar year (rather than, say, one month of the year). This is necessary to prevent any bias induced by seasonality in labor demand. Second, hours worked are measured in a consistent way: actual (rather than usual) hours in all jobs (not just the primary job), and in the week prior to the interview. Finally, hours worked cover the production of goods or services counted in the National Income and Product Accounts (NIPA). Thus, our hours measures cover unpaid work in agricultural or non-agricultural businesses, as well as wage employment, but do not cover home-produced services, such as child care.¹

We use our database to document that average hours per adult are substantially higher in lowincome countries (the bottom third of the world income distribution) than in high-income countries (the top third of the world income distribution). In the low-income countries, adults work 28.9 hours per week on average, compared to 19.2 hours per week in the high-income countries. This difference is both statistically and economically significant, with the cross-country differences in average hours per adult (9.7 hours per week) being twice as large as the decline in hours per adult in the United States over the twentieth century (4.7 hours per week) (Francis and Ramey, 2009a). Our finding of higher average hours in low-income countries holds for both males and females, and for all age groups.

Our finding of higher hours per adult in low-income countries is shaped by cross-country differ-

¹We return to the issue of home-produced services in Section 7, where we document (using a smaller set of countries) that average hours spent on home production are also higher in low-income countries than in high-income countries.

ences in both the extensive margin (employment rates) and the intensive margin (hours per employed). In relative terms, employment rate differences play a larger role than hours per employed differences to explain the decrease in hours per adult between low- and high-income countries. Both margins exhibit different shapes over the income distribution. Employment rates are much higher in low-income countries than in middle-income countries, but similar in middle- and highincome countries. Hours per employed by contrast are similar between low- and middle-income countries, but much lower in high-income countries. Thus, the extensive margin accounts for the higher average hours per adult differences between the poorest tercile and the rest of the world income distribution, while the intensive margin accounts for hours differences between the top tercile and the rest of the world income distribution.

To explain our main empirical findings, we build a simple model in which agents value consumption and leisure, and have a subsistence consumption requirement in preferences taking the Stone-Geary form. There is a representative household with a continuum of members that are heterogeneous in their marginal disutility of working. The distribution of disutility of work is the same across countries, and countries differ only in their aggregate productivity levels. The model implies that hours per adult and employment rates are decreasing in aggregate productivity, while the effect of aggregate productivity on hours per employed is ambiguous. The intuition is that when aggregate productivity is low, the subsistence preferences imply a high marginal utility from each additional consumption good. Thus, it is optimal to work even for individuals with a high marginal disutility of supplying labor. Yet, they optimally supply few hours of work. As productivity rises, these individuals drop out, which lowers the employment rate and which raises hours per employed, all else equal. On the other hand, the higher productivity induces all remaining workers to decrease their hours. This generates an ambiguous effect of aggregate productivity on hours per employed.

We calibrate the model to match several salient features of high-income countries, and choose the subsistence consumption requirement to be in line with existing estimates. The model makes several quantitative predictions that are in accordance with the data. First, it predicts that hours per adult are decreasing in aggregate productivity, generating a ratio of 1.39 between low- and high-income countries, compared to 1.50 in the data. Second, it generates the fact that the decrease in employment rates is larger in magnitude than the decrease in hours per employed. The ratio of employment rates in low- to high-income countries is 1.24 in the model and 1.33 in the data, while the corresponding ratios for hours per employed are 1.11 in the model and 1.13 in the data. The model correctly replicates that the decrease in the employment rates mainly arises between low-and middle-income countries. But it is not successful in replicating the fact that hours per employed fall mostly between middle- and high-income countries: the model predicts a counterfactually

small decline over this range.

To highlight the importance of our results, we construct measures of welfare differences across countries building on the welfare metric of Jones and Klenow (2011). The version we employ is intended to capture the flow of utility that arises not just from consumption but also from leisure. Relative to Jones and Klenow (2011), we add data on hours worked from the whole income distribution, whereas their data restricts them only to rich countries, and non-homothetic preferences, which our theory shows to be important in matching the facts. Using our hours data, plus standard measures of consumption per capita, we calculate that our welfare metric differs by a factor of 40 between the high-income and low-income countries. This compares to a factor of 21 when we ignore differences in hours worked, but include non-homothetic preferences, and a factor of 13 when we ignore both hours worked and non-homothetic preferences. Thus, once we include non-homothetic preferences are by differences in consumption per capita. Put differently, poor countries are poor not just in terms of consumption, but also in terms of leisure.

This paper is structured as follows. Section 2 places our paper in the context of the existing literature. Section 3 describes our underlying data sources, and our efforts to construct internationally comparable data on hours worked. Section 4 documents that hours per adult are decreasing in GDP per capita, with employment rates contributing more to this decrease than hours worked per employed, and also presents the shapes of both margins over the full income distribution. Section 5 presents our model, and compares its quantitative predictions to the data. Section 6 shows that welfare differences across countries are much larger than suggested by output-per-worker data alone. Section 7 presents data on home-production time across countries. Section 8 concludes.

2. Related Literature

Our study is the first to measure and explain average hours worked across the world income distribution. Prior studies trying to understand hours worked across countries have almost exclusively focused on rich countries, and in particular on the United States and European countries. Explanations of U.S.-Europe gaps in average hours have focused on differences in labor income taxation (e.g., Prescott (2004), Rogerson (2006), Ohanian et al. (2008), McDaniel (2011) and Bick and Fuchs-Schündeln (2014), among others), institutions (Alesina et al. (2005)), and social security systems (Erosa et al. (2012), Wallenius (2013), and Alonso-Ortiz (2014)). The study by Lee et al. (2007) branches out into some poorer countries as well, though their evidence is limited mostly to non-nationally representative establishment surveys covering only wage earners in the manufacturing sector. Their data thus excludes the self-employed and those working in agriculture, which

together form the vast majority of all workers in the developing world.

Other studies have focused on understanding changes in hours worked over time, though these have also focused on rich countries. For example, McGrattan and Rogerson (2004), Ohanian et al. (2008) and Bick et al. (2014) measure changes in hours among OECD countries over time, and Francis and Ramey (2009a,b) measure long-run changes in hours in the United States. Aguiar and Hurst (2007), Ramey (2009) and Francis and Ramey (2009a) focus in addition on hours spent in home production and leisure in the United States, and Duernecker and Herrendorf (2014) document patterns in home production time in Europe and the United States. In terms of theory, our explanation comes closest to that of Ohanian et al. (2008), in which subsistence preferences help explain higher hours of European countries in the past, and to that of Lagakos and Waugh (2013), in which subsistence preferences lead workers with low productivity in agricultural work to nonetheless work in the agricultural sector when aggregate productivity is low. In terms of how we approach the measurement of hours, we follow these previous studies closely, in particular the work of Francis and Ramey (2009a), as we detail below. Our main difference is that we consider recent cross sections rather than time series evidence, and countries of all income levels, not just richer countries.²

A large literature on development accounting has attempted to explain cross-country differences in income per capita, but has acknowledged that existing data on average hours worked are inadequate (Klenow and Rodríguez-Clare, 1997; Hall and Jones, 1999; Caselli, 2005; Hsieh and Klenow, 2010). The handbook chapter by Caselli (2005) considers hours worked data for 28 countries from the International Labor Organization (ILO), though just two of these 28 countries are in the bottom half of the world income distribution. Furthermore, these data are only on hours worked per employed, and ignore the extensive margin, which we show is important. Gollin et al. (2014) compare average hours worked among workers in the agricultural and non-agricultural sectors of a large set of countries using nationally representative surveys. Their data are comparable across sectors within each country, though not necessarily comparable across countries, and their study does not attempt to measure or explain the relationship between average hours worked and average income. Jones and Klenow (2011) consider hours worked in their study of welfare differences across countries, though their hours data cover countries in the top half of the income distribution, but not the bottom half.

²See Aguiar et al. (2012) for a recent review of the literature on hours worked and leisure. Aguiar et al. (2013) measure variation in hours worked, home production, and leisure during the Great Recession in the United States.

3. Data

In this section, we describe the survey data underlying our analysis. We then introduce the criteria that we use to define the set of "core countries," which are those that have the most scope for international comparability. Afterwards, we explain our procedure to generate employment rates, hours per employed, and and hours per adult.

3.1. Data Sources

Our analysis draws on nationally representative household surveys. The key advantage of using household surveys, as opposed to firm surveys or administrative records, is that our measures of labor supply are not restricted to activities for which individuals receive a wage, but also include self-employed and unpaid family work. As is well known, especially the self-employed form an important fraction of the workforce in all countries, and particularly so in developing countries (see e.g. Gollin (2008)).

All of the surveys we employ are publicly available for researchers, mostly via an application through national statistical agencies or similar institutions. We were able to collect data for 84 countries with a population of at least one million. For 36 of our countries we can draw from harmonized data sets, for which efforts have already been made to standardize questions across countries. These comprise the European Labor Force Survey (ELFS; 27 countries) the International Public-Use Microdata Project (IPUMS; 7 countries), and the Cross-National Equivalent File (CNEF; 2 countries). For the remaining 48 countries, we draw on country-specific censuses, house-hold or labor force surveys, including 16 surveys conducted as part of the World Bank's Living Standards Measurement Surveys (LSMS).

When multiple years of appropriate data are available, we choose the year closest to 2005, which is the year in which the latest benchmark estimates of GDP are available from the Penn World Tables (Heston et al., 2012). Most of our data is within a few years of 2005; exact years and data sources for all countries are given in Table A.1 in Appendix B. Our sample sizes range from 5,000 to over 700,000. We focus on all individuals of at least age 15, whom we refer to as "adults".³

3.2. Core Countries

The key measurement challenge we face is that not all of our surveys are conducted in the same way, and more specifically, not all surveys collect hours information in the same way. To ensure that international comparability is as high as possible, we focus our main analysis on a set of *core countries* which satisfy the following criteria:

³The US is an exception here as the youngest available age is 16.

- 1. Activity definition: Hours worked are for the production of a good or service counted in the National Income and Product Accounts (NIPA).
- 2. Hours worked information:
 - (a) Hours are actual hours worked rather than usual hours worked.
 - (b) Hours cover all jobs, and not only the primary job.
 - (c) Hours are for the last week or a recent reference week.
- 3. Time coverage: the survey covers the whole calendar year.

Out of the 84 countries in our sample, 44 qualify as core countries. Table A.1 indicates this status for each country. We discuss each of these criteria in turn.⁴

Activity Definition: To measure labor supply, we include all activities which produce output that is counted in NIPA. This includes individuals working for a wage as well as those working in own-account farm activities or nonagricultural businesses. Henceforth, we refer to all such activities as job(s). Thus, our data cover hours worked in agricultural and non-agricultural production even if it is ultimately used for own consumption. This is important if we want to maintain a nationally representative sample of workers, particularly in the poorest countries, where agricultural work and self-employment are very common. Not included in our main definition of hours worked are hours spent on non-market services, such as cleaning or home-provided child care.⁵

Hours Worked Information: To get the most comprehensive measure of labor supply, our core countries include only those that ask about actual hours worked, as opposed to usual hours worked. We use actual hours to capture that people at a given point may work more or less than usual, e.g. because of over-time or sickness, respectively. Our core countries also focus on all jobs, rather than just the primary job. Our focus on all jobs is justified by the fact that especially in poorer countries, many individuals work for wages as well as engage in self-employed work or subsistence farming. We want to capture all of these activities when measuring labor supply. While for some countries actual hours in all jobs are available directly, for other countries we add up actual hours in the main job and secondary job(s), i.e. hours spent in any activity producing output that is counted in NIPA as explained in the previous paragraph. Finally, to ensure that we have a precise measurement, we focus only on surveys providing the hours information close to the actual survey week and over a short time period, namely a week, rather than longer time horizons like the last month or even quarter, which would suffer much more from recollection problems.

⁴As part of our robustness analysis, in Section 4.5 we consider all countries rather than only the core countries.

