NBER WORKING PAPER SERIES

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Working Paper 17259
http://www.nber.org/papers/w17259

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
July 2011

Mark Aguiar thanks Princeton University for summer financial support. Erik Hurst thanks the John E. Jeuck Faculty Fund at Chicago Booth for financial support. Loukas Karabarbounis thanks the Federal Reserve Bank of Minneapolis for its hospitality during the early stages of this work. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 17259
July 2011
JEL No. D13,E32,J22

ABSTRACT

We use data from the American Time Use Survey (ATUS), covering both the recent recession and the pre-recessionary period, to explore how foregone market work hours are allocated to other activities over the business cycle. Given the short time series, it is hard to distinguish business cycle effects from low frequency trends by simply comparing time spent on a given category prior to the recession with time spent on that category during the recession. Instead, we identify the business cycle effects on time use using cross state variation with respect to the severity of the recessions. We find that roughly 30% to 40% of the foregone market work hours are allocated to increased home production. Additionally, 30% of the foregone hours are allocated to increased sleep time and increased television watching. Other leisure activities absorb 20% of the foregone market work hours. We use our evidence from the ATUS to calibrate and test the predictions of workhorse macroeconomic models with home production. We show that the quantitative implications of these models regarding the allocation of time over the business cycle matches reasonably well the actual behavior of households.

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1 Introduction

How do individuals allocate their lost work hours during recessions? Do individuals allocate their foregone market production to home production? How much of the foregone work hours are allocated to job search and which categories of leisure increase during recessions? Answering these questions is important for computing the welfare costs of recessions and for interpreting the co-movement of economic aggregates at business cycle frequencies. For example, a long standing issue in macroeconomics is explaining the joint movements of household spending and labor supply during recessions. Benhabib, Rogerson and Wright (1991) and Greenwood and Hercowitz (1991) develop models where the extent to which market expenditures and market work fall during recessions depends on the willingness of households to substitute between market-produced and home-produced goods. Despite the theoretical importance of incorporating a home production sector into models of business cycle fluctuations, data limitations have prevented a systematic analysis of the extent to which households actually substitute their time across the two sectors during recessions. In this paper, we fill this gap.

Our goals in this paper are two-fold. First, we use newly released data from the American Time Use Survey (ATUS) to document how the allocation of time evolves over the business cycle. Up to now, such an analysis was not possible given that there was no dataset that had a large enough sample to consistently measure how households allocated their time during both a major recession and the pre-recessionary period. The ATUS samples a large cross section of Americans in every year between 2003 and 2010. The recently released 2010 data allow for a comprehensive analysis of time use prior to and during the recent U.S. recession. The 2008-2010 period is one marked by the aggregate unemployment rate rising from around 5.8% to around 9.6%. According to statistics of the Bureau of Labor Statistics (BLS), aggregate private work hours in the U.S. fell by roughly 7% between 2008 and 2010. The ATUS data also show that market work hours fell by a similar amount during this period.

We start our analysis by identifying the time series trends in the different time use categories. While such an analysis is useful as a descriptive measure, the short time series dimension of the data prevents us from using standard statistical methods to detrend the time series data. As a result, the time series patterns we document combine both low frequency trends as well as any potential business cycle variation. This is particularly important for the trends in time use for both non-market work and leisure. During the non-recessionary period 2003-2008, home production time was falling and leisure time was increasing. These patterns are extensions of the well documented trends in aggregate home production time and aggregate leisure time that started in the 1960s (Robinson and Godbey, 1997; Aguiar and Hurst, 2007a; Ramey, 2009;

Ramey and Francis, 2009). A naive comparison of the time spent on various activities before and during the recent recession would lead one to conclude that about 80% of the foregone market hours were reallocated to leisure and essentially none to non-market work.[1] Such a comparison is misleading. To infer how many of the foregone market hours are reallocated to each activity one would have to compare the actual time use during the recession with the time use we would have observed in the absence of the recession.

To overcome these problems, we present our formal estimates using state level variation of business cycles. As we show, there is substantial variation of changes in market work hours across the U.S. states. We also show that many states experienced similar trends in time use before the recent recession. As a result, using the variation of changes in time use across states allows us to control for these common low frequency trends. Using this analysis, we find that roughly 30% of the foregone market work hours are reallocated to non-market production (excluding child care). All sub-categories of non-market work increase when market work decreases. In particular, about 13% of foregone work hours are allocated to what we refer as core home production activities (cooking, cleaning, laundry, etc.), about 8% to increased shopping intensity, another 4% to the care of other older adults, and about 7% to home maintenance and repair. In addition, around 6% of the foregone market work hours are reallocated to child care. Restricting our analysis only to the recent recession sample (2007-2010) shows that about 45% of foregone market hours are reallocated to non-market work and child care.

Using the cross state variation of changes in market work, we show that less than 1% of the foregone market work hours are allocated to job search. However, this represents a fairly large percentage increase given how little time unemployed workers allocate to job search (Krueger and Mueller, 2010). We show that individuals increase their time investments in their own health care, their own education, and civic activities. Specifically, around 12% of foregone market hours are allocated to these investments. Our results suggest that it is important to understand whether these are new investments that would not have occurred absent the recession or whether these are investments that would have occurred at some point in the future that are instead moved up to recessionary times when the opportunity cost of time is low. This distinction is important for understanding the welfare costs of business cycles given the large amount of foregone work hours allocated to these activities.

We show that the bulk of the foregone market work time during the recent recession is allocated to leisure. We define leisure activities similarly to Aguiar and Hurst (2007a) in that leisure activities are activities for which time and expenditure are complements. These

[1] For such an analysis using the ATUS data see, for example, the *Wall Street Journal* article "What Would You Do With an Extra Hour?" published on 06/23/2010.

categories include, for example, socializing with one's friends, watching television, reading, and going to the movies. We include sleep, eating, and personal care into our leisure measure given that the marginal investments in these activities may be more akin to leisure than personal maintenance. Even though around 80% of the 2.11 hours of market work lost between 2006-2008 and 2009-2010 showed up as additional leisure, in the cross section of U.S. states in which we can control for aggregate trends, leisure activities absorb only about 50% of a given decrease of market work. Additionally, a large fraction of this reallocation is directed towards sleep (more than 20% of foregone work hours). Our estimates suggest that, in response to declining market work hours, non-market work is three to four times a more elastic margin of substitution than leisure.

Using cross state differences in business cycles, we find that more of the foregone work hours between the 2007-2008 average and the 2009-2010 average are allocated to non-market work and less to leisure compared to the pre-recessionary period (changes between the 2005-2006 average and the 2007-2008 average). This could indicate that either the type of individual who became unemployed during the recession is different from the type of individual who became unemployed during the non-recessionary period or it could indicate that the economic environment during periods of high aggregate volatility is sufficiently different that it has an independent effect on the time use of individuals. We then show that an equally large fraction of foregone market work hours is allocated to non-market work when we look at the sub-sample between the 2003-2004 average and the 2005-2006 average. This was a period in which the aggregate unemployment rate fell from around 6% to around 4.5% as the economy was recovering from the 2001 recession. This finding suggests that our results may extend to periods outside of the current recession and that one should be cautious about using the cross state estimates from periods of low aggregate volatility to predict how time use will respond when the economy is close to the peak or the trough of the business cycle.

Our second goal of the paper is to assess quantitatively whether a standard macroeconomic model with home production matches the patterns of time allocation we document in the ATUS data. Particularly, we start with the model of Benhabib, Rogerson and Wright (1991). This model and its various extensions have been successful in explaining a number of facts of aggregate fluctuations.[2] However, until today, there has been no systematic evidence that compares the allocation of time over the business cycle in the model with the actual time use behavior of households. We fill this gap in the literature by using as an informative moment the

[2]See Greenwood, Rogerson and Wright (1995) for a review. See Greenwood and Hercowitz (1991) and Chang (2000) for residential investment; McGrattan, Rogerson and Wright (1997) for fiscal policy; Baxter and Jermann (1999) for the "excess sensitivity" of consumption; Karabarbounis (2011) for real exchange rates.

fraction of time actually reallocated from market work to leisure and to non-market work over the business cycle. Using their parameters as our base case, we show that the model produces a reallocation of market work time into home production time that overestimates somewhat the patterns we document in the data. Then we show that if we reduce the elasticity of substitution between market-produced and home-produced goods from 5.0 to around 2.5, the prediction of the model matches well the patterns we observe in the data.