⁵Note that home-produced goods, such as agricultural output, are counted as output in NIPA, though homeproduced services are not. See Gollin et al. (2014) for a more detailed discussion of how agricultural output is treated in the national income and product accounts. We return to data on home-produced services in Section 7.

Time Coverage: To get the broadest coverage in terms of survey time periods, we include the restriction that our core countries cover the entire calendar year. While all surveys are nationally representative in terms of the covered population, they are not necessarily representative with respect to the weeks of the year covered. Some surveys cover each week of the year, while others are conducted only in a single week or month. This creates potentially biased estimates of the employment rate and hours worked unless the subset of weeks is representative for the entire year. This bias may be most pronounced in developing countries, which are largely agricultural and hence seasonal. Appendix A provides a detailed explanation of how we determine the time coverage of each survey and which surveys qualify as covering the entire year according to our definition.

Comparison of Country Samples: Our definition of whether a country in our sample is a low-(bottom third of the world income distribution), middle- or high-income (top third of the world income distribution) country is based on GDP per capita for all countries in the Penn World Tables (PWT). We find that when comparing GDP per capita in our core and full set of countries to those in the PWT, they have similar levels of GDP per capita. Our low-, middle- and high-income core countries have GDP per capita of \$1,594, \$7,298 and \$27,353 respectively, compared to \$1,411, \$6,428 and \$28,211 for those in the PWT.

3.3. Measuring Employment and Hours Worked

Our population of interest contains i = 1, ..., N individuals and may be only a subset of all individuals in our survey data (e.g., only men, or only older individuals). For all our calculations, we use individual survey weights, but refrain from displaying them in the following paragraphs for the ease of notation. We rely on two key variables: the self-reported employment status e_i and actual hours worked in all jobs h_i in the last week.

To measure employment, we use the self-reported employment status e_i of each individual *i*. It takes the value 1 for anyone reporting to be employed, which includes self-employed and unpaid family workers, and 0 otherwise. We replace a missing employment status (including answers like "Don't know" and "Refuse to Answer") with 1 if positive actual hours worked are reported, and leave it missing otherwise. In general, missing employment status information is not very common in our data, with 38 of the 44 core countries having less than one percent of observations with missing employment status.

Letting the indicator $\mathbf{1}_{\mathbf{e}_i=\mathbf{n}\mathbf{m}}$ (where nm stands for non-missing) take the value one if the employment status is known and zero otherwise, the employment rate (*ER*) is given by

$$ER = \frac{\sum_{i=1}^{N} e_i \mathbf{1}_{\mathbf{e}_i = \mathbf{n}\mathbf{m}}}{\sum_{i=1}^{N} \mathbf{1}_{\mathbf{e}_i = \mathbf{n}\mathbf{m}}}.$$
(1)

Our measure of hours per employed (H^e) is based on the actual number of hours worked in all jobs h_i in the reference period. This variable is directly available in some surveys, while in other surveys we add up actual hours in the main job and in all additional jobs. We assign zero hours to non-employed individuals. Employed individuals may have zero hours if they have been absent from work for the entire reference period, e.g. because of annual leave or sickness.

We impose a common cap of 112 weekly hours (7 days x 16 hours per day), though slightly lower country-specific caps may in fact be binding, since the maximum possible hours reported vary by survey. For example, for the United States, the reported number of actual hours worked in all jobs cannot exceed 99, while in the ELFS the reported actual hours in the main job are capped at 80 and in all additional jobs at 80 as well. In our data, the number of observations that are top-coded is small, with only seven core countries exceeding 0.1 percent of all observations, and the maximum being 0.87 percent in Tanzania.⁶

Letting $\mathbf{1}_{\mathbf{h}_i=\mathbf{n}\mathbf{m}}$ take the value one if actual hours worked in all jobs are available, hours worked employed are then given by⁷

$$H^{e} = \frac{\sum_{i=1}^{N} e_{i} h_{i} \mathbf{1}_{\mathbf{h}_{i}=\mathbf{n}\mathbf{m}}}{\sum_{i=1}^{N} e_{i} \mathbf{1}_{\mathbf{h}_{i}=\mathbf{n}\mathbf{m}}}.$$
(2)

Our measure of hours per adult (H^a) is then obtained by multiplying the extensive (ER) with the intensive (H^e) margin of labor supply:

$$H^{a} = ER \times H^{e} = \frac{\sum_{i=1}^{N} e_{i} \mathbf{1}_{\mathbf{e}_{i}=\mathbf{n}\mathbf{m}}}{\sum_{i=1}^{N} \mathbf{1}_{\mathbf{e}_{i}=\mathbf{n}\mathbf{m}}} \times \frac{\sum_{i=1}^{N} e_{i} h_{i} \mathbf{1}_{\mathbf{h}_{i}=\mathbf{n}\mathbf{m}}}{\sum_{i=1}^{N} e_{i} \mathbf{1}_{\mathbf{h}_{i}=\mathbf{n}\mathbf{m}}},$$
(3)

which is how Francis and Ramey (2009a) measure hours per adult as well. For each country in our data we use (1), (2) and (3) to compute H^a , H^e and ER in the aggregate, and by sex and age groups.⁸

⁶Bick et al. (2014) show that capping of hours makes little difference for the United States and a subset of European countries from the ELFS. Under a cap of 80 hours per week, the difference between the capped and uncapped average hours for prime adults is below 0.2 percent for all countries in their sample, and the fraction of individuals for which this cap is binding is 0.7 percent for the ELFS and 0.2 percent for the United States.

⁷We include the employment status e_i in the denominator in Equation (2) only for transparency. Conceptually, this is redundant since $h_i = 0$ if $e_i = 0$.

⁸An alternative approach is to drop all individuals with any missing data, and to compute H^a as the sum of hours over the sum of adults. We prefer our current approach since it drops fewer observations, though in practice the two approaches provide very similar results, since missing observations are small fraction of the total in our data.

4. Empirical Findings

In this section we present the main empirical findings of our paper. We show that average hours worked per adult are higher on average in poor countries than in rich countries. Both employment rates and hours worked per employed decrease as GDP increases, but in relative terms the decrease in the employment rate is larger than the decrease in hours worked per employed. Analyzing the shapes over the full income distribution, we show that employment rates decrease between low-and middle-income countries, while hours worked per employed decrease between middle- and high-income countries. We then look at these patterns separately by age and sex.

4.1. Average Hours Worked Per Adult

Figure 1 plots average weekly hours per adult against the log of GDP per capita in 2005. Also plotted for reference are the mean hours per adult per tercile, given at the mean GDP of the sample countries in each tercile. The vertical lines separate the three income terciles, which correspond to the bottom, middle, and top thirds of the world income distribution. In our sample, the lowest bottom comprises 9 countries, the middle tercile 10 countries, and the top tercile 25 countries. The figure shows that average hours per adult are downward sloping in income per capita. The poorest countries in the world range from a low of around 24 hours per week in Uganda and Rwanda to a high of 39.1 hours per week in Cambodia. The richest countries average between a low of around 16 hours in Italy, Spain, Belgium and France to highs of 21.6 hours in Switzerland and 24.4 hours in the United States. Iraq has the lowest hours per adult in our sample, which is driven entirely by women, as discussed in Section 4.7.

Panel A of Table 1 reports in the first row the average hours per adult by country income. The columns represent the three country income groups: low, middle, and high. Average hours per adult are 28.9 hours per week in low-income countries, compared to 22.2 hours in middle-income countries and 19.2 hours in high-income countries.

Given that the number of core countries is relatively small, particularly in the lower end of the income distribution, we conduct statistical tests of the hypothesis that average hours worked in all countries are drawn from the same distribution. We do so using permutation tests, which have more favorable small-sample properties than other commonly used tests, such as t-tests (Lehmann and Romano, 2005). The logic of the permutation test is that, if average hours in each country are drawn from the same underlying distribution, one can resample the data many times to ask how likely it is that we get the observed differences in mean hours by chance. We conduct these permutation tests on differences between the three income groups.

Panel B of Table 1 reports the results of these permutation tests. For hours worked per adult,

shown in the first row, the observed difference in mean hours between the low- and high-income groups is 9.7 hours per week, and the P-value is well under one percent. The difference in mean hours between the low- and middle-income groups is 6.7 hours, while the difference between the middle- and high-income groups is 3.0 hours. Both differences have P-values less than one percent. We conclude that the decreasing average hours over the income terciles are quite unlikely to be a coincidence.

The ratio of average hours per adult in low-income countries to those in high-income countries is 1.50, as shown in the first row of Panel C of Table 1, i.e. adults in low-income countries work on average 50 percent more hours than adults in high-income countries. This is certainly an economically significant difference. Another way to illustrate the magnitude of our observed hours differences across countries is to compare them to the decline in average hours in the United States over the last century. Francis and Ramey (2009a) report that in 1900, the average adult (individuals aged 14+) worked 27.7 hours per week. A century later in 2005, the average adult worked 23.0 hours, corresponding to a decline of 4.7 hours per week. Compared to this decline, the difference of 9.7 hours that we measure between the low- and high-income groups is more than twice as large. Taking into account the GDP in the US a century ago, the cross-country difference is however completely in line with the decline of hours during the US history. The ratio of hours in middle-income countries to hours in high-income countries of 1.16 is close to the ratio of hours in the US a century ago and today (1.2). The US GDP per capita in 1900 corresponded roughly to the mean GDP of the middle-income countries today.

4.2. Employment Rates

We now present our findings for employment rates, which represent the extensive margin of average hours per adult. Figure 2 plots the employment rates for our core set of countries. The figure shows that employment rates are decreasing for much of the income distribution, with a modest increase for the richest countries. In the low-income countries, the majority of countries have high employment rates near the average of 73 percent, see the second row of Panel A of Table 1. In middle- and high-income countries, employment rates are 53 and 55 percent, respectively. Thus, employment rates decline mostly between the low- and middle-income countries, rather than between the middle- and high-income countries.

To test whether the patterns in Table 1 are statistically significant, we again conduct permutation tests of the null hypothesis that employment rates are drawn from the same distribution in all countries. The second row of Panel B of Table 1 reports the results of these tests. The positive difference between low- and middle-income countries is statistically significant at the one percent level, while the negative difference between middle- and high-income countries is insignificant.

Panel C of Table 1 shows in the second row the ratio of employment rates between countries of different income levels. The ratio of employment rates between low- and high-income countries is 1.33, i.e. the average employment rate in low-income countries is around a third higher than in high-income countries. This is entirely driven by the difference between low- and middle-income countries.

4.3. Average Hours Per Employed

Figure 3 presents our findings for average hours per employed person, which represent the intensive margin of average hours per adult. As the figure shows, the data feature decreasing hours per employed by log GDP per capita, driven by differences between the middle-income and highincome countries. Among the three poorest countries, Rwanda (RWA) and Uganda (UGA) have substantially lower hours than the remaining countries in the low income group, whereas Tanzania (TZA) is right on the average. Hours worked per employed are similar on average between the low-income group and middle-income group.

The third row of Panel A of Table 1 reports the average hours per employed by country income group. Workers in low-income countries average 40.0 hours per week, compared to 41.8 hours and 35.3 hours in the middle- and high-income countries.

The third row of Panel B of Table 1 represents the differences in mean hours by income group and the result of permutation tests of the hypothesis that average hours per employed are drawn from the same distribution in all countries. While the negative difference between low- and middle-income countries is insignificant, the positive difference between middle- and high-income countries, and the overall positive difference between low- and high-income countries, are both highly statistically significant. The ratio of hours worked per employed in low- to high-income countries, shown in Panel C, is 1.13, i.e. workers in low-income countries work on average 13 percent more hours than workers in high-income countries.