Our work contributes to various strands of literature. First, some researchers have recently modeled business cycle movements in aggregate consumption and aggregate market work by assuming households have non-separable preferences between market consumption and leisure. See, for example, the work of Hall (2009). In a world with stable preferences and no changes in the parameters of the home sector, a model with non-separable preferences between market consumption and home production is isomorphic to some version of a model without home production and non-separable preferences between market consumption and leisure. However, when home production technologies, housing capital, or government policies which affect the incentive of households to work in the home sector evolve over time, the two models are only similar if preferences over leisure and consumption are not stable over time.[3] Our work shows that the home production sector is a viable margin of substitution even at business cycle frequencies. If the home sector is truly important and if that sector experiences evolving technologies, capital, or sector specific policies, models without home production must either allow households to receive shocks to their relative valuation of leisure over time or allow the estimated degree of substitutability between market consumption and leisure to vary over time.

Second, there has been a recent flurry of articles that have used time diaries to address a variety of economic questions. Recent research has documented substantial changes in the allocation of time over past half century. Aguiar and Hurst (2007a) show that, since the mid 1960s, aggregate time spent on home production has fallen while aggregate time spent on leisure has increased. Additionally, research has also documented the extent to which the allocation of time evolves over the lifecycle (Ghez and Becker, 1975; Aguiar and Hurst, 2007b; Hurd and Rohwedder, 2008). Households dramatically increase their time spent on home production allowing them to reduce the market expenditures needed to sustain their consumption during their retirement years. Guryan, Hurst and Kearney (2008) and Ramey and Ramey (2010) have explored the importance and changing nature of parental inputs into child care. Lee, Kawaguchi and Hamermesh (2011) use time diaries from Japan and Korea to analyze the effects of legislated labor demand shocks on time use, finding that very little of the reduction

[3]See Greenwood, Seshadri and Yorukoglu (2005) for an example of technology shocks in the home sector.

in market time is reallocated to home production. Morrill and Pabilonia (2011) use 2003-2009 data from the ATUS and find that the leisure time that families spend together displays a U-shaped relationship with the state level unemployment rate. Finally, there is an emerging literature on the time use of unemployed. Recent work by Krueger and Mueller (2010) has carefully analyzed the time use behavior of the unemployed and the relationship between time spent on job search and unemployment benefit generosity. Taskin (2010) documents how time spent on home production by the unemployed varies across states with unemployment benefits.

There is a rich literature on cross country differences in the allocation of time. Freeman and Schettkat (2005) examine time use data from a number of countries and conclude that there is a very high substitution between market and home work across individuals. For instance, they report that in the 1990s Europeans worked 20% more than Americans in the home sector. Burda, Hamermesh and Weil (2008) compare the U.S. to Germany, Italy and the Netherlands and find similar patterns. Ngai and Pissarides (forthcoming) examine a broad sample of OECD countries and show that taxation reduces work hours substantially in sectors that have close substitutes in the home sector.

Because of data limitations, however, there has been no systematic analysis of the allocation of time at business cycle frequencies. Burda and Hamermesh (2010) use ATUS data from the non-recessionary period 2003-2006 to explore the relationship between metro-level unemployment, market work and home production. While unemployed persons allocate very little of their extra time to home production relative to the employed, the authors show that individuals residing in areas with temporarily high unemployment levels allocate a large fraction (around 75%) of a given decrease of market work to home production. Our paper differs along two crucial dimensions. First, we measure how foregone market work is allocated to alternate time uses both during non-recessionary periods and during recessions. Second, we measure how state differences in *changes* in market work imply differences in changes in other time uses, rather than how individual differences in *levels* of market work imply differences in levels of other time uses. While individual level analysis is certainly useful, we believe that a state level panel analysis, which allows us to control for state-specific fixed effects and aggregate trends, is better suited for evaluating macroeconomic models of time use to uncover the degree of substitutability over the business cycle.

2 Data

In this paper, we use data from the 2003-2010 waves of the American Time Use Survey (ATUS). The ATUS is conducted by the U.S. Bureau of Labor Statistics (BLS) and individuals in the

sample are drawn from the existing sample of the Current Population Survey (CPS). The individual is sampled approximately 3 months after completion of the final CPS survey. At the time of the ATUS survey, the BLS updates the respondent's employment and demographic information. Each wave is based on 24-hour time diaries where respondents detail the activities from the previous day in detailed time intervals. Survey personnel then assign the activities reported by the individual to a specific category in the ATUS's set classification scheme. The ATUS represents the state of the art of time use surveys for the United States and reports over 400 detailed time use categories. For more information on the types of activities that are recorded in the ATUS see Hamermesh, Frazis, and Stewart (2005). The 2003 wave of the survey included over 20000 respondents, while the 2004-2010 waves included around 13000 respondents each year.

We segment the allocation of time into a number of broad time use categories. We construct the categories to be mutually exclusive and to sum to the household's entire time endowment. The seven categories we look at are described in detail below and are based on the respondents response for their primary time use activity.

Market work includes all time spent working in the market sector on main jobs, second jobs, and overtime, including any time spent commuting to/from work and time spent on work related meals and activities. We separate from total market work the time spent on job search and the time spent on other income-generating activities outside the formal sector. This allows us to study the extent to which households spend time looking for employment or substitute time from the formal to the informal sector.

Other income-generating activities include all time spent on activities such as hobbies, crafts, food preparation and performances that generate income and the time spent on income-generating services such as babysitting and home improvements for pay.

Job search includes all time spent by the individual searching for a job. As with all time use categories, we include the time spent commuting associated with job search as part of time spent on job search. Job search includes, among others, activities such as sending out resumes, going on job interviews, researching details about a job, asking about job openings, or looking for jobs in the paper or on the Internet.

Child care measures all time spent by the individual caring for, educating, or playing with their children. Guryan, Hurst and Kearney (2008) show that the time series and lifecycle patterns of time spent on child care differ markedly from the patterns of time spent on home production. In particular, the income elasticity of time spent on child care is large and positive while the income elasticity of time spent on home production is large and negative. Addition-

ally, some components of child care have a direct leisure component. For example, according to Juster (1985), individuals report spending time playing with their children as among their most enjoyable activities. On the other hand, there is a well developed market for child care services that parents are willing to pay for to reduce their time spent with their children. Given these dichotomies, we treat child care as a separate category.

Non-market work (home production) consists of four sub-categories: core home production, activities related to home ownership, obtaining goods and services, and care of other adults. Core home production includes any time spent on meal preparation and cleanup, doing laundry, ironing, dusting, vacuuming, indoor household cleaning, cleaning or repairing vehicles and furniture, and activities related to the management and the organization of the household. Home ownership activities include time spent on household repairs, time spent on exterior cleaning and improvements, time spent on the garden and lawn care.[4] Time spent obtaining goods and services includes all time spent acquiring any goods or services (excluding medical care, education, and restaurant meals). Examples include grocery shopping, shopping for other household items, comparison shopping, coupon clipping, going to the bank, going to a barber, going to the post office, obtaining government services, and buying goods online. Finally, care of other adults includes any time supervising and caring for other adults, preparing meals and shopping for other adults, helping other adults around the house with cleaning and maintenance, and transporting other adults to doctors offices, grocery stores, etc. For our broad time use analysis, we look at the four sub-categories collectively in the form of total non-market work. However, for some of our more detailed analysis, we will look at the four sub-categories individually.

Leisure includes most of the remaining time individuals spend that is not on market work, non-market work, job search, or child care. Specifically, we follow Aguiar and Hurst (2007a, 2009) and try to isolate goods for which time and expenditure are complements as opposed to substitutes. The time spent on activities which comprise leisure include time spent watching television, time spent socializing (relaxing with friends and family, playing games with friends and family, talking on the telephone, attending and hosting social events, etc.), time spent exercising and on sports (playing sports, attending sporting events, exercising, running, etc.), time spent reading (reading books and magazines, reading personal mail and email, etc.), time spent on entertainment and hobbies (going to the movies or theater, listening to music, using

[4]With respect to the long run trends in time use, there is a debate about whether time spent gardening or spending time with one's pets should be considered as home production or leisure. See, for example, Ramey (2007). Given that the ATUS time use categories can be disaggregated into finer sub-categories, in this paper we include gardening and lawn care in non-market work and we include pet care into leisure.

the computer for leisure, doing arts and crafts, playing a musical instrument, etc.), time spent with pets, and all other similar activities. We also include in our leisure measure activities that provide direct utility but may also be viewed as intermediate inputs such as time spent sleeping, eating, and personal care. While we exclude own medical care, we include such activities as grooming, having sex, sleeping or napping, and eating at home or in restaurants. For the key analyses performed in this paper, we also report detailed sub-categories of leisure. This allows to understand which components of the total leisure measure are driving the results.