4.4. Summary: Accounting for Differences in Hours Worked Per Adult

Putting together the results for employment rates and hours per employed, we can account for the cross-country differences in hours per adult as follows. The ratio of hours per adult in low-income countries to those in high-income countries is 1.50. This is mainly driven by a difference in employment rates, for which the ratio is 1.33, supported further by a decrease in hours per worker, for which the ratio is 1.13. In relative terms, the decrease in employment rates by income is larger than the decrease in hours worked per employed.

Analyzing further the differences between low- and middle-income vs. middle- and high-income

countries, the following patterns arise. Between low- and middle-income countries, the differences in hours per adult are accounted for more than fully by differences in employment rates, i.e. changes in the extensive margin. Hours per employed however move in the opposite direction as hours per adult. Between middle- and high-income countries, by contrast, the differences in hours per adult are accounted for more than fully by declines in hours per employed, while employment rates move in the opposite direction. None of the differences moving in opposite direction than hours per adult are however statistically significant.

4.5. Robustness to Full Set of Countries

Until now, we have focused entirely on the 44 core countries which satisfy the comparability criteria described in Section 3. In this section, we assess whether our results are robust to including broader sets of countries. The simple tradeoff is that including more countries gives more data points, but allows for less compatibility across countries in terms of how hours are measured.

Table 2 displays average hours per adult in each income tercile for three alternative sets of countries. The parentheses indicate the number of countries in each tercile. The first row reproduces our results for just the core countries, where adults average 28.9 hours per week in the low-income countries, 22.2 hours worked in the middle-income countries, and 19.2 hours worked in the high-income countries. The second row adds all countries whose surveys satisfy the core criteria for hours measurement, but do *not* cover the entire calendar year. Across these 76 countries, average hours worked are 25.7 in the low-income, 22.0 in the middle-income, and 20.0 in the high-income countries. Thus, within the low-income countries average hours worked are slightly lower in this group than in the core. But average hours worked in the middle- and high-income countries are very similar in this group to the averages in the core.

The third row adds all remaining countries for which we have data, including those that have hours worked measured differently than the countries in our core sample. For example, these countries may ask for usual hours worked rather than actual hours worked in the last week, or for hours in just the main job rather than in all jobs. Across these 84 countries, average hours per adult are still 25.7 in the low-income group, and rise slightly to 22.5 hours in the middle-income countries and 20.4 hours in the high-income countries. Permutation tests (unreported, for brevity) show that these differences by country income are still all significant at the one percent level. We conclude that our finding of higher hours per adult in poor countries than in rich countries holds in a broader set of countries as well as in our core countries.

4.6. Differences by Age

In this subsection we document the facts separately for three age groups, namely the young, aged 15-24, the prime aged, aged 25-54, and the old, aged 55+. Starting with hours worked per adult, Panel A of Table 3 shows that average hours per adult are higher in the low-income countries than in rich countries for all age groups. The largest differences arise for the old. Old workers in the low-income countries work 19.7 hours per week on average, compared to 12.9 and 7.8 hours in the middle and rich countries. Panel B of Table 3 reports the results of permutation tests on differences for the three age groups (the results for all age groups together are repeated in the first row to facilitate comparison). For young and prime aged workers, the differences between low- and middle-income countries are 7.5 hours and 6.2 hours, and the P-values are less than one percent. For middle- and high-income countries, however, the differences are smaller, at 1.6 and 1.1 hours, and the P-values there are much higher, and well above ten percent in the case of prime workers. For old workers, on the other hand, differences are large and statistically significant between low- and middle-income countries, and between middle- and high-income countries. Thus, while differences between low- and middle-income countries appear large and statistically significant for all age groups, differences between middle- and high-income countries are large and significant only for older workers.

Given that we observe systematic differences in hours per adult by age, and that the age composition differs across countries, the question arises how much these differences in the age composition matter in explaining aggregate differences in hours across countries. To answer this question, we first compute average hours per person for 5 year age groups, starting from 15-19 and ending at 95+. We then calculate hypothetical average weekly hours per adult by multiplying US-population weights for the 5 year age groups with average hours of the corresponding age group in each country, and then summing up over all age groups. Appendix Figure A.3 gives the results and shows that, while average weekly hours per adult change for some countries when the US age structure is imposed, the changes are relatively minor. The basic pattern of declining hours by income is confirmed, and if anything increases.

Employment rates are clearly related to age. Table 4 shows the average employment rate by age group across income terciles. The most dramatic differences in employment rates are for the old, with 61 percent of old adults employed in the low-income group, compared to 33 percent in the middle-income group and 24 percent in the high-income group. This reflects an obvious retirement margin present in the richest countries, which appears to be less important for the very poorest countries. Moreover, due to higher life expectancy in richer countries, the group of old individuals is on average older there than in poorer countries, which also partly explains the lower employment rates. Employment rates have a similar pattern among the young, with a stark decline

between the low- and middle-income countries, which reflects a schooling margin.⁹ For prime adults, employment rates are high in all countries, and fall only modestly with income. In the low-income group, 86 percent of prime adults are employed, compared to 70 percent in the middle-income group on average, and 80 percent in the high-income group on average.

To test whether these patterns are statistically significant, we again conduct permutation tests of the null hypothesis that employment rates are drawn from the same distribution in all countries. Panel B of Table 4 reports the results of these tests. The positive differences between low- and middle-income countries are statistically significant at the one percent level for all age groups. In contrast, the negative differences between middle- and high-income countries are insignificant for all age groups, but the positive difference between middle- and high-income countries for old workers is significant.

Finally, Panel A of Table 5 reports the average hours per employed by age and country income group. The modest gain in hours worked per employed between the low- and middle-income groups is present for all ages, as is the more substantial drop between middle- and high-income countries. While all the differences between low- and middle-income countries are negative, none of these differences are statistically significant, see Panel B. What is significant are the differences between the middle- and high-income countries. This decrease between middle- and high-income countries ranges from 4.8 hours for the old, to 6.6 hours for prime and 8.0 hours for the young. When comparing low- and high-income countries, the differences for all ages, young, and prime aged workers are significant, while the difference of 0.3 hours for old workers is not. Old workers feature a hump-shaped pattern, working 33.9 hours in the low-income countries, 38.4 hours in the middle-income countries.

Summarizing, the fact that differences in hours worked per adult between low- and middle-income countries are accounted for more than fully by differences in employment rates is true for all age groups. Similarly, the fact that differences in hours per adult between middle- and high-income countries arise solely due to differences in hours worked per employed is true for the young and the prime aged; this time however the old are an exception. For the old, both margins matter when explaining the difference between middle- and high-income countries.

4.7. Differences by Gender

It is well known that hours worked by men and women can differ substantially in different contexts. We therefore look at average hours worked separately by gender. Figure 4 plots average hours per adult for males (top panel) and females (bottom panel). We find that hours per adult are higher in

⁹We find that when including students as employed, under the thinking that they are employed producing human capital, we find much smaller differences in employment rates across countries for the young.

poor countries for both men and women. For the low income countries, males average 32.6 hours per week, while in the middle- and high-income countries they average 29.6 and 23.8 hours per week. The difference of 8.8 hours per week between the low and high income group is statistically significant at the one percent level. Women average 25.4 hours in the low income group, 15.2 hours in the middle income group and 15.0 hours in the high-income group, and the low-high difference of 9.6 hours per week is also significant at the one percent level.¹⁰

Differentiating by age (results not shown), we find similar cross-country patterns for males and females, with lower average hours for females at all age and income levels. For both sexes, the biggest differences across countries come for young and old individuals, with more modest declines for prime aged individuals. Among men, for example, the old average 12.3 more hours per week in low-income countries than in high-income ones (23.6 hours vs. 11.3 hours), while the prime aged average 7.6 more hours per week in the low-income countries (41.1 hours vs. 33.8 hours). For women, the old average 10.8 more hours per week in the low-income countries (16 hours vs. 5.2 hours), while the prime aged work 7.9 hours per week more on average in the low-income countries (31.2 hours vs. 23.3 hours).

Employment rates for men and women exhibit some similarities as well as some differences. Figure 5 plots the employment rates for men and women. The figure shows that employment rates for men are decreasing between low- and middle-income countries, and still mildly decreasing between middle- and high-income countries. Employment rates for women, on the other hand, increase between middle- and high-income countries. This arising U-shape for women has been studied by others, e.g. Goldin (1995) and Olivetti (2014), and we are not the first to find it. Overall, women and men both have high employment rates in the poorest countries in the world, which fall as income per capita rises to intermediate levels. The difference is that female employment rates rise between middle- and high-income countries, while male employment rates slightly fall.¹¹ Iraq features an extremely low employment rate for women of 7 percent, followed by Pakistan with 22 percent.

Figure 6 plots hours per employed by gender for the core countries. The figure shows that hours per employed exhibit a decrease between middle- and high-income countries for both men and

¹⁰Another notable feature of the graphs by sex is that female hours are substantially lower for countries with large Muslim populations, such as Iraq (IRQ), Pakistan (PAK) and Turkey (TUR).

¹¹When looking by age, employment rates exhibit much more dramatic declines for older and younger men and women than for the prime aged. Among males, the prime aged have employment rates of 93 percent in the low-income countries, and 86 percent in the middle- and high-income countries. Of old men, 69 percent are employed in the low-income countries, compared to 47 percent in the middle-income, and 31 percent in the high-income countries. Among women, 80 percent of the prime aged are employed in low-income countries, compared to 54 percent in middle-income countries. For the old, 53 are employed in middle-income countries, compared to 23 percent and 18 percent in the middle- and high-income groups.

women. For men, they are slightly increasing between low- and middle-income groups, while for women they are essentially flat. Across all age groups, hours per employed among males are 41.9 hours in the low-income, 44.1 in the middle-income, and 38.3 in the high-income groups. Among women, hours per employed are 37.2 hours in the low-income, 36.8 hours in the middle-income, and 31.5 hours in the high-income group. We find similar shapes by age for both sexes, though with lower hours in all countries for women than for men, and for young and old workers than prime-aged workers. As when looking at both sexes taken together, the increases in hours from the low- to middle-income countries are statistically insignificant, while the decreases from middle- to high-income are significant at the one percent level and larger in magnitude.¹²

4.8. Potential Biases Resulting from Survey Methodology

No matter how carefully one tries to ensure comparability of different surveys across countries, there is still the potential for bias arising from limitations in the survey methodology. In this section, we discuss several such potential biases and their possible influences on our findings.

One potential bias may arise from surveyors avoiding geographic regions during periods of peak seasonal labor demand in those regions, such as planting and harvest times in agricultural production. The reason is that workers may be less likely to participate in surveys during periods of peak labor demand. How might such a bias affect our results, if it were present? If anything, we argue that it would bias downward our average hours in low income countries, which have much higher shares of employment in agriculture (see e.g. Herrendorf et al. (2013)). Thus, if this bias were present, our findings of higher average hours in poor countries would still be true and the differences would be even larger than the ones we report in Table 1. An indication for our prior is that hours in low-income countries, as shown in Table 2. This is much less pronounced in middle- and high-income countries, in which seasonality likely plays less of a role.

A second potential bias may arise from vacation periods. Bick et al. (2014) document for a subset of countries in the ELFS that, even though all weeks of a year are covered, hours worked lost due to annual leave and public holidays are less than half of what the country-wide averages from external data sources are. The latter are obtained e.g. from government agencies or employer organizations. This difference amounts on average across the countries in their sample to 3.5 weeks per year. Bick et al. (2014) further present evidence that for Germany, the country with the largest difference, the hours lost implied by the labor force survey are implausibly low. As a consequence, they adjust their measure of hours per employed for this bias. In order to do so, they use information not only

¹²Iraq is again an outlier in female hours per employed, though with 23.7 hours per employed they are higher than in the Netherlands with 21.3 hours.

on actual hours worked, but also on usual hours worked, as well as the main reason why actual hours differ from usual ones. This allows them to impose the average vacation days and public holidays from external data sources on the sample. These type of information are only available for a subset of countries in our sample. In order to maintain consistency, we therefore abstract from making such an adjustment. Since the days of annual leave and public holidays taken by employed individuals are most likely increasing in GDP per capita, we may overestimate hours worked more in rich countries than in poor countries. Again, this would imply that our estimated differences in hours worked between rich and poor countries underestimate the true difference.

5. Model

In this section, we present a simple model to explain the facts that we have documented thus far. The baseline assumption in the model is that the productivity of labor differs across countries. The key model feature is a non-homotheticity in preferences in the form of a subsistence consumption requirement. As labor productivity increases, countries become richer, subsistence consumption becomes less important, and thus the incentive to work decreases. The more challenging part is to account for the different patterns of the employment rate and hours per employed as labor productivity increases. We introduce heterogeneity in the marginal disutility of working across household members along with consumption insurance at the household level. This generates an explicit extensive margin, i.e. employment choice. As we detail below, this mechanism has the potential to generate employment rates and hours per adult which do not move in lockstep as labor productivity increases. We then calibrate the model and compute its predictions across the world income distribution.

5.1. Environment

Each country has a representative household with a continuum of members (individuals), indexed by η (explained below). Each household member is endowed with one unit of time and her preferences are given by

$$U(\boldsymbol{\eta}) = \log(c(\boldsymbol{\eta}) - \bar{c}) - \frac{\alpha}{1 + \frac{1}{\epsilon}} (\boldsymbol{\eta} + h(\boldsymbol{\eta}))^{1 + \frac{1}{\epsilon}}, \tag{4}$$

where $c(\eta) \ge 0$ and $h(\eta) \in [0, 1]$ are consumption and hours worked of individual η , \bar{c} is a subsistence consumption need, α is a distaste for work, and ε is related to the Frisch elasticity of labor supply.¹³ η affects the marginal disutility of working and is assumed to be heterogenous across individuals. This introduces differences in how costly it is to supply the first hour of working (and

¹³When $\bar{c} = \eta = 0$, ε is exactly equal to the Frisch elasticity. See Shimer (2010) for a clear exposition of the various labor supply elasticities in this version of the model.

obviously every additional hour as well). We restrict η to fall in the unit interval, and assume that it is drawn from a distribution with PDF $f(\eta)$ and CDF $F(\eta)$.

Output is produced using a constant returns technology

$$Y = A \int_0^1 h(\eta) f(\eta) d\eta, \qquad (5)$$

where A represents labor productivity, and $\int_0^1 h(\eta) f(\eta) d\eta$ aggregate hours worked. Both, the labor market and output market are competitive, and there is unrestricted access to the production technology.

5.2. Household Problem

We assume that the household values all members' utility of consumption the same. Since preferences are separable, it chooses a single consumption $c(\eta) = c$ for each household member. The problem of the household is to choose c and $\{h(\eta)\}_{\eta=0}^{1}$ to maximize

$$\max_{\substack{c,\{h(\eta)\}_{\eta=0}^{1}}}\log(c-\bar{c}) - \alpha \int_{0}^{1} \frac{1}{1+\frac{1}{\varepsilon}}(\eta+h(\eta))^{1+\frac{1}{\varepsilon}}f(\eta)d\eta$$
s.t. $c = A \int_{0}^{1}h(\eta)f(\eta)d\eta$. (6)

The first order condition for an individual with a draw η is (assuming the individual supplies positive hours):

$$\frac{1}{c-\bar{c}} \cdot A = \alpha (\eta + h(\eta))^{1/\varepsilon}$$
(7)

When deciding how many hours each member should work, the household utilizes both the extensive margin and the intensive margin. Define $\bar{\eta}$ as the (endogenously chosen) draw of η for which it is optimal to set $h(\eta) = 0$. Individuals with a relatively high marginal cost of working, i.e. those with $\eta \geq \bar{\eta}$, will supply zero hours, whereas those with $\eta < \bar{\eta}$ will supply positive hours. Since the marginal utility of consumption is the same across all household members, and since preferences are separable in consumption and leisure, it follows that the marginal disutility of working conditional on working must also be the same across household members. From the first order condition, Equation (7), this means that $\eta + h(\eta)$ is the same for all individuals with $\eta < \bar{\eta}$. This must however also be true for those individuals who optimally (in the sense that the first order condition holds) supply exactly zero hours, i.e. those with the draw $\bar{\eta}$. This implies that $\bar{\eta} + 0 = \eta + h(\eta) \forall \eta < \bar{\eta}$, or put differently $h(\eta) = \bar{\eta} - \eta \forall \eta < \bar{\eta}$.¹⁴

¹⁴There are several other ways to add heterogeneity across household members that would lead to both an extensive

Thus, the household's problem reduces to choosing a single variable, $\bar{\eta}$, to satisfy a single equation, which is the household's first order condition, (7), taking *c* from the budget constraint, and replacing each individual's optimal hours, $h^*(\eta) = \bar{\eta} - \eta \forall \eta < \bar{\eta}$ and $h^*(\eta) = 0 \forall \eta \ge \bar{\eta}$:

$$\left(1 - \int_{\bar{\eta}}^{1} f(\eta) d\eta\right) \cdot \{\bar{\eta} - E(\eta|\eta < \bar{\eta})\} = \left[\alpha \bar{\eta}^{1/\varepsilon}\right]^{-1} + \frac{\bar{c}}{A}$$
(8)

The left hand side of Equation (8) is aggregate hours worked, and at the same time hours per adult:

$$H^{a}(\bar{\eta}) = \int_{0}^{1} h^{*}(\eta) f(\eta) d\eta = \left(1 - \int_{\bar{\eta}}^{1} f(\eta) d\eta\right) \cdot \{\bar{\eta} - E(\eta|\eta < \bar{\eta})\};$$
(9)

see Appendix 4.1 for the derivation of Equation (9). Hours per adult are the product of the employment rate and hours per employed. The former is equal to the fraction of working individuals:

$$ER(\bar{\eta}) = Pr(\eta < \bar{\eta}) = 1 - \int_{\bar{\eta}}^{1} f(\eta) d\eta.$$
⁽¹⁰⁾

The employment rate explicitly excludes the individuals for whom $\eta = \bar{\eta}$ as these optimally supply zero hours (optimally in the sense that the first order condition Equation (7) holds.) Averaging over the individual hours of each worker $h(\eta) = \bar{\eta} - \eta$ gives us hours per employed:

$$H^{e}(\bar{\eta}) = \bar{\eta} - E(\eta | \eta < \bar{\eta}).$$
⁽¹¹⁾

5.3. Comparative Statics

Proposition 1 Decreasing labor productivity A

- *i. increases the employment rate,*
- ii. may decrease or increase hours per employed,
- iii. increases hours per adult.

Applying the implicit function theorem to Equation (8), the derivative of $\bar{\eta}$ with respect to A is given by:

$$\frac{\partial \bar{\eta}}{\partial A} = -\frac{\bar{c}}{A^2} \left[\frac{1}{\epsilon \alpha \bar{\eta}^{1+1/\epsilon}} + F(\bar{\eta}) \right]^{-1}$$
(12)

and intensive margin of labor supply. Alternative possibilities include that either all household members have the same η , but have heterogeneity in α , or to have constant η and α , but to allow for productivity differences across members.

Since the term in brackets is positive by definition, $\frac{\partial \bar{\eta}}{\partial A}$ is negative. In words, as labor productivity decreases, the threshold $\bar{\eta}$ increases. In the following, we will demonstrate how our labor market statistics change as $\bar{\eta}$ changes.

The derivative of the employment rate w.r.t. $\bar{\eta}$ is straightforwardly given by

$$\frac{\partial ER}{\partial \bar{\eta}} = f(\bar{\eta}). \tag{13}$$

Increasing the threshold marginally induces those who were right at the threshold and optimally supplied zero hours to supply positive hours. The employment rate increases exactly by the density of those individuals, which is $f(\bar{\eta})$. In terms of Proposition 1, decreasing A increases $\bar{\eta}$ and thus the employment rate. Intuitively, the lower labor productivity makes it harder to satisfy the subsistence consumption needs and hence more people are working.

The derivative of hours per employed w.r.t. $\bar{\eta}$ is given by

$$\frac{\partial H^e}{\partial \bar{\eta}} = 1 - \frac{f(\bar{\eta})}{F(\bar{\eta})} H^e(\bar{\eta}), \tag{14}$$

where F is the CDF; see Appendix 4.3 for how Equation (14) is determined. At the larger threshold, the new hours per employed are a weighted average of the hours per employed of the *already employed* workers and the hours per employed of the *newly employed* workers. Hours per employed increase one to one with the change in the threshold because both the *already employed* workers and the *newly employed* workers increase their hours marginally. This marginal change represents also the hours (in levels) per *newly employed* worker, which are by construction lower than the hours per *already employed* worker $H^e(\bar{\eta})$ before changing $\bar{\eta}$. The change in hours per employed reflects this difference by subtracting $H^e(\bar{\eta})$ weighted with the ratio of *newly employed* $[f(\bar{\eta})]$ to *all employed* workers $[F(\bar{\eta})]$.

Since for continuous distributions $f(\bar{\eta})$ may exceed $F(\bar{\eta})$, $\frac{\partial H^e}{\partial \bar{\eta}}$ could potentially be negative. Intuitively, this can be best interpreted when considering the case of a positive mass exactly at the threshold (Appendix 4.4 provides the formula for the change in hours per employed with discrete distributions). Assume that hours per employed are relatively high and that the mass of individuals at the threshold who optimally supply zero hours is large relative to the mass of already employed individuals. A small increase in the threshold induces these individuals to start working. But since they only work few hours, average hours per employed may decrease. This prediction is in contrast to the one for the employment rate, which unambiguously increases as $\bar{\eta}$ increases. Hence, depending on the distributional properties of η , this might help to reconcile the different patterns documented for the employment rate and hours per employed. Finally, decreasing the labor productivity A leads to a higher threshold $\bar{\eta}$ and thus an unambiguous increase of hours per adult because:

$$\frac{\partial H^a}{\partial \bar{\eta}} = F(\bar{\eta}),\tag{15}$$

see Appendix 4.3 for its derivation. The interpretation is straightforward as well. Already employed and newly employed workers increase their hours one to one with an increase in the threshold, but they only constitute the fraction $F(\bar{\eta})$ of the population.

5.4. Calibration

We now calibrate the model, and assess its predictions for hours worked in the cross section of countries. Our strategy is to parameterize the model to match moments of the high-income countries, and then to lower A to compute the model's predictions for countries with lower income levels. We begin by normalizing A = 1 for the United States.¹⁵ We set the level of subsistence consumption equal to 3 percent of U.S. GDP per capita, which given our normalization of $A_{US} = 1$ yields a value of 0.0042 and is slightly above 40% of the average consumption of our low-income group. This is roughly in line with estimates from Atkeson and Ogaki (1996) and Rosenzweig and Wolpin (1993), who estimate that subsistence is about one third of the average consumption level of village India. India's GDP per capita is about 50% higher than the average of our low-income group.

For ε , which relates to the Frisch elasticity, we choose a value of 0.5. This is consistent with Frisch elasticities on the intensive margin estimated by previous studies by Chetty et al. (2011, 2013) and in line with the range of micro elasticities used by e.g. Rogerson and Wallenius (2009). Next, we let one unit of time represent 112 hours per week, which corresponds to one week minus 8 hours per day for sleep. We set the distribution of η , $F(\eta)$, to be a beta distribution. The beta distribution is naturally bounded by zero and one, which corresponds to the range of η in the model. This distribution has two parameters to discipline, which we denote α_{η} and β_{η} .