Other includes all the remaining time spent on one's education, time spent on civic and religious activities, and time spent on one's own medical and health care.

For our main sample, we include all ATUS respondents between the ages of 18 and 65 (inclusive) who had complete time use record. Specifically, we exclude any respondent between the age of 18 and 65 who had any time that was not able to be classified by the ATUS staff. In total, we have 76,203 individuals in our sample. We use the sample weights provided by the ATUS to aggregate responses to either the period level or the state-period level. As we discuss later, periods will be 1-3 year aggregates.

A full list of the time use categories analyzed in this paper is available in the Appendix that accompanies our paper. Table A.1 in the Appendix provides summary statistics of the various time use categories for the total sample and for men and women separately.

3 Time Series Analysis of Time Use

Figures 1-3 and Tables 1-2 provide descriptive results for the time series analysis of different time use categories for our entire base sample as well as the separate patterns by gender. Figure 1 shows the patterns of market work for the entire sample and separately for men and women. Between 2007 and 2010, total market work fell from 32.90 hours per week to 30.14 hours per week for the average individual in our sample. The 8.38% decline in work hours for our sample is close to the 8.06% decline in work hours as reported by the U.S. Bureau of Labor Statistics (BLS). Most of the decrease of market work occurred between 2008 and 2010. The 6.68% decline in work hours for our sample during this period also matches well with the 6.90% decline reported by the BLS.[5] Since the largest fraction of the decrease of market work hours and of the increase of unemployment occurred between 2008 and 2009, in our Tables we treat years prior to 2009 as being the pre-recessionary period which differs slightly from the NBER recession dating (December 2007). The time use data also show that market work

[5]See http://www.bls.gov/ces/cesbtabs.htm for details. We used data from Table B-4 and reported the change in the averaged index of aggregate weekly hours between 2007/2008 and 2010.

hours have fallen more for men than for women during this time period. We find that market work for men fell by 10.83% between 2008 and 2010, while market work for women fell by only 0.32% between 2008 and 2010.

To help smooth out potential measurement error in year to year variations, Table 1 reports the time use in various categories averaged over 2003 through 2005 (column 1), averaged over 2006 through 2008 (column 2), and averaged over 2009 and 2010 (column 3). In column 4, we report the unconditional difference between the 2006-2008 average (pre-recessionary period) and the 2009-2010 average (recessionary period). In column 5, we report the conditional difference in the time spent on the given category between the pre-recessionary period and the recessionary period. To get the conditional differences, we use the underlying micro data from the 2006-2010 period and regress the time spent by an individual on a given category on a recessionary period (2009-2010) dummy and demographic controls measuring the age of the individual (via five year age dummies), the education of the individual (via four education dummies), the race of the individual, the marital status of the individual, the gender of the individual, and a dummy variable indicating whether or not the individual has a child. The controls are included to see if the sample composition of the ATUS was changing over time. As noted above, all statistics are also weighted using the harmonized individual weights provided by the ATUS for each year. Given that we are weighting the data, controlling for demographics only has very small effects on our estimated time series changes in time use by category. For each time use category, we present the p-values associated with the unconditional and the conditional difference between 2006-08 and 2009-10 in the Appendix (Table A.2).

The results in Table 1 are for our full sample including both men and women. In Table 2, we show the same results for only men. Conditioning on demographics, we find that the time spent on market work declined by 2.14 hours per week for the average individual in our sample (a 6.6% decline) and declined by 2.83 hours per week for the men in our sample (a 7.4% decline) between the pre-recessionary period and the recessionary period. These numbers are smaller than the 2008-2010 results reported above because market work hours in 2010 were lower than market work hours in the combined 2009-2010 period. The results in Tables 1 and 2 and in Figure 1 show that the changes in time allocated to market work in the ATUS during the recession are consistent with the changes in market work as reported by the BLS using different data during the same time period.[6]

[6]We stress that the change in the unemployment rate in the ATUS between 2008 and 2010 matches well the change in the unemployment rate in the BLS. Specifically, the BLS reports an increase of the unemployment rate from 5.8% to 9.6%. In the ATUS, the number of the unemployed divided by the total number of respondents in our sample increases from 5.0% to 8.0%. Excluding retirees, students and other persons out of the labor force from the ATUS sample leads to an increase of the unemployment rate from 5.7% to 9.3%.

The rest of Tables 1 and 2 and in Figures 2 and 3 show the time series evolution of categories other than market work. Specifically, Figure 2 shows the trends in leisure time over our sample. A few things are of note. First, as noted by Aguiar and Hurst (2007a), men allocate more of their time to leisure than women do. We find that this is also the case in all years of our sample. Second, for the combined sample of men and women and for the sample of men, there was an upward trend in leisure during the 2003-2008 period. Third, between 2008 and 2010, there were big increases of leisure time for all, men and women even relative to trend. Conditional on demographic changes, the entire sample experienced a 1.69 hours increase of leisure time between the pre-recessionary period (2006-2008) and the recessionary period (2009-2010). Nearly all of this increase was concentrated in two leisure categories: television watching and sleep. Men experienced a 1.49 hours increase of leisure conditional on demographic changes between the pre-recessionary period and the recessionary period. Again, all of this increase was concentrated in sleep and television watching. As we report in the Appendix, the hypothesis that there is no difference in time spent on leisure, television watching and sleeping between the pre-recessionary period and the recession can be rejected at conventional levels of significance.

Figure 3 shows the time trends in non-market work between 2003 and 2010 for all individuals in our sample and then for men and women separately. Like with leisure, both men and women were experiencing trends in non-market work time during the 2003-2008 period. For example, women's non-market work hours fell by nearly 2 hours per week between 2003 and 2008. Men's non-market work hours fell by almost 1 hour per week between the 2003 to 2008 period. The decrease of non-market production and the increase of leisure are directly related. Given that market work hours during the pre-recessionary period were relatively constant, the increase of leisure time was made possible by the declining time allocated to non-market production. As shown by Aguiar and Hurst (2007a), the increase of leisure despite constant market work hours during the 1965 to 2003 period was also made possible by declining time spent on non-market production. In other words, the trends in leisure and non-market work in the ATUS between 2003 and 2008 are representative of broader trends in the U.S. that occurred in the 1965-2003 period. Also evident from Table 1 is that all sub-categories of non-market work experienced declines in time spent on those activities during the 2003-2008 period. For example, core home production, home ownership activities, obtaining goods and services, and others care all fell between 2003 and 2008. Conditional on demographic changes, the time series analysis suggests that non-market work hours were roughly constant during the recession for the entire sample (Table 1). The time series analysis suggests that non-market work increased slightly for the sample of men (Table 2), but as we report in the Appendix the difference between the

pre-recessionary period and the recession is not statistically significant.

A few other results are of note from the descriptive results of Tables 1 and 2. First, there was also a downward trend in child care time during the 2003-2008 period. For men, however, about 7% of the foregone work hours during the recent recession are reallocated to child care. Also, there was definitely an increase of job search during the recession. The time series results suggest that about 7% of foregone work hours for the full sample and for men were reallocated to job search, which represents an increase of about 50% compared to the 2006-08 period. Lastly, the simple time series analysis suggests that there are large movements in the time allocated to education, health care, and civic activities during the recession.

The upward trend in leisure and the downward trend in non-market work before the recession can cause problems with respect to interpreting the effects of the recession on time use. The change in leisure and non-market work during the recessionary period will potentially be comprised of the low frequency trends over the non-recessionary periods that could have continued during the recession and the effect of the recession itself. The standard time series method for dealing with such low frequency trends is to filter the data so as to remove the trends. However, our time series is too short to use such methods. This fact is what necessitates our alternate approach of using the variation of business cycles across states to remove these aggregate trends.