These choices leave three parameters to calibrate: α , the distaste for work, and the two parameters of the η distribution, α_{η} and β_{η} . To discipline these parameters we target three moments: (1) the average hours per employed among the high-income countries of 35.3 hours per week, (2) the employment rate of 55 percent in the high-income countries, and (3) the fraction of all individuals working less than 30 hours among all employed with non-missing hours information, which is 23

¹⁵We measure labor productivity according to our production function given in Equation (5). We calculate GDP per adult by dividing GDP per capita from the Penn World Tables with the fraction of adults in the total population, which we take from the World Development Indicators. In a next step, we divide GDP per adult by hours per adult from our data. Our measure of labor productivity thus captures cross-country differences in capital, human capital, as well as total factor productivity.

percent. Intuitively, these moments help pin down the central tendency of the η distribution and its dispersion as well as the time cost of work. We list the parameter values resulting from our calibration strategy in Table 6.

5.5. Quantitative Results

To compute the model's predictions for hours and employment, we use the country-specific empirical estimates of A. Figure 7 displays the calibrated distribution of η . The distribution of η contains more mass on the higher values, corresponding to higher disutility of labor, than the lower values. Given that in equilibrium those with the relatively highest values of η do not work, this means that much of the potential population of workers has high cost of working and does not work. Intuitively, these may correspond to older individuals for example.

Figure 8 shows the model's predictions against log GDP per capita in the data for each country. Panel (a) plots the model's predicted hours per adult (red diamonds) and the hours per adult in the data (black dots). The red line is the fitted line through the model predictions. Because the model targets employment rates and hours per employed in the rich countries, it also matches hours per adult on average in the rich countries by construction. For lower income levels, hours per adult are flat for much of the income distribution, and then rise in the poorest countries. Table 7 summarizes the model's predictions for ratios of hours across country income groups in the model and data. It shows that hours per adult in the model are 1.39 times as high in the low-income countries as in the high-income countries, compared to 1.50 in the data, i.e. the model explains roughly 80% of the decrease. The model replicates the ratio of low- to middle-income countries in the data (1.32 in the model vs. 1.30 in the data) but predicts a smaller ratio of middle- to high-income countries (1.05 in the data). The model is successful in generating the larger decline in hours per adult between the low- and middle-income countries than between the middle and rich.

Panel (b) of Figure 8 plots the model's predicted employment rates. Employment rates match the data on average in the richest countries by construction. As log GDP per capita falls, employment rates rise slowly at first, and then rise more dramatically for low levels of income, as in the data. The reason is that when A falls near the subsistence level, the marginal utility of consumption rises rapidly, which induces the household to rapidly increase the cutoff disutility of work $\bar{\eta}$. The model predicts that employment rates are 1.24 times as high in the low-income countries as in the high-income countries, compared to a ratio of 1.33 in the data (see Table 7), i.e. the model explains about 70% of the decrease. The model is also consistent with the fact that the decrease in employment rates occurs between low- and middle-income countries (1.03 in the model vs. 0.97 in the data).

Finally, panel (c) plots the model's predictions for hours per employed. Again, the model's predictions for the rich countries match on average by construction in the calibration. As income per capita falls, hours per employed stay flat through intermediate income levels, and then rise modestly in the poorest countries. Table 7 shows that the ratio of hours per employed in the low-income countries to the high-income countries is 1.11 in the model, which is similar to the ratio of 1.13 in the data. Compared to the model's employment rates, hours per employed rise much less substantially in the lowest income countries. This is consistent with the data, as we emphasize in Section 4.

On the other hand, the model is less successful in replicating the shape of the decline in hours per employed over the full income distribution. It generates a decline in hours per employed mostly between low- and middle-income countries, while in the data the decline occurs between middle-and high-income countries. The model predicts that hours per employed are only 1.02 times as high in the middle-income countries than in the high-income countries, while in the data the ratio is 1.18. The model fails on this dimension because far from subsistence levels, the cutoff $\bar{\eta}$ changes only very little as *A* rises, leaving hours per employed similar in the model for middle-income and rich countries. We are working on a version of the model with taxes and transfers which may help improve the model's predictions for the shape of hours per employed.¹⁶

6. Implication for Welfare Differences Across Countries

In this section, we consider what our findings imply for welfare differences across countries. To do so, we build on the welfare metric of Jones and Klenow (2011), which provides a simple measure of the flow value of welfare that residents of each country experience. It is meant to be an analogue to GDP per capita, which is the most commonly cited flow measure of output. Our analysis here differs from Jones and Klenow (2011) in that we include data on hours worked from the entire income distribution, not just the rich countries, while their metric includes life expectancy and income inequality.¹⁷

Our welfare metric involves all household members, those who are employed and those are not, and thus includes next to consumption both margins of labor supply. Conceptually, our welfare

¹⁶Cross-country data on taxes and transfers show increasing levels of income taxes and transfers as income per capita rises. Higher taxes and transfers in rich countries than middle-income countries can at least qualitatively explain the lower hours per employed in the rich countries that our current model is unable to replicate. A second, alternative approach, is using preferences that feature income effects that dominate substitution effects, such as CRRA preferences, rather than log.

¹⁷Our welfare measure, as well as the one by Jones and Klenow (2011), takes into account only the flow of utility in a single year. Basu et al. (2012) propose a welfare metric that takes into consideration the entire sequence of discounted future periods, and show that their welfare measure is summarized, under minimal assumptions, by TFP and the capital stock per capita.

metric imagines giving the household of some country *i* a choice between two options: the first is to have the same fraction of individuals working as in our high income countries (ER_{HI}) and for those employed to work the average hours of our high income countries (H_{HI}^e) and to consume a fraction λ of the average consumption of our high income countries $(c_{HI} - \bar{c})$. The second option is to "stay in country *i*", and to have this country's fraction of individuals working (ER_i) at the country's hours per employed (H_i^e) , and enjoy its average consumption level $(c_i - \bar{c})$. We then find the λ_i that makes the individual indifferent between the two choices. In our analysis, country *i* will refer either to the average for our low income countries (i = LO) or the average for our middle income countries (i = MI)

For convenience, we restate the households utility function in country group $j = \{LO, MI, HI\}$:

$$U_{i} = log(c_{i} - \bar{c}) - \frac{\alpha}{1 + \frac{1}{\varepsilon}} \underbrace{\int_{0}^{1} (\eta + h(\eta))^{1 + \frac{1}{\varepsilon}} f(\eta) d\eta}_{\equiv u_{i}^{d}},$$
(16)

where the term u_i^d represents the disutility of those working and those not working since the marginal utility cost η enters the household utility even if $h(\eta) = 0$. Formally, the welfare metric in country *i* is λ_i which solves

$$log(\lambda_i \cdot (c_{HI} - \bar{c})) - \frac{\alpha}{1 + \frac{1}{\varepsilon}} u_{HI}^d = log(\lambda_i \cdot (c_i - \bar{c})) - \frac{\alpha}{1 + \frac{1}{\varepsilon}} u_i^d.$$
(17)

In our analysis, we use all parameters from our calibrated model but use the empirical observations for the employment rate and hours per employed, which we denote by $\widehat{ER_i}$ and $\widehat{H_i^e}$, to compare welfare across the three country groups. Hence, consumption for each country group is given by

$$c_i = \widehat{A}_i \cdot \widehat{ER}_i \cdot \widehat{H}_i^e, \tag{18}$$

where \widehat{A}_i is the average labor productivity for each country group. We now need to compute for each country group u_j^d . We first back out the threshold value $\widehat{\eta}_i$ which is consistent with \widehat{ER}_i . Note that for a given \widehat{A}_i , this does not necessarily solve our threshold equation (8). It does so however for the high income countries because \widehat{ER}_{HI} was targeted explicitly in our calibration. The first order equation (7) dictates that

$$h(\eta) + \eta = \mu_i \,\forall \, \eta < \widehat{\bar{\eta}}_i, \tag{19}$$

where μ_i is a country-group specific constants. Optimality would imply that $\mu_i = \hat{\eta}_i$, which is true for the high income country group because of our calibration strategy, but not for the low and middle income country groups. For them $\hat{\eta}_i$ is not optimal in first place. Consequently, we do not

impose this condition here neither. For a given cut-off value $\hat{\bar{\eta}}_i$ and using Equation (19), hours per employed are given by

$$H_i^e = \mu_i - E(\eta | \eta < \widehat{\bar{\eta}}_i).$$
⁽²⁰⁾

Using the empirical hours per employed in country *i*, we back out the corresponding value of μ_i , which we denote as $\hat{\mu}_i$:

$$\widehat{\mu}_i = \widehat{H}_i^e + E(\eta | \eta < \widehat{\overline{\eta}}_i).$$
(21)

Using $\widehat{\eta}_i$ and $\widehat{\mu}_i$, with $\eta + h(\eta) = \widehat{\mu}_i \forall \eta < \widehat{\eta}_i$, we obtain u_i^d :

$$u_i^d = \int_0^{\widehat{\eta}_i} \widehat{\mu_i}^{1+\frac{1}{\varepsilon}} f(\eta) d\eta + \int_{\widehat{\eta}_i}^1 \eta^{1+\frac{1}{\varepsilon}} f(\eta) d\eta = \widehat{\mu_i}^{1+\frac{1}{\varepsilon}} \widehat{ER_i} + \int_{\widehat{\eta}_i}^1 \eta^{1+\frac{1}{\varepsilon}} f(\eta) d\eta.$$
(22)

Using Equations (18) and (22), we can solve for Equation (17) the country-specific consumptionequivalent welfare measure λ_i , where the welfare of the high-income countries is normalized to 100.

The first row of Table 8 shows, as a frame of reference, the average λ_i s by tercile when we consider only cross-country differences in consumption, and neglecting non-homothetic preferences (that is, we set \overline{c} and α to zero). Countries in the bottom third of the income distribution have around 7.7 percent of the consumption-equivalent welfare level of the richest third. The middle third has 30.5 percent of the richest third. The differences reflect only the consumption differences between these countries through the standard homothetic preferences. The final column shows that the ratio of the top to bottom third is 12.9, meaning, as expected, very sizable differences in consumptionequivalent welfare coming through consumption alone.

The second row of Table 8 repeats the calculations under non-homothetic preferences. We let $\bar{c} = 0.0042$, as in the quantitative model. As a result of adding non-homothetic preferences, the average λ in the low-income group is now 4.8 percent of the richest quartile, lower than under homothetic preferences. The middle third of the income distribution has 28.3 percent of the consumption-equivalent welfare of the richest third, similar to the value under homothetic preferences. This indicates that for the middle-income countries, subsistence consumption plays already only a minor role. The ratio of average λ between the richest and poorest terciles is now 21.0. Thus, adding non-homothetic preferences alone implies modestly larger welfare differences than under more standard preferences.

Finally, we add differences in employment rates and hours per employed across countries. The third row of Table 8 summarizes the results. Welfare in the bottom tercile is now just 2.5 percent of the richest tercile. The middle third has 24.1 percent of the welfare level of the top third. The ratio of welfare between the top and bottom thirds is now a factor 39.7, or three times the ratio without

hours worked or non-homothetic preferences.

Measuring welfare differences across countries is not an exact science. Nevertheless, the results of this section suggest that including non-homothetic preferences leads to mildly larger, and adding cross-country differences in hours worked leads to substantially larger welfare differences across countries, all else equal. Compared to a world with only consumption differences, adding sub-sistence constraints and our measured differences in hours worked implies three times as much variation across countries in well being. An important caveat is that we have ignored hours spent on non-market activities that are not leisure, in particular home-produced services, such as cooking or cleaning. We turn to this issue next.

7. Time Spent on Home Production

In our welfare calculations, we assume that hours not worked in the market contribute fully to leisure. However, there exists another time category besides hours worked in the market and leisure that we do not consider so far, namely time spent on home production. If there exist systematic differences in time spent on home production across countries, this will bias our estimates of welfare differences. Despite the difficulty of measuring home production output, one can reasonably assume that, if individuals in poor countries spend on average more time on home production than individuals in rich countries, our welfare estimates will provide a lower bound of the true welfare differences between poor and rich countries. By contrast, the true welfare differences will be smaller than our estimated ones if time spent on home production is on average lower in poor countries than in rich countries.

Home production hours are notoriously hard to measure. The two most important reasons are the difficult differentiation between leisure and home production in some categories, and the possibility of multi-tasking. Both difficulties apply especially when it comes to child care, but can also arise in other categories like cooking (see Aguiar and Hurst (2007) and Ramey (2009) for excellent discussions of the difficulties of measuring leisure and home production hours). Questions on time spent on home production are therefore not usually included in labor force surveys or censuses. However, a few of the surveys we use do in fact ask about time spent on some categories of home production. We complement these surveys with data from the Multinational Time Use Study (MTUS) starting in 1990.¹⁸ Table A.2 provides an overview of the countries with data on time use by income terciles. All data from the bottom and middle terciles come from our main data source for the respective country. All data from the top tercile come from the MTUS, with the exception of Russia. We have data from 9 countries in the bottom tercile, 6 countries in the middle tercile,

 $^{^{18}}$ For each country, we use the year closest to 2005.

and 9 countries in the top tercile, but only 14 of these 24 countries belong to the core sample.¹⁹

We provide evidence on average weekly hours spent in five aggregated major home production categories, namely cooking (including preparing food and washing dishes), cleaning, child care, shopping, and collecting water and firewood. Child care comprises time spent taking care of children, if possible excluding the category "playing with children in free time". These data should be considered suggestive evidence: we do not apply the same standards to ensure comparability across countries that we apply when calculating hours worked in the market. The MTUS covers all five categories except collecting water and firewood. The other individual country surveys often cover only a subset of the categories. Table A.2 shows for each country the average weekly hours in the five categories. For each category and each income tercile, we have data from at least five countries, with the exception of hours spent on collecting water and firewood in the middle income tercile, which come from only two countries, and in the top income tercile, where they are missing completely.

Since different countries in the low income tercile have different missing categories, we take averages of each category across all countries with available data in a given income tercile, and report these in Table 9, together with the number of countries with available data in parentheses. The table then adds up the five different category averages in each income tercile to report total hours spent on home production by income tercile. These total home production hours amount to 26.4 weekly hours in the bottom tercile, 25.8 hours in the middle tercile, and 18.1 hours in the top tercile. While they are very similar among the low- and middle-income countries, they are around 8 hours lower in the high-income countries. Average hours are lowest for the high-income countries in every single category except shopping.

This evidence thus points towards time on home production being very similar across low- and middle-income countries, and significantly lower in high-income countries. This indicates that we likely underestimate the welfare difference between the low- and high-income countries in Table 8 substantially, as well as the welfare difference between the middle- and high-income countries.

8. Conclusion

In this paper, we document a new fact, which is that average hours worked are higher in developing countries than in richer countries. To do so, we compile and harmonize international survey data from 84 countries of all income levels, focusing on the 44 countries with the most scope for international comparisons. We show in addition that the decrease in hours per adult by income

¹⁹5 of the 9 low-income countries, 1 of the 6 middle-income countries, and 8 of the 9 high-income countries belong to the sample of core countries.

is driven by a decrease in both employment rates and hours per employed, with the former being relatively stronger than the latter. Regarding the shape over the income distribution, the decrease in employment rates occurs between low- and middle-income countries, and the decrease in hours per employed between middle- and high-income countries.

To help explain our findings, we build a simple model in which agents value consumption and leisure, and have a subsistence consumption requirement in preferences taking the Stone-Geary form. There is a representative household with a continuum of members that are heterogeneous in their marginal disutility of working. The distribution of the marginal disutility of working is the same across countries, and countries differ only in their aggregate productivity levels. The model implies that hours per adult and employment rates are decreasing in aggregate productivity, while the effect of aggregate productivity on hours per employed is ambiguous. The intuition is that when aggregate productivity is low, the subsistence preferences imply a high marginal utility from each additional consumption good. Thus, it is optimal to work even for individuals with a high marginal disutility of supplying labor. Yet, they optimally supply few hours of work. As productivity rises, these individuals drop out, which raises hours per employed, all else equal. On the other hand, the higher productivity induces all remaining workers to decrease their hours.

We calibrate the model to match the average employment rates and hours worked for the rich countries. We then compute the model's predictions for the rest of the world income distribution. We find that the model successfully predicts the sharp decline in employment rates between the poorest countries and the middle income countries. It also predicts that hours per employed are flatter across the income distribution than employment rates, as in the data, which implies that employment rates account for the bulk of international differences in hours per adult. Overall, the model generates 80% of the decrease in hours per adult between the low- and high-income countries. The model is not successful in matching the decline in hours per employed between the middle-income and richer countries. In future work we plan to add taxes and transfers to the model, which may help improve the model's predictions on this dimension.

Our findings have important implications for welfare differences across countries. By ignoring hours worked, previous studies have missed an important reason why welfare differences across countries may be much larger than implied by looking at consumption differences alone. Put differently, the fact that residents of the poorest countries work so much more than their counterparts in the richest countries means that residents of the poorest countries are substantially worse off than previously thought.

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	Panel A Levels	:	
	Low	Middle	High
Hours Per Adult	28.9	22.2	19.2
Employment Rate	73.1	53.2	54.9
Hours Per Employed	40.0	41.8	35.3

Table 1: Average Hours Worked per Adult, Employment Rates, and Hours per Employed

Panel B:	
Tests of Differences in N	Means

	Low - High	Low - Middle	Middle - High
Hours Per Adult	9.7***	6.7***	3.0***
Employment Rate	18.2***	19.9***	-1.7
Hours Per Employed	4.8***	-1.7	6.5***

Panel C: Ratios

	<u>Low</u> High	Low Middle	<u>Middle</u> High
Hours Per Adult	1.50	1.30	1.16
Employment Rate	1.33	1.38	0.97
Hours Per Employed	1.13	0.96	1.18

Note: Panel A reports average weekly hours worked per adult, employment rates, and hours worked per employed among the core countries by country income group. Panel B reports differences in means among pairs of country income groups. The stars represent the P-values from a permutation test of the hypothesis that the distribution of hours worked is the same in the two groups in question: *** means a P-value less than 0.01, ** means a P-value less than 0.05, and * means a P-value less than 0.10. Panel C reports the ratios of average weekly hours worked per adult, employment rates, and hours worked per employed between different country income groups.

Set of Countries	Coun	Country Income Group		
	Low	Middle	High	Ν
Core Countries	28.9	22.2	19.2	44
	(9)	(10)	(25)	
+ Partial-Year Surveys	25.7	22.1	20.0	76
	(18)	(27)	(31)	
+ All Hours Measures	25.7	22.5	20.4	84
	(20)	(30)	(34)	

Average Hours Worked Per Adult

Table 2: Robustness to Including Broader Sets of Countries

Table 3: Average Hours	Worked Per	Adult, Both	Sexes
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Aver	age Hours by A	Age and Country Inc	come	
Age Group		Country Income Group		
	Low	Middle	High	
All	28.9	22.2	19.2	
Prime	35.9	29.7	28.6	
Young	21.0	13.5	11.9	
Old	19.7	12.9	7.8	

Panel A:
Average Hours by Age and Country Incom

Panel B:
Tests of Differences in Means

Age Group	Di	Differences in Mean Hours		
	Low - High Low - Middle Middle - High			
All	9.7***	6.7***	3.0***	
Prime	7.3***	6.2***	1.1	
Young	9.1***	7.5***	1.6*	
Old	11.9***	6.8***	5.1***	

Note: Panel A reports average weekly hours worked per adult among the core countries by age group and country income group. Panel B reports differences in mean hours among pairs of country income groups. The stars represent the P-values from a permutation test of the hypothesis that the distribution of hours worked is the same in the two groups in question: *** means a P-value less than 0.01, ** means a P-value less than 0.05, and * means a P-value less than 0.10.

	Pa	anel A:		
Ave	erage Hours by A	Age and Country Inc	come	
Age Group		Country Income Group		
	Low	Middle	High	
All	73.1	53.2	54.9	
Prime	86.3	69.7	79.5	
Young	56.3	33.5	37.9	
Old	60.6	33.5	23.7	

Table 4: Employment Rates, Both Sexes

Panel B:
Tests of Differences in Means

Age Group	Differen	ces in Mean Employ	ment Rates
	Low - High	Low - Middle	Middle - High
All	18.2***	19.9***	-1.7
Prime	6.8***	16.6***	-9.8
Young	18.3***	22.8***	-4.4
Old	36.9***	27.1***	9.8**

Note: Panel A reports employment rates among adults in the core countries by age group and country income group. Panel B reports differences in mean employment rates among pairs of country income groups. The stars represent the P-values from a permutation test of the hypothesis that the distribution of employment rates is the same in the two groups in question: *** means a P-value less than 0.01, ** means a P-value less than 0.05, and * means a P-value less than 0.10.

Panel A:						
Ave	Average Hours by Age and Country Income					
Age Group Country Income Group						
	Low	Middle	High			
All	40.0	41.8	35.3			
Prime	42.0	42.6	36.0			
Young	37.9	40.7	32.7			
Old	33.9	38.3	33.5			

Table 5: Average Hours Worked Per Employed, Both Sexes

Tests of Differences in Means							
Age Group	Differences in Mean Hours						
	Low - High	Low - Middle	Middle - High				
All	4.8***	-1.7	6.5***				
Prime	6.0***	-0.6	6.6***				
Young	5.2***	-2.8	8.0***				
Old	0.3	-4.5	4.8***				

Panel B:

Note: Panel A reports average weekly hours worked per employed adult among the core countries by age group and country income group. Panel B reports differences in mean hours per employed among pairs of country income groups. The stars represent the Pvalues from a permutation test of the hypothesis that the distribution of hours worked is the same in the two groups in question: *** means a P-value less than 0.01, ** means a P-value less than 0.05, and * means a P-value less than 0.10.

Parameter	Value	Interpretation
ε	0.5	Frisch-like elasticity of labor supply
ī	0.0042	Subsistence requirement
α	10.9	Distaste for work
η_{lpha}	1.20	α -shape parameter for η distribution
η_{eta}	0.69	β -shape parameter for η distribution

Table 6: Parameter Values Used in Quantitative Analysis

	Table 7:	Ratios	in the	Model	and	Data
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	Low High	Low Middle	Middle High
Hours Per Adult			
Data	1.50	1.30	1.16
Model	1.39	1.32	1.05
Employment Rate			
Data	1.33	1.38	0.97
Model	1.24	1.20	1.03
Hours Per Employed			
Data	1.13	0.96	1.18
Model	1.11	1.09	1.02

	Country Income Group					
	Low	Middle	High	High/Low		
Consumption	7.7	30.5	100	12.9		
+ Non-homothetic Prefs	4.8	28.3	100	21.0		
+ Labor Supply	2.5	24.1	100	39.7		

Table 8: Welfare Differences Across Countries

Table 9: Home Production Hours by Income Group
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	Coun	try Income	e Group
	Low	Middle	High
Cooking	8.9	8.1	6.1
	(5)	(6)	(9)
Cleaning	6.0	7.1	5.7
	(5)	(6)	(9)
Childcare	6.0	6.4	2.6
	(7)	(6)	(9)
Shopping	2.0	2.2	3.7
	(5)	(6)	(9)
Collecting Water	3.5	2.0	-
	(8)	(2)	(0)
Total Hours	26.4	25.8	18.1



Figure 1: Average Hours Worked per Adult



Figure 2: Employment Rates

× Tercile Mean



Figure 3: Averaged Hours Worked per Employed



Figure 4: Average Hours per Adult by Sex



(a) Men



Figure 5: Employment Rates by Sex

× Tercile Mean

(b) Women





Figure 6: Average Hours per Employed by Sex

(b) Women



Figure 7: η Distribution





Figure 8: Model vs. Data

50 -

Employment Rate (in %)

Hours per Week

(c) Hours Per Employed

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Model: Fitted Values

Model

Data



Appendix

A. Survey Time Coverage

Our core countries have the restriction that their surveys cover the entire calendar year. Because surveys are structured differently across countries, this classification is however not as straightforward as one may think. We categorize the surveys as follows, based on how much we know about the timing of household interviews:

- (a) For any individual interview the week is known.
- (b) For any individual interview the month is known, but not the week.
- (c) Any individual interview falls within a period longer than a month and shorter than a quarter, but neither the week nor the month is known.
- (d) Any individual interview falls within a quarter, but neither the week nor the month is known.
- (e) Any individual interview falls within a period longer than a quarter, but neither the week nor the month is known.