The correct comparison is what various time use categories would have been in 2009 and 2010 absent the recession compared to what they actually are during 2009 and 2010. Interestingly, the estimates we find from our cross state sample in Section 4 are not that different from the estimates that we would have found if we assumed that the time use trends between 2003 and 2008 extend linearly over 2009-2010. Figure 4 shows the year-to-year estimates for average market work, leisure and non-market work and their linear trends. Specifically, we calculate a linear trend for each time use category based on the 2003-2008 period and then we extrapolate linearly to periods 2009 and 2010. For example, this calculation suggests that in the absence of the recession market work would have increased from 32.31 hours in 2008 to 32.57 hours in 2010. The 0.26 hours increase over these two years is obtained under the assumption that the 0.13 hours per week increase observed on average between 2003-2008 extends through 2010. We can use the linear trends as counterfactual time series to calculate how foregone market work hours were reallocated to other time uses during the recent recession. This is shown in column 6 of Tables 1 and 2. In the aggregate sample, we find that 45% of the 2.09 hours shock to market work has been allocated to non-market work and 51% to leisure.[7] In the sample of

[7]The market work shock is calculated as the difference between the counterfactual level of 32.50 hours in

men, the corresponding numbers are 39% and 28% respectively.

These estimates are close to our estimates when we use the cross state variation of business cycles during the recent recession described in the next section. However, they differ dramatically from the numbers one would obtain without controlling for the trend. Looking at column 5 of Table 1, a naive analysis may conclude that nearly 80% of the foregone market work hours during the recession were reallocated to leisure (i.e., 1.69 hours per week out of the 2.14 hours per week) and essentially none of the to non-market work. However, given the upward trend in leisure and the declining trend in non-market work before the recession, such a conclusion can be premature.

4 Identifying Business Cycle Effects From Cross State Variation

The above analysis indicates that the interpretation of changes in time allocation during a recession depends on how one controls for low frequency trends. A simple linear trend is a first step. However, the time trend may have strong non-linearities that are not apparent in our short time frame. In this section, we control for an aggregate, low frequency trend by exploiting cross-state variation. Specifically, we use cross state variation of changes in market work to identify how foregone market work hours are reallocated to other time use categories at business cycle frequencies. We use changes in time use categories (as opposed to levels) to control for any state-specific time-invariant effect in time use. As one would expect given the low frequency trends that we described above, we find that the simple time series analysis overestimates the substitution of foregone market work hours to leisure and underestimates the substitution of foregone market work hours to non-market work.

We start by defining state level aggregates of our different time use categories:

$$\tau_{st}^{j} = \sum_{i=1}^{N_{st}} \left(\frac{w_{ist}}{\sum_{i=1}^{N_{st}} w_{ist}} \right) \tau_{ist}^{j} \tag{1}$$

where τ_{ist}^{j} is hours per week that individual i from state s during period t spent on time use category j. We denote by N_{st} the number of individuals in our sample from state s during time t. When computing the state averages, we weight the data using the ATUS sampling weights w_{ist}. The time use categories denoted by j are the same as the ones we show in Table 1. Our states include all 50 states plus the District of Columbia, $s = 1, ..., 51$. For our base analysis, we divide our sample into four non-overlapping two-year time periods (2003-2004, 2005-2006,

2009-2010 obtained under the extrapolated linear trend and the observed level of 30.41 hours in 2009-2010. Similarly for non-market work and leisure.

2007-2008 and 2009-2010), i.e. $t = 1, 2, 3, 4$. The ATUS is designed to be representative at the national level but the ATUS weighting procedure does not guarantee that the sample will be representative of the population within each separate state during each year. Averaging over the two years helps to mitigate measurement error in our data sets due to sampling variation within the survey at the state level. Using data from all state-period pairs yields 204 observations (51 states multiplied by the 4 two-year time periods).

To assess how foregone market work hours are reallocated across different time use categories, for each time use category j we estimate the following regression:

$$\Delta\tau_{st}^{j} = \alpha^{j} - \beta^{j}\Delta\tau_{st}^{market} + \gamma^{j}D_{t} + \delta^{j}\Delta X_{st} + u_{st}^{j} \tag{2}$$

where $\Delta\tau_{st}^{j}$ is the change in hours per week spent on time use category j for the average individual in state s between period $t-1$ and period t, and $\Delta\tau_{st}^{market}$ is the change in hours per week spent on market work for the average individual in state s between period $t-1$ and period t. The vector D_t consists of three dummies for the 2005-2006 period, the 2007-2008 period and the 2009-2010 period. We include the time dummies to ensure that our identification of how market work hours are reallocated to different time use categories is coming from the cross state differences and not the common trend (i.e. we are looking at the "within period" variation of the sample). Note that all years of the sample are used to estimate β^j, including both the periods before the recession and the recessionary period. We discuss this further below when we look at specific sub-periods. The vector ΔX_{st} controls for changes in state demographic and economic variables between $t-1$ and t. We estimate these regressions with and without these controls. We include the controls to see if changing economic or demographic conditions at the state level can explain the allocation of time that we identify. Finally, when estimating (2), we weight observations by the population of each state.[8] Therefore, we put less weight on smaller states for which sampling error is likely to be the most problematic.

The coefficient of interest is β^j. This coefficient measures the fraction of foregone market hours allocated to time use j, identified from the cross state variation of changes in market work. Because we have defined our time use categories to be mutually exclusive and to sum to the total endowment of time, we have $\sum_j \beta^j = 1$. We stress that the coefficients β^j are not structural parameters, but simply accounting devices. We do not assume that market hours are moving exogenously relative to other time allocation decisions, and indeed they are likely to be chosen simultaneously. The coefficients are simply sample moments of how each activity covaries with market work, once we control for aggregate trends and demographic shifts. To

[8] The results are similar when we weight observations with the number of respondents per state-period N_{st}.

make the interpretation of the results more transparent, in all Tables below we multiply all estimated coefficients by 100.

Before proceeding, we discuss two criteria that are necessary for us to isolate the cyclical decomposition of foregone market work hours to other time use categories using the cross state variation. First, there must be variation of changes in market work hours across states. This criterion is easily met. Table 3 shows descriptive statistics for $\Delta\tau_{st}^{market}$ for our pooled sample and for each separate sub-period. Not surprisingly, there is substantial variation of the change in market work over the two year pairs in our sample. For example, between the 2007-08 period and the 2009-10 period, the average state experienced a 2.13 hours decline in market work with a cross state standard deviation of 3.32 hours. The 25th and 75th percentiles of the $\Delta\tau_{s,2009-10}^{market}$ distribution are -3.64 hours and 0.22 hours respectively.

Second, we need to assume that there are no state-specific low frequency trends in time uses. The evidence we have mitigates our concerns that differential low frequency trends in time use at the state level are biasing our decompositions. First, with the aggregate data we were concerned that low frequency decreases of non-market work and low frequency increases of leisure were contaminating our time series analysis. However, the aggregate time series patterns are found in many states. Table 4 presents summary statistics of the distribution of changes in leisure and non-market production between 2003/04 and 2007/08. The Table shows that more than 80% of all the states experienced decreases of the time spent on non-market work hours and more than 60% of all states experienced increases of the time spent on leisure. This suggests that it may be possible to control for an aggregate trend by using the cross state business cycle variation. Second, in our robustness specification, we go one step further and specifically allow for state-specific time trends when estimating the above regression. As expected from the fact that the aggregate trend in time use categories is found in many states, controlling for the state-specific trends in time use for any given category does not alter our decomposition results in any meaningful way.

4.1 Base Results

Figures 5 and 6 show the simple scatter plots of $\Delta\tau_{st}^{market}$ against $\Delta\tau_{st}^{non-market}$ and separately against $\Delta\tau_{st}^{leisure}$ using our pooled sample of all years. The weighted least squares regression line fitting the data in the scatter plot is also shown. The regression line in the scatter plots is analogous to estimating (2) excluding both the D_t and the ΔX_{st} vectors. As seen from the two figures, a one hour per week reduction in market work increases time spent on non-market work by around 0.30 hours per week and increases time spent on leisure by around 0.51 hours

per week. Both estimates are significant at any conventional statistical level. As was predicted given the aggregate trends discussed in the previous section, the response of non-market time is biased downward if the effect is only identified from the time series variation while the response of leisure time is biased upwards.