Going from (a) to (e), the information about the individual interview is becoming less precise. In order to qualify as a core country, it has to

- i. fall in category (a) or (b) and cover each month of the year
- ii. fall in category (d) and cover each quarter
- iii. fall in category (c) and (e) and cover the entire year.

To give a concrete example, the CPS in the US is conducted in each month but only covers one week (specifically, the reference week contains the 12th of a month). Hence, the US falls into category (a) and in our set of core countries. Brazil also falls in category (a) since we know the exact reference week. However, the Brazilian survey was conducted only in one week of the year, such that Brazil is not a core country. Except for case i, it may very well be that not each month is covered since we do not know for sure whether for countries in categories (c) to (e) interviews took place in each month. For the 43 core countries only 8 fall in categories (c) to (e), though. Figures A.1 and A.2 split the countries by core and non-core countries, respectively, and show for each country the relevant category (a) to (e).



Figure A.1: Survey Coverage – Core Countries



Figure A.2: Survey Coverage - Non-core Countries

B. Appendix Tables

Country	Source	Year	Tercile	Core
Albania	Living Standards Measurement Study (LSMS)	2005	2	No
Angola	Inquerito Integrado sobre o Bem Estar da Pop- ulacao (IBEP)	2008	1	No
Argentina	Encuesta Permanente de Hogares (EPH)	2011	2	Yes
Armenia	Labour Force Survey	2008	2	No
Australia	Household, Income and Labour Dynamics in Australia (HILDA-CNEF)	2005	3	No
Austria	European Union Labour Force Survey	2005	3	Yes
Belgium	European Union Labour Force Survey	2005	3	Yes
Benin	Enquete Modulaire Integree sur les Conditions de Vie des Menages (EMICOV)	2010	1	No
Bolivia	Encuesta de Hogares (RIGA)	2005	2	No
Bosnia and Herzegovina	Living Standards Measurement Survey (LSMS)	2001	2	No
Botswana	Labour Force Survey	2005	2	Yes
Brazil	National Household Sample Survey (PNAD)	2009	2	No
Bulgaria	European Union Labour Force Survey	2005	2	Yes
Cambodia	Cambodia Socio-Economic Survey (CSES)	2011	1	Yes
Canada	Census of Canada (IPUMS)	2001	3	No
Chile	National Socioeconomic Survey (CASEN)	2009	3	No
China	The China Health and Nutrition Survey	2006	2	No
Columbia	Integrated Household Survey (GEIH)	2008	2	Yes
Cyprus	European Union Labour Force Survey	2005	3	Yes
Czech Re- public	European Union Labour Force Survey	2005	3	Yes
Denmark	European Union Labour Force Survey	2005	3	Yes
Ecuador	Population and Housing Census, 2001 (IPUMS)	2001	2	No
Egypt	Labor Market Panel Survey	2006	2	No
El Salvador	VI Population and V Housing Census	2007	2	No
Estonia	European Union Labour Force Survey	2005	3	Yes
Finland	European Union Labour Force Survey	2005	3	Yes

Table A.1: Data Sources

Country	Source	Year	Tercile	Core
France	European Union Labour Force Survey	2005	3	Yes
Germany	European Union Labour Force Survey	2005	3	Yes
Ghana	Living Standards Survey (LSMS)	1998	1	Yes
Greece	European Union Labour Force Survey	2005	3	Yes
Guatemala	Encuesta Nacional Sobre Condiciones de Vida (ENCOVI) (LSMS)	2000	2	No
Hungary	European Union Labour Force Survey	2005	3	Yes
Indonesia	Integrated Public Use Microdata Series	2010	2	Yes
Iraq	Household Socio-Economic Survey (LSMS)	2007	2	Yes
Ireland	European Union Labour Force Survey	2005	3	No
Italy	European Union Labour Force Survey	2005	3	Yes
Jamaica	Population Census (IPUMS)	2001	2	No
Jordan	Population and Housing Census (IPUMS)	2004	2	No
Kazakhstan	Living Standards Measurement Survey (LSMS)	1996	2	No
Kenya	Labor Force Survey	1999	1	No
Korea, Re- public of	Korean Labor and Income Panel Study (KLIPS-CNEF)	2005	3	No
Kyrgyzstan	Living Standards Measurement Survey (LSMS)	1998	1	No
Lao PDR	Expenditure and Consumption Survey	2007	1	Yes
Latvia	European Union Labour Force Survey	2005	3	Yes
Lesotho	Integrated Labour Force Survey	2008	1	No
Lithuania	European Union Labour Force Survey	2005	3	Yes
Malawi	Integrated Household Survey (LSMS)	2010	1	No
Malaysia	Integrated Public Use Microdata Series	1991	3	No
Mali	Permanent Household Survey (EPAM)	2010	1	No
Mauritius	Continuous Multi Purpose Household Survey (CMPHS)	2010	2	Yes
Mexico	Population and Housing Census (IPUMS) 2010	2010	3	No
Mongolia	Labour Force Survey	2006	1	Yes
Namibia	Labour Force Survey	2012	2	No

Table A.1: Data Sources

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Country	Source	Year	Tercile	Core
Netherlands	European Union Labour Force Survey	2005	3	Yes
Nicaragua	National Household Survey Measurements on Living Standards (EMNV) (LSMS)	2005	1	No
Norway	European Union Labour Force Survey	2005	3	Yes
Pakistan	Labor Force Survey	2011	1	Yes
Panama	Encuesta de Niveles de Vida (ENV) (LSMS)	2008	2	No
Paraguay	Encuesta de Hogares (household survey)	2011	2	No
Peru	Encuesta Nacional de Hogares (ENAHO)	2010	2	Yes
Philippines	Labor Force Survey (Jan, Apr, Jul, Oct)	2010	1	No
Poland	European Union Labour Force Survey	2005	3	Yes
Portugal	European Union Labour Force Survey	2005	3	Yes
Romania	European Union Labour Force Survey	2005	2	Yes
Russia	Russia Longitudinal Monitoring Survey (RLMS)	2009	3	No
Rwanda	Enquete Integrale sur les conditions de vie des menages 2010-2011	2011	1	Yes
Serbia	Living Standards Measurement Survey (LSMS)	2007	2	No
Slovak Re- public	European Union Labour Force Survey	2005	3	Yes
Slovenia	European Union Labour Force Survey	2005	3	Yes
South Africa	Census 2001 (IPUMS)	2001	2	No
Spain	European Union Labour Force Survey	2005	3	Yes
Sweden	European Union Labour Force Survey	2005	3	Yes
Switzerland	European Union Labour Force Survey	2010	3	Yes
Taiwan	Labor Force Survey	2011	3	No
Tajikistan	Living Standards Survey (LSMS)	2007	1	No
Tanzania	National Panel Survey (LSMS)	2009	1	Yes
Timor Leste	Living Standards Survey (LSMS)	2001	1	No
Tunisia	Enquete Nationale sur la Population et l'Emploi de 2010 (ENPE 2010)	2010	2	No
Turkey	Household Labour Force Survey	2010	2	Yes
Uganda	National Panel Survey (LSMS)	2010	1	Yes

Table A.1: Data Sources

Country	Source	Year	Tercile	Core
United King- dom	European Union Labour Force Survey	2008	3	Yes
United States	Current Population Survey	2005	3	Yes
Venezuela	Population and Housing Census (IPUMS)	2001	2	No
Vietnam	Household Living Standards Survey (LSMS)	2002	1	Yes

Table A.1: Data Sources

	cooking	cleaning	childcare	shopping	collwf	Tercile
BEN	_	6.9	_	3.9	_	1
GHA	6.9	1.9	8.0	2.8	3.1	1
KGZ	_	_	9.8	_	3.7	1
LSO	_	_	2.1	0.1	1.9	1
MLI	5.1	2.7	3.3	_	3.1	1
MNG	6.3	4.4	2.0	1.0	4.3	1
PAK	16.4	13.9	7.2	2.1	0.8	1
TZA	_	_	_	_	4.9	1
UGA	10.0	_	9.7	_	6.6	1
CHN	4.9	4.0	2.9	2.4	_	2
EGY	10.8	9.3	9.6	2.6	0.3	2
GTM	8.6	8.3	10.3	1.7	3.6	2
IRQ	7.3	5.7	3.2	2.1	_	2
KAZ	9.1	8.2	10.1	3.4	_	2
ZAF	7.7	7.2	2.2	1.4	_	2
AUT	6.6	7.8	3.0	4.4	_	3
DEU	6.1	4.9	2.3	3.3	_	3
ESP	7.4	6.5	2.1	3.3	_	3
FRA	6.3	5.7	2.0	4.1	_	3
GBR	6.2	5.6	2.6	3.7	_	3
ITA	7.5	7.6	1.9	4.2	_	3
NLD	6.3	3.9	2.4	3.7	_	3
RUS	4.6	4.4	3.7	2.4	_	3
USA	3.7	4.7	2.9	4.1	_	3

Table A.2: Home Production Hours by Individual Country and Category

C. Appendix Figures



Figure A.3: Average Weekly Hours per Adult: US Population Weights

D. Appendix Model

4.1. Hours per Person

 $\mathbf{1}_{\{\eta < \bar{\eta}\}}$ denotes an indicator function which takes the value 0 if the individual optimal hours $h^*(\eta) = 0$, i.e. whenever $\eta \ge \bar{\eta}$, and takes the value 1 if the individual hours are $h^*(\bar{\eta}) = \bar{\eta} - \eta$, i.e. whenever $\eta < \bar{\eta}$. Using this definition, we can write aggregate hours and thus hours per person H^p as

$$\begin{aligned} H^{p}(\bar{\eta}) &= \int_{0}^{1} h(\eta) f(\eta) d\eta \\ &= \int_{0}^{1} \mathbf{1}_{\{\eta < \bar{\eta}\}}(\bar{\eta} - \eta) f(\eta) d\eta \\ &= \bar{\eta} \int_{0}^{1} \mathbf{1}_{\{\eta < \bar{\eta}\}} f(\eta) d\eta - \int_{0}^{1} \mathbf{1}_{\{\eta < \bar{\eta}\}} \eta f(\eta) d\eta \\ &= \bar{\eta} \left(\int_{0}^{1} f(\eta) d\eta - \int_{\bar{\eta}}^{1} f(\eta) d\eta \right) - \left(\int_{0}^{1} \eta f(\eta) d\eta - \int_{\bar{\eta}}^{1} \eta f(\eta) d\eta \right) \\ &= \bar{\eta} \left(1 - \int_{\bar{\eta}}^{1} f(\eta) d\eta \right) - (E(\eta) - E(\eta) |\eta \ge \bar{\eta}) \cdot Pr(\eta \ge \bar{\eta})) \\ &= \bar{\eta} \cdot Pr(\eta < \bar{\eta}) - E(\eta) |\eta < \bar{\eta}) \cdot Pr(\eta < \bar{\eta}) \\ &= Pr(\eta < \bar{\eta}) \{ \bar{\eta} - E(\eta) |\eta < \bar{\eta}) \} \\ &= ER(\bar{\eta}) \cdot H^{w}(\bar{\eta}). \end{aligned}$$

where we have replaced in the last line the definitions for the employment rate and hours per worker used in the main text. In the fifth line of Equation (23), we have used

$$\int_{\bar{\eta}}^{1} \eta f(\eta) d\eta = E(\eta \cap \eta \ge \bar{\eta}) = E(\eta | \eta \ge \bar{\eta}) \cdot Pr(\eta \ge \bar{\eta})$$
(24)

and in the sixth line

$$E(\eta|\eta<\bar{\eta})\cdot Pr(\eta<\bar{\eta}) = E(\eta) - E(\eta|\eta\geq\bar{\eta})\cdot Pr(\eta\geq\bar{\eta}).$$
⁽²⁵⁾

4.2. Including vs. Excluding Individuals at the Threshold

Mathematically, with a continuous distribution function, including or excluding those exactly at the threshold in the measure of the employment rate or of hours per person/worker does not affect the relevant statistics because there is zero mass at each point and thus also at the threshold. Put differently, instead of using $\mathbf{1}_{\{\eta < \bar{\eta}\}}$ we could have used $\mathbf{1}_{\{\eta < \bar{\eta}\}}$ in Equation (23).