Table 5 shows that controlling for the time dummies and controlling for the vector of state demographic and economic variables does little to alter the conclusions of the scatter plots.[9] In the first column of Table 5, we report the estimates from the above regression including only the vector of time dummies D_t while the second and third columns include both the time dummies D_t and the vector of controls ΔX_{ts}. In column 2, the ΔX_{ts} vector only includes changes in state averages of demographic variables. Specifically, we include the state level change between period $t-1$ and period t in the fraction of the sample that is included in five different age bins, the change between period $t-1$ and period t in the fraction of the sample that is included in four different education bins, the change between period $t-1$ and period t in the fraction of the sample within the state that is male, the change between period $t-1$ and period t in the fraction of the sample within the state that is married, the change between period $t-1$ and period t in the fraction of the sample within the state that has a child, and the change between period $t-1$ and period t in the fraction of the sample within the state that is of black race. We include these controls to capture the potential that the demographic composition of the state is changing over time either due to migration or due to sampling variation. In column 3 we include the demographic controls as well as state level economic variables that proxy for potential shocks to the home production sector. The recent recession is also associated with big changes in the fraction of the population owning a home. If homeownership is associated with increased home production, changes in homeownership rates or the desire to maintain a home could bias our results. To help to control for this potential problem, we include the change in the state homeownership rate between $t-1$ and t and the change in housing prices at the state level between $t-1$ and t as additional regressors.[10]

As seen from the first three columns of Table 5, our estimates of the amount of foregone market work that is reallocated to non-market production and leisure at business cycle frequencies is unchanged in response to controlling for the time dummies D_t or the ΔX_{ts} vector of state level demographic and economic variables. Roughly 30% of foregone market work hours are allocated to non-market work while slightly more that 50% of foregone market work hours

[9] We present the standard errors of the estimated coefficients in the Appendix under Table A.3. In general, the standard errors are small.

[10] The homeownership rate by state is calculated using data from the U.S. Census (see Table 15 at http://www.census.gov/hhes/www/housing/hvs/annual10/ann10ind.html). Housing prices by state are calculated from the Federal Housing Finance Agency (see http://www.fhfa.gov/Default.aspx?Page=87).

are allocated to leisure. Table 5 also decomposes the changes in non-market work and leisure into its sub-components. In particular, almost two-thirds of the increase of non-market work is due to an increase of the time allocated to core home production activities (e.g. cooking, cleaning, laundry) and shopping. As seen in Aguiar and Hurst (2007b), the shopping margin is also important in explaining the movements in non-market work time in response to changes in market work over the lifecycle. Although we treat it as a separate category, 5% of the foregone market work hours are reallocated to child care. If one treats the marginal increase of child care as being akin to non-market production, non-market production would absorb roughly one-third of the reduction in market work hours at the business cycle frequency.

Columns 1-3 of Table 5 also show that roughly two-thirds of the increase of leisure time associated with the decline in market work at the business cycle frequency are concentrated in television watching and sleeping. To the extent the individuals consider recessions to be a period of increased leisure, the bulk of the leisure increase shows up as an increase of time in these two categories. Given the large movements in the time allocated to these two categories, our results suggest that economists need to think hard about how individuals value the marginal time spent watching television or sleeping when computing the welfare costs of business cycles. We do not find that socializing (spending time with one's spouse, extended family, and friends) increases significantly during recessions. However, we do find that the relatively small category "other leisure" absorbs about 15% of the foregone market work hours. All other leisure is a broad category that includes various leisure activities other than sleeping, eating, personal care, socializing and watching TV. Of these sub-categories, "entertainment other than TV" (e.g. listening to music and playing with the computer), "exercising, sports and recreation," and "hobbies" (arts, collecting, writing) comprise the bulk of the movement in the "other leisure" category. Specifically, each of the first two sub-categories absorbs roughly 5% of the decline of market work hours, and the category hobbies absorbs another 2%.

Table 5 also shows that about 1% of foregone market work hours are allocated to job search. The 95% confidence interval for the estimate shown in the first column of Table 5 is -0.30% to 2.25%. This is quite different than the 6.5% estimate shown in column 5 of Table 1 using the time series variation. As column 6 of Table 1 shows, part of this difference seems to be driven by aggregate trends. That is, once we linearly detrend the time use categories, around 3.3% of foregone market work hours are allocated to job search. Our estimates using cross state variation are not surprising given the work of Krueger and Muller (2010) who find that the unemployed allocate a small fraction of their time to job search. Additionally, work in the informal sector absorbs another 1% of the foregone market work hours.

Finally, we find that about 5% of foregone market work hours are allocated to increased educational attainment and another 5% are allocated to increased time in own medical care. How much of the increased time spent on medical care is the result of increased preventive maintenance and how much is it increased medical shocks associated with the recession? Is the increased time spent on human capital development investments that would have never occurred absent the recession or are they simply investments that have been moved forward given the individual's temporary low opportunity cost of time? Given the large movements of time into these activities during periods of reduced market work hours, our work suggests that it is important to better understand the nature of these investments so as to better understand the welfare costs of recessions.

Our result that non-market work absorbs about one-third of the shock in market work hours while leisure absorbs about one-half of the shock in market work hours implies that non-market work is a much more elastic margin of substitution than leisure at business cycle frequencies. This is because non-market work accounts for only about 11% of the total time endowment, whereas leisure occupies 65% of the total time endowment. More formally, we define the elasticity of time use category j with respect to market work as:

$$\varepsilon^j = \left(\frac{\sum_t \sum_s w_s \tau_{st}^{market}}{\sum_t \sum_s w_s \tau_{st}^{j}} \right) \beta^j \tag{3}$$

where w_s denote population-based weights for each of the 51 states. Using the base estimates of column 1 of Table 5, we find that the elasticity of non-market production is around 0.55. In contrast, the elasticity of leisure is around 0.15. In other words, when market work hours fall by 10%, non-market work hours increase by 5.5% while leisure increases by 1.5%. Child care is also quite elastic, with an elasticity of around 0.37. The most elastic category is own medical and health care with an elasticity of about 1.57. The estimated elasticities of job search and working in the informal sector are about 1.

Columns 4 and 5 of Table 5 are analogous to the specification in column 3 aside from the fact that the time categories τ^j's and the demographic component of the controls are based on an underlying sample of only women (column 4) or only men (column 5). In general, the patterns of men and women look similar and in most cases we fail to reject at the 10% level of significance the hypothesis that men's and women's time use responds similarly when market work decreases. There are some notable exceptions. In particular, women spend more of their reduced market work hours on non-market work by engaging in core home production activities (e.g., cooking, cleaning, laundry) than men (12.8% vs. 7.1%). The difference between men and women in the estimated response of the core home production category is significant at

the 10% level. Additionally, for women around 23.9% of their foregone market work hours is allocated to sleep. The corresponding number for men is only 12.1%. The difference between these responses is again significant at the 10% level. Finally, men allocate a larger fraction of their foregone market work hours to obtaining human capital (6.2% vs. -1.1%) and their own medical care (5.4% vs. 0.2%). These differences are significant at the 10% and 5% level respectively.

Column 6 of Table 5 looks at the responsiveness of the various time use categories to a change in market work hours based only on the intensive margin variation of market work hours. Again, this specification includes the time dummies and the full vector of demographic and economic controls. Specifically, in this regression we measure how foregone market work hours are reallocated into different time use categories when the underlying state level sample is constructed only based on those individuals who are employed. As a result, all the variation of market work hours across states is on the intensive margin of labor supply. Even along the intensive margin, the results are very similar to the results of column 3.

In the Appendix (Table A.4), we present a series of additional robustness exercises. All of the robustness exercises yield results similar to the results in our base case specification. In particular, across different robustness exercises we find that around 26-34% of foregone market work hours are allocated to non-market production while around 46-55% of foregone market work hours are allocated to leisure. Specifically, first we estimate equation (2) using one-year time periods as opposed to the two-year time periods we used in our base specifications. Second, we estimate the regression when the underlying state level data is constructed based on the sample of respondents of all ages (instead of only ages 18-65) whose answers could be classified by the ATUS stuff. Third, we estimate the regression when the underlying state level data is constructed based on the full ATUS sample, including respondents whose answers could not be classified by the ATUS staff. Fourth, we estimate the regression including state fixed effects. State fixed effects capture differential average changes in each time use category across states. Fifth, we estimate the regression introducing state-specific linear time trends in each time use category. That is, we allow states to have differential low frequency trends in each time use category. Finally, we repeat these robustness checks including the demographic and the economic controls.

4.2 Results From Different Sub-Periods

In this section, we explore the stability of our estimates across the three different sub-periods. Given the size of the negative market work hours during the recent recession, it is conceivable

that the allocation of foregone work hours to alternative time uses may have changed relative to earlier periods. For example, the marginal individual who experiences a decline in work hours during the recession may have different preferences for leisure or home production from the marginal individual who experiences a decline in work hours during the non-recessionary periods. Alternatively, given that the aggregate economic environment is different, an individual who experiences a decline in work hours may choose to allocate their time to different activities when the economy as a whole is in a deep recession relative to a smaller recession.

We explore the stability of our estimates over different time periods in Figures 7 and 8. The Figures are akin to Figures 5 and 6 except they are estimated on each of our sub-periods separately. For example, Figure 7 shows the unconditional cross state relationship between changes in market hours worked and changes in non-market production for the 03/04 period relative to 05/06 (left panel), the 05/06 period relative to 07/08 (center panel), and the 07/08 period relative to 09/10 (right panel). Figure 8 has the same structure but explores the relationship between changes in market work and changes in leisure at the state level.

A few things are noticeable from Figures 7 and 8. First, the responsiveness of changes in non-market work time to changes in market work time is highest during the most recent (recessionary) time period. In particular, during the recession, 38% of foregone market work hours are allocated to non-market work. This is 4 percentage points larger than the estimated response from the 2003-2006 sub-period and 15 percentage points larger than the response from the 2005-2008 sub-period. Likewise, the responsiveness of the changes in leisure is lower during the aggregate recessionary period. Only 43% of foregone market work hours during the 2009-2010 period are allocated to leisure. This is roughly 3 percentage points lower than what was estimated for the first sub-period and 16 percentage points lower than what was estimated for the second sub-period.

Second, the results from Figures 7 and 8 indicate that the first period is much more similar to the recessionary period than the second period with respect to the reallocation of foregone market work hours. The p-value for the null hypothesis that the response of non-market work is the same between the early and the recent period is 0.621, and the p-value for the null hypothesis that the response of leisure is the same between the early and the recent period is 0.769. We view this as an reassuring result given that, arguably, much of the variation of changes in market work across states during the early period was also due to business cycle variation. During this time period, the aggregate unemployment rate fell from around 6% to around 4.5% as the economy was recovering from the early 2000s recession. While not conclusive, this suggests that our findings may extend to other periods of high aggregate

volatility outside of the current recession.

The third point we want to emphasize is that the estimates are much lower for the response of non-market work and much higher for the response of leisure during the 2005-2008 period when there was essentially no movement in the national unemployment rate. The p-value for the null hypothesis that the response of non-market work is similar between the recent recession and the pre-recessionary period is 0.046, and the p-value for the null hypothesis that the response of leisure is the same between the recent recession and the pre-recessionary period is 0.0855. This result suggests that one should be cautious about using the cross state estimates from non-recessionary periods to predict how time use will respond to foregone work hours during recessions.

Table 6 shows the estimates from repeating regression (2) for each of the three sub-periods for each of our time use categories. These regressions include the full vector of the demographic and economic controls. Columns 1-3 show the results from the regressions for the most recent time period, the middle time period, and the early time period, respectively. Column 4 reports the p-value of the difference in estimates from the recent time period relative to the middle time period. The last column reports the p-value of the difference in the estimates from the recent time period relative to the early time period.

In general, the results of Table 6 uncover similar patterns to the ones discussed with the help of Figures 7 and 8. In particular, the response of non-market work is higher during the recent and the early period relative to the middle period, and the response of leisure is lower during the recent and the early period relative to the middle period. Using conventional significance levels, we reject the hypothesis that the response of non-market work and leisure is different between the early and the recent period. On the other hand, we fail to reject the hypothesis that the response of non-market work and leisure is different between the recent and the middle period.

Looking at the specific sub-categories offers some additional interesting patterns. First, the only leisure or non-market work sub-category which responds similarly between the middle and the recent period is home ownership activities (home maintenance, exterior repair etc.). In these periods, home ownership activities absorb around 0-4% of the shock in market work hours. In contrast, in the early period home ownership activities absorb a huge fraction of foregone market work hours (around 17%). This finding suggests that the aggregate housing shock starting in 2006-2007 affected the incentive of households to reallocate foregone work hours to the activities closely related to the ownership of houses. Since we find this difference even though we control for any cross state variation of changes in homeownership rates and changes

in housing prices, this difference is due to the aggregate housing shock that affected many parts of the country simultaneously. Second, for child care activities we observe the opposite pattern relative to homeownership activities. Child care absorbs an important fraction of the market work shock in the two later periods (7-8%), but moves in the same direction as market work in the earlier period (absorbing around -3% of the shock). Third, sleep and television watching are the sub-categories mostly responsible for the finding that leisure absorbs a smaller fraction of foregone market work hours in the early and recent periods relative to the middle period. Finally, while job search always absorbs a small fraction of the foregone market work hours, working in the informal sector absorbs around 3% of the foregone market work hours in the sub-sample of the recent recession.

5 Implications for Business Cycle Models

Equilibrium business cycle models with home production have been successful in explaining a number of stylized facts of aggregate fluctuations. A central issue with these models is that they typically assume a high degree of substitution of time over the business cycle in order to match business cycle facts. Until today, however, there has been no systematic evidence that the substitution of time in these models is consistent with the actual behavior of the households with respect to their allocation of time during recessions. In this section, we investigate whether the business cycle model of Benhabib, Rogerson and Wright (1991) is able to generate movements in the allocation of time over the business cycle that are consistent with our evidence. We start with this model because it, along with Greenwood and Hercowitz (1991), was the first to propose the importance of the substitutability between the market sector and the home sector in explaining the joint dynamics of labor supply and consumption at business cycle frequencies.

In our quantitative experiments, we will focus on the cyclical behavior of market work, leisure and home (non-market) work which does not include child care.[11] Business cycle models typically exclude sleeping, eating and personal care from leisure. However, as we have shown before, a substantial amount of time is directed to sleeping when market work decreases. Therefore, we analyze two versions of the model. In the first version, we exclude sleeping, eating and personal care from leisure. In the second version, we include these activities into leisure.

[11] Our evidence suggests that child care's elasticity with respect to market work is more similar to the elasticity of non-market work than to the elasticity of leisure. As a result, including child care into non-market work moves the predictions of the model even closer to the evidence in the data.

We describe briefly the Benhabib, Rogerson and Wright (1991) model. Time is discrete and the horizon is infinite, $t = 0, 1, 2, ...$ In the market sector, the representative household provides labor services N_t^m and capital services K_{t-1}^m to a competitive, profit-maximizing producer who produces final goods according to the Cobb-Douglas technology:

$$Y_t = \exp(z_t^m) \left(K_{t-1}^m\right)^{\alpha_m} \left(N_t^m\right)^{1-\alpha_m} \tag{4}$$

where z_t^m denotes an exogenous technology shock in the market sector and $\alpha_m \in (0, 1)$.

In the home sector, the household good is produced according to a Cobb-Douglas technology that combines time in household activities (N_t^h) with household capital goods (K_{t-1}^h):

$$C_t^h = \exp(z_t^h) \left(K_{t-1}^h\right)^{\alpha_h} \left(N_t^h\right)^{1-\alpha_h} \tag{5}$$

where z_t^h denotes an exogenous technology shock in the home sector and $\alpha_h \in (0, 1)$.