Recall that we define the employment rate as $ER(\bar{\eta}) = Pr(\eta < \bar{\eta}) = 1 - \int_{\bar{\eta}}^{1} f(\eta) d\eta$, where we stress that this definition excludes those exactly at the threshold, who do not supply positive hours. Since

$$\int_0^1 f(\eta) d\eta = \int_0^{\bar{\eta}} f(\eta) d\eta + \int_{\bar{\eta}}^1 f(\eta) d\eta$$
(26)

the employment rate can also be written as

$$ER(\bar{\eta}) = 1 - \int_{\bar{\eta}}^{1} f(\eta) d\eta = \int_{0}^{\bar{\eta}} f(\eta) d\eta = F(\bar{\eta}).$$
(27)

Conceptually, we prefer the notation of excluding those at the threshold because they supply zero hours and thus do not work. If there would be positive mass at the threshold, as it is the case in our quantitative application where have to discretize a distribution, this is also the relevant concept. This becomes clear further below where we discuss how the labor market statistics change in a discrete setting. A similar argument can be made for the expression of hours per worker. Since

$$\int_0^1 \eta f(\eta) d\eta = \int_0^{\bar{\eta}} \eta f(\eta) d\eta + \int_{\bar{\eta}}^1 \eta f(\eta) d\eta$$
(28)

and thus hours per worker can be rewritten as

$$H^{p}(\bar{\eta}) = E(\eta|\eta < \bar{\eta}) = \int_{0}^{1} \eta f(\eta) d\eta - \int_{\bar{\eta}}^{1} \eta f(\eta) d\eta = \int_{0}^{\bar{\eta}} \eta f(\eta) d\eta = E(\eta|\eta \le \bar{\eta}).$$
(29)

4.3. Derivatives of Hours per Worker and per Person w.r.t. $\bar{\eta}$

Restating the expression for hours per worker as

$$H^{w}(\bar{\eta}) = \bar{\eta} - E(\eta|\eta < \bar{\eta}) = \bar{\eta} - \frac{\int_{0}^{1} \eta f(\eta) d\eta - \int_{\bar{\eta}}^{1} \eta f(\eta) d\eta}{1 - \int_{\bar{\eta}}^{1} f(\eta) d\eta} = \bar{\eta} - \frac{\int_{0}^{\bar{\eta}} \eta f(\eta) d\eta}{\int_{0}^{\bar{\eta}} f(\eta) d\eta} = \bar{\eta} - \frac{\int_{0}^{\bar{\eta}} \eta f(\eta) d\eta}{F(\bar{\eta})}, \quad (30)$$

the derivative w.r.t. the threshold $\bar{\eta}$ is given by

$$\begin{aligned} \frac{\partial H^{w}(\bar{\eta})}{\partial \bar{\eta}} =& 1 - \left\{ -\frac{f(\bar{\eta})}{F(\bar{\eta})^{2}} \left(\int_{0}^{\bar{\eta}} \eta f(\eta) d\eta \right) + \frac{1}{F(\bar{\eta})} \left[\frac{\int_{0}^{\bar{\eta}} \eta f(\eta) d\eta}{\partial \bar{\eta}} \right] \right\} \\ =& 1 - \left\{ -\frac{f(\bar{\eta})}{F(\bar{\eta})} \frac{\int_{0}^{\bar{\eta}} \eta f(\eta) d\eta}{F(\bar{\eta})} + \frac{\bar{\eta} f(\bar{\eta})}{F(\bar{\eta})} \right\} \\ =& 1 - \left\{ \frac{f(\bar{\eta})}{F(\bar{\eta})} E(\eta | \eta < \bar{\eta}) + \frac{\bar{\eta} f(\bar{\eta})}{F(\bar{\eta})} \right\} \\ =& 1 - \left\{ \frac{f(\bar{\eta})}{F(\bar{\eta})} \{\bar{\eta} - E(\eta | \eta < \bar{\eta})\} \right\} \end{aligned}$$
(31)
$$=& 1 - \left\{ \frac{f(\bar{\eta})}{F(\bar{\eta})} \{\bar{\eta} - E(\eta | \eta < \bar{\eta})\} \right\}$$

Restating the expression for hours per person

$$H^{p}(\bar{\eta}) = ER(\bar{\eta})H^{w}(\bar{\eta}) = F(\bar{\eta})H^{w}(\bar{\eta})$$
(32)

the derivative w.r.t. the threshold $\bar{\eta}$ is given by

$$\frac{\partial H^{p}(\bar{\eta})}{\partial \bar{\eta}} = \frac{\partial F(\bar{\eta})}{\partial \bar{\eta}} \cdot H^{w}(\bar{\eta}) + F(\bar{\eta}) \cdot \frac{\partial H^{w}(\bar{\eta})}{\partial \bar{\eta}} \\
= f(\bar{\eta}) \cdot H^{w}(\bar{\eta}) + F(\bar{\eta}) \left(1 - \frac{f(\bar{\eta})}{F(\bar{\eta})} H^{w}(\bar{\eta}) \right) \\
= f(\bar{\eta}) \cdot H^{w}(\bar{\eta}) + F(\bar{\eta}) - f(\bar{\eta}) H^{w}(\bar{\eta}) \\
= F(\bar{\eta})$$
(33)

4.4. Discrete Changes in $\bar{\eta}$

Our quantitative application relies on a discretized distribution, where in contrast to the continuous distribution there will be positive mass at the threshold. To highlight the analogy between the two setups, the following formulas describe the changes in the the employment rate and our two hours measures for the discrete case. We always consider a change in $\bar{\eta}$ to $\bar{\eta}' = \bar{\eta} + \delta$, with $\delta > 0$.

4.4.1. Employment Rate

The two employment rates are given by $ER(\bar{\eta}) = Pr(\eta < \bar{\eta})$ and $ER(\bar{\eta} + \delta) = Pr(\eta < \bar{\eta} + \delta)$. Note that we assumed a positive mass at the threshold $\bar{\eta}$. Those individuals are not included in the first employment rate as they optimally (in sense that the FOC holds exactly) zero hours. As a consequence, the difference $ER(\bar{\eta} + \delta) - ER(\bar{\eta}) > 0$.

4.4.2. Hours per Worker

Restating $H^w(\bar{\eta}) = \bar{\eta} - E(\eta | \eta < \bar{\eta})$, hours per worker after an increase of the threshold by δ are the average of the hours per *already employed* worker and of the hours per *newly employed* worker weighted with the share of the respective group in total employment:

$$H^{w}(\bar{\eta}+\delta) = \frac{ER(\bar{\eta})}{ER(\bar{\eta}+\delta)} \{\bar{\eta}+\delta - E(\eta|\eta<\bar{\eta})\} + \frac{ER(\bar{\eta}+\delta) - ER(\bar{\eta})}{ER(\bar{\eta}+\delta)} \{\bar{\eta}+\delta - E(\eta|\bar{\eta}\leq\eta<\bar{\eta}+\delta)\}$$

$$= \delta + \frac{ER(\bar{\eta})}{ER(\bar{\eta}+\delta)} H^{w}(\bar{\eta}) + \frac{ER(\bar{\eta}+\delta) - ER(\bar{\eta})}{ER(\bar{\eta}+\delta)} \{\bar{\eta} - E(\eta|\bar{\eta}\leq\eta<\bar{\eta}+\delta)\}$$
(34)

The difference between $H^w(\bar{\eta} + \delta)$ and $H^w(\bar{\eta})$ is

$$\Delta H^{w} = \delta + \frac{ER(\bar{\eta})}{ER(\bar{\eta}+\delta)} H^{w}(\bar{\eta}) + \frac{ER(\bar{\eta}+\delta) - ER(\bar{\eta})}{ER(\bar{\eta}+\delta)} \{\bar{\eta} - E(\eta|\bar{\eta} \le \eta < \bar{\eta}+\delta)\} - H^{w}(\bar{\eta})$$

$$= \delta + \frac{ER(\bar{\eta}) - ER(\bar{\eta}+\delta)}{ER(\bar{\eta}+\delta)} H^{w}(\bar{\eta}) + \frac{ER(\bar{\eta}+\delta) - ER(\bar{\eta})}{ER(\bar{\eta}+\delta)} \{\bar{\eta} - E(\eta|\bar{\eta} \le \eta < \bar{\eta}+\delta)\}$$

$$= \delta - \frac{ER(\bar{\eta}+\delta) - ER(\bar{\eta})}{ER(\bar{\eta}+\delta)} [H^{w}(\bar{\eta}) - \{\bar{\eta} - E(\eta|\bar{\eta} \le \eta < \bar{\eta}+\delta)\}]$$
(35)

To make the connection to the continuous change, if $\delta \to 0$ the expected value in the second to last line would cancel with the $\bar{\eta}$, because that expected value would be $\bar{\eta}$ itself.

4.4.3. Hours per Person

Restating hours per person $H^p(\bar{\eta}) = ER(\bar{\eta}) \{\bar{\eta} - E(\eta | \eta < \bar{\eta})\}$, hours per person after an increase of the threshold by δ are the hours per *already employed* worker and of the hours per *newly employed* worker weighted with the share of the respective group in the total population:

$$H^{p}(\bar{\eta}+\delta) = ER(\bar{\eta})\{\bar{\eta}+\delta-E(\eta|\eta<\bar{\eta})\} + (ER(\bar{\eta}+\delta)-ER(\bar{\eta}))\{\bar{\eta}+\delta-E(\eta|\bar{\eta}\leq\eta<\bar{\eta}+\delta)\}$$

$$= ER(\bar{\eta})\delta + ER(\bar{\eta})\{\bar{\eta}-E(\eta|\eta<\bar{\eta})\} + ER(\bar{\eta}+\delta)\delta - ER(\bar{\eta})\delta$$

$$+ (ER(\bar{\eta}+\delta)-ER(\bar{\eta}))\{\bar{\eta}-E(\eta|\bar{\eta}\leq\eta<\bar{\eta}+\delta)\}$$

$$= H^{p}(\bar{\eta}) + ER(\bar{\eta}+\delta)\delta + (ER(\bar{\eta}+\delta)-ER(\bar{\eta}))\{\bar{\eta}-E(\eta|\bar{\eta}\leq\eta<\bar{\eta}+\delta)\}$$
(36)

The difference between $H^p(\bar{\eta} + \delta)$ and $H^p(\bar{\eta})$ is:

$$\Delta H^{p} = H^{p}(\bar{\eta}) + ER(\bar{\eta} + \delta)\delta + (ER(\bar{\eta} + \delta) - ER(\bar{\eta}))\{\bar{\eta} - E(\eta|\bar{\eta} \le \eta < \bar{\eta} + \delta)\} - H^{p}(\bar{\eta})$$

$$= ER(\bar{\eta} + \delta)\delta + (ER(\bar{\eta} + \delta) - ER(\bar{\eta}))\{\bar{\eta} - E(\eta|\bar{\eta} \le \eta < \bar{\eta} + \delta)\},$$
(37)

where again in the case of a continuous change, i.e. if $\delta \to 0$, the expected value in the last line would cancel with the $\bar{\eta}$, because that expected value would be $\bar{\eta}$ itself.