There is a representative household with preferences defined over bundles of aggregate consumption C_t and leisure L_t:

$$\mathbf{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t, L_t) \tag{6}$$

where $\beta \in (0, 1)$ is the discount factor. The utility function is specified as:

$$U(C_t, L_t) = \frac{\left(C_t^{1-b} L_t^b\right)^{1-\gamma} - 1}{1-\gamma} \tag{7}$$

with $\gamma > 0$ and $b \in (0, 1)$. Aggregate consumption is a basket of market goods and home goods:

$$C_t = \left((1-a)\left(C_t^m\right)^{\rho} + a\left(C_t^h\right)^{\rho}\right)^{\frac{1}{\rho}} \tag{8}$$

where $a \in (0, 1)$ and $\epsilon = 1/(1-\rho) > 0$ denotes the elasticity of substitution between market and home consumption goods. The time constraint is:

$$L_t + N_t^m + N_t^h = 1 \tag{9}$$

In the beginning of period t, the household owns a total stock of capital K_{t-1} and invests a total of X_t in new capital goods. Total investment X_t is allocated between the two sectors, $X_t = X_t^m + X_t^h$. We note that capital goods are produced exclusively in the market sector, but they can be used as inputs either in market or in home production. The law of motion for capital stock $j = m, h$ is:

$$K_t^j = X_t^j + (1-\delta) K_{t-1}^j \tag{10}$$

The household chooses sequences of consumption, leisure, market and home work and capital stocks to maximize utility subject to the period budget constraint:

$$C_t^m + X_t = w_t N_t^m + r_t K_{t-1}^m$$

where w_t is the competitive wage and r_t is the competitive rental rate of market capital that the household receives from the firm. Finally, the resource constraint is:

$$Y_t = C_t^m + X_t \tag{11}$$

To close the model we specify a stochastic process for the technology shocks $Z_t = [z_t^m, z_t^h]'$:

$$Z_t = \mathbf{R}Z_{t-1} + \nu_t \tag{12}$$

where $\nu_t \sim \mathbf{N}(0, \mathbf{\Sigma})$.

The competitive equilibrium of the model is defined as a sequence of quantities and prices such that households maximize their utility subject to the budget constraint, the time constraint and the available technology in the home sector, firms maximize their profits subject to the available technology in the market sector and all markets clear.

Our quantitative experiment is to investigate how the cyclical behavior of market work, leisure and home work in the model compares to the evidence from the ATUS. In the first version of the model, we define total time to be the sum of market work, home work and leisure excluding sleeping, eating and personal care. In our sample, the average time spent on market work (as a fraction of this definition of total time) is 37.26%, the average time spent on home work is 21.35% and the average time spent on leisure activities is 41.39%. We calibrate the model in order reproduce these targets in the steady-state. The model is evaluated against the evidence presented in the first column of Table 5 that around 50% of a given decrease of market work is allocated to home work and around 50% of a given decrease of market work is allocated to leisure. In the recent recession sample (i.e. when we repeat the specification of column 1 of Table 5 only to the recent period), we find that around 57% of a given decrease of market work is allocated to home work and around 43% to leisure.

In the second version of the model, we define total time to be the sum of market work, home work and leisure including sleeping, eating and personal care. In our sample, the average time spent on market work (as a fraction of this definition of total time) is 20.04%, the average time spent on home work is 11.48% and the average time spent on leisure activities is 68.48%. We calibrate the model in order reproduce these targets in the steady-state. The model is evaluated against the evidence presented in the first column of Table 5 that around 39% of a given decrease of market work is allocated to home work and around 61% of a given decrease of market work is allocated to leisure. In the recent recession sample (i.e. when we repeat the specification of column 1 of Table 5 only to the recent period), we find that around 47% of a given decrease of market work is allocated to home work and around 53% to leisure.

Table 7 presents the parameters values. We follow the calibration strategy of Benhabib, Rogerson and Wright (1991). In particular, the crucial parameter that governs the willingness of the household to substitute between market and home goods is set equal to $\epsilon = 1/(1-\rho) = 5$. We choose the parameters a and b to generate steady-state values of market work, leisure and home work in the model that equal their corresponding mean values in the ATUS data.

After assigning parameters, we solve and simulate the model to generate model-based time series. In each simulation, we simulate 51 panels for 58 years and use the last 8 years of the data to construct a pooled dataset. To calculate the implied allocation of time over the business cycle, we use the model-generated time series in a similar manner to Section 4 and regress:

$$\Delta L_{st} = \alpha^l - \beta^l \Delta N^m_{st} + u^l_{st} \tag{13}$$

$$\Delta N^h_{st} = \alpha^h - \beta^h \Delta N^m_{st} + u^h_{st} \tag{14}$$

where $\beta^l + \beta^h = 1$. As in Section 4, β^h denotes the fraction of time allocated to home work when market work decreases and β^l denotes the fraction of time allocated to leisure when market work decreases.[12] To reduce the dependence of the results on the simulated shocks, we report average coefficients obtained over 50 such simulations.

Table 8 presents the results. The first version of the model generates $\beta^h = 74\%$ which is higher than the 50-57% of foregone market work hours that are reallocated to home production (relative to leisure) in the data. The second version of the model generates $\beta^h = 48\%$, which is fairly close to the 39-47% in the data. The second version of the model comes closer to matching the evidence in the data because sleep, while absorbing a large fraction of foregone market work, is one of the least elastic time use categories (i.e. it absorbs a small fraction of foregone market work time relative to its size).

The final quantitative experiment that we consider is varying the elasticity of substitution between market-produced and home-produced goods, $\epsilon = 1/(1-\rho)$. In particular, we ask what value of the elasticity leads to a business cycle allocation of time in the model that matches closer the evidence we documented using the ATUS data. Table 8 presents the results when the elasticity equals $\epsilon = 2$. Figure 9 shows results under a variety of alternative values.[13] We consider both the first version of the model (i.e. when leisure does not include sleep, eating and personal care) and the second version of the model (i.e. when leisure includes these activities).

[12] Since the model is calibrated at quarterly frequency while our base results from the ATUS are based on two-year variation, in our regressions with model-generated data differences in each time use category (ΔL_{st}, ΔN^h_{st} and ΔN^m_{st}) denote changes relative to the previous period. Periods are constructed by averaging the time use categories over eight quarters.

[13] The steady-state allocation of time in the model is a function of the parameter ϵ. As we vary ϵ, we change the parameter a to keep the steady-state allocation of time into market work, leisure and home work constant.

Our results show that the value of the elasticity ϵ that makes the model match the evidence from the ATUS is around 2.5 for the first version and around 4 for the second version. This difference is explained intuitively by the fact that sleep, eating and personal care are among the least elastic time uses in the data. As a result, in the second version of the model home production becomes more substitutable to market consumption relative to leisure.

Our estimate of the elasticity parameter ϵ (around 2.5) is identified from the cross state variation in changes of market work. However, our results are in general consistent with various other estimates in the literature using alternative sources of identification. Based on macro data and likelihood methods, McGrattan, Rogerson and Wright (1997) estimate this elasticity to be slightly less than 2, while Chang and Schorfheide (2003) estimate it to be around 2.3. Using micro data, Rupert, Rogerson and Wright (1995) estimate a value of around 1.8 and Aguiar and Hurst (2007b) estimate a value of around 2.

What does our evidence imply about the cyclical properties of the labor market? A useful way to summarize the business cycle properties of the model is to look at the behavior of the labor wedge.[14] The labor wedge is defined similarly to Chari, Kehoe and McGrattan (2007):

$$\exp(\tau_t) := \frac{(1-a_m)Y_t/N_t^m}{bC_t^m/(1-b)(1-N_t^m)} \tag{15}$$

Figure 10 presents the volatility of the labor wedge relative to output (left panel) and the contemporaneous correlation of the labor wedge with output (right panel) as a function of the elasticity parameter ϵ. Using the base parameters of Benhabib, Rogerson and Wright (1991), in the first version of the model the labor wedge is 0.79 times as volatile as output and displays a -0.50 contemporaneous correlation with output. In the second version of the model, the labor wedge is 0.56 times as volatile as output and displays a -0.34 contemporaneous correlation with output. Using US data between 1959 and 2004, Chari, Kehoe and McGrattan (2007) report that the measured labor wedge is 0.92 times as volatile as output and displays a -0.71 contemporaneous correlation with output. Figure 10 shows that when we calibrate the elasticity parameter ϵ to a value such that the model-generated value of the coefficient β^h matches the empirical value of β^h from the ATUS, the model produces a labor wedge that is about 50% as volatile as the measured labor wedge in the data. Our results suggest that home production explains a sizable fraction of the business cycle behavior of the measured labor wedge. These results are also supportive of reduced-form models of home production. For an example, see Hall (2009) where work and consumption are modeled as complements.

[14] See Karabarbounis (2011) for an expression that links the measured labor wedge in the data to the model-generated labor wedge in the home production model and for a discussion of the volatility and countercyclicality of the labor wedge.

6 Conclusions

Using data from the American Time Use Survey (ATUS), we explore how households allocate their time over the business cycle. To distinguish business cycle effects from low frequency trends, we use the cross state variation with respect to the severity of the business cycle to identify how market work time is reallocated to different time uses over the business cycle. We find that roughly 35% of the foregone market work hours are allocated to increased non-market work and increased child care. Additionally, 30% of the foregone worked hours are allocated to increased sleep time and increased television watching and 20% to other leisure activities. Other investments (education, health care, civic activities) account for more than 10% of the foregone market work hours. Job search and work in the informal sector absorb small fractions of the foregone work hours. Collectively, our results suggest that economists measuring the welfare effects of aggregate fluctuations need to think how households value the marginal increases of these alternative activities over the business cycle.

Given that non-market work is an important margin of substitution along the business cycle, our results are in general supportive of workhorse macroeconomic models with home production. Despite the theoretical importance of these models, the empirical analysis of the business cycle properties of these models was not previously possible because of data limitations. We show how a calibrated macroeconomic model with home production performs well in explaining the actual allocation of time that we observe over the business cycle.

We wish to stress that when evaluating the response of home production during recessions, we only observe changes in home production inputs and not changes in home production outputs. Like the returns to market work, it is possible that the returns to non-market work changes during the recession. Under this scenario, it may not be appropriate to use the elasticities of substitution between non-market time and expenditures estimated during non-recessionary periods to predict the joint movements of market work, non-market work, and expenditure during recessions. An important area of future research would be to assess the returns to non-market work during recessions.

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Table 1: Time Use by Period (All Sample)

Time Use Category	2003-05 Average (1)	2006-08 Average (2)	2009-10 Average (3)	Difference (U) 09-10 vs. 06-08 (4)	Difference (C) 09-10 vs. 06-08 (5)	Difference 09-10 vs. Trend (6)
Market Work	31.48	32.53	30.41	-2.11	-2.14	-2.09
Other Income-Generating Activities	0.16	0.16	0.24	0.07	0.07	0.05
Job Search	0.20	0.27	0.42	0.15	0.14	0.07
Child Care	4.84	4.57	4.47	-0.09	0.01	-0.17
Non-Market Work	18.78	17.78	17.58	-0.19	-0.09	0.95
- Core Home Production	9.56	9.38	9.38	0.00	0.10	0.51
- Home Ownership Activities	2.40	2.17	2.11	-0.05	-0.04	0.21
- Obtaining Goods and Services	5.20	5.03	4.84	-0.18	-0.19	0.11
- Others Care	1.61	1.19	1.24	0.04	0.04	0.10
Leisure	107.46	107.71	109.55	1.83	1.69	1.08
- TV Watching	17.03	17.55	18.57	1.01	1.00	-0.44
- Socializing	7.82	7.59	7.59	0.00	-0.02	0.12
- Sleeping	59.30	59.54	60.18	0.64	0.68	0.65
- Eating and Personal Care	13.36	13.26	13.32	0.05	0.02	0.05
- Other Leisure	9.93	9.74	9.86	0.11	0.00	0.67
Other	5.03	4.95	5.29	0.34	0.30	0.09
- Education	2.11	2.00	2.16	0.16	0.14	-0.03
- Civic and Religious Activities	1.93	1.98	2.15	0.16	0.15	0.18
- Own Medical Care	0.98	0.96	0.97	0.00	0.00	-0.05

Notes: Columns 1-3 present estimates of the average hours per week spent on each time use category by sample period. Column 4 shows the unconditional difference in each time use category between the period 2009-10 and the period 2006-08. Column 5 presents the conditional difference in each time use category between the period 2009-10 and the period 2006-08. The conditional difference is the coefficient for the dummy variable on the 2009-10 period in a regression of individual time spent on a given category on the dummy and demographic controls (age, education, race, gender, marriage status, kids). Column 6 presents the difference between the observed average value of each time use category in 2009-2010 and the linearly extrapolated value of each time use category in 2009-2010.

Table 2: Time Use by Period (Men Sample)

Time Use Category	2003-05 Average (1)	2006-08 Average (2)	2009-10 Average (3)	Difference (U) 09-10 vs. 06-08 (4)	Difference (C) 09-10 vs. 06-08 (5)	Difference 09-10 vs. Trend (6)
Market Work	37.38	38.16	35.10	-3.06	-2.83	-3.11
Other Income-Generating Activities	0.15	0.15	0.25	0.09	0.09	0.09
Job Search	0.27	0.37	0.56	0.19	0.18	0.00
Child Care	2.90	2.82	2.98	0.16	0.21	-0.08
Non-Market Work	14.52	13.78	14.04	0.25	0.25	1.23
- Core Home Production	5.53	5.75	5.83	0.07	0.05	0.23
- Home Ownership Activities	3.21	2.95	2.93	-0.01	-0.00	0.30
- Obtaining Goods and Services	4.13	3.93	4.05	0.11	0.11	0.49
- Others Care	1.64	1.13	1.21	0.07	0.08	0.19
Leisure	108.25	108.62	110.36	1.73	1.49	0.86
- TV Watching	18.61	19.29	20.33	1.04	0.96	-0.50
- Socializing	7.48	7.24	7.23	-0.01	-0.03	0.31
- Sleeping	58.51	58.88	59.39	0.50	0.47	0.04
- Eating and Personal Care	12.99	12.76	12.84	0.08	0.07	-0.04
- Other Leisure	10.64	10.43	10.54	0.11	0.01	1.06
Other	4.49	4.07	4.69	0.62	0.59	1.00
- Education	1.97	1.54	1.98	0.43	0.42	0.67
- Civic and Religious Activities	1.68	1.75	1.88	0.13	0.13	0.20
- Own Medical Care	0.83	0.77	0.82	0.04	0.04	0.11

Notes: Columns 1-3 present estimates of men's average hours per week spent on each time use category by sample period. Column 4 shows the unconditional difference in each time use category between the period 2009-10 and the period 2006-08. Column 5 presents the conditional difference in each time use category between the period 2009-10 and the period 2006-08. The conditional difference is the coefficient for the dummy variable on the 2009-10 period in a regression of individual time spent on a given category on the dummy and demographic controls (age, education, race, gender, marriage status, kids). Column 6 presents the difference between the observed average value of each time use category in 2009-2010 and the linearly extrapolated value of each time use category in 2009-2010.

Table 3: Summary Statistics of State-Level Changes in Market Work

Statistic	Pooled Sample (1)	2006/05 vs. 2004/03 (2)	2008/07 vs. 2006/05 (3)	2010/09 vs 2008/07 (4)
Mean	-0.32	0.56	0.59	-2.13
Standard Deviation	3.45	2.92	3.42	3.32
Minimum	-14.66	-9.75	-6.36	-14.66
10th percentile	-3.91	-2.98	-2.99	-6.31
25th percentile	-2.86	-0.70	-1.41	-3.68
50th percentile	0.00	0.88	0.42	-2.66
75th percentile	1.47	2.42	1.23	0.18
90th percentile	2.91	2.51	6.60	2.46
Maximum	19.21	11.27	19.21	4.46
% Negative Changes	54.24	39.21	49.01	74.50

Notes: The Table presents summary statistics of the changes in market work hours per week at the state level. Observations are weighted with each state's population.

Table 4: Summary Statistics of State-Level Changes in Leisure and Non-Market Work: 2003/2004 vs. 2007/2008

Statistic	Leisure Time (1)	Non-Market Time (2)
Mean	0.43	-1.31
Standard Deviation	2.39	1.30
Minimum	-10.93	-6.72
10th percentile	-2.83	-2.58
25th percentile	-0.07	-2.13
50th percentile	0.44	-1.01
75th percentile	1.94	-0.28
90th percentile	2.69	0.24
Maximum	9.01	2.70
% Negative Changes	39.21	82.35

Notes: The Table presents summary statistics of the changes in leisure and non-market work hours per week at the state level between 2003/2004 and 2007/2008. Observations are weighted with each state's population.

Table 5: State Sample: Pooled Results

Time Use Category	Base (1)	Demo (2)	Demo+Econ (3)	Women (4)	Men (5)	Employed (6)
Other Income-Generating Activities	0.56	0.82	0.91	1.29	0.91	1.40
Job Search	0.97	0.73	0.74	0.84	1.41	0.33
Child Care	5.52	4.98	4.45	5.99	2.70	4.29
Non-Market Work	31.30	29.68	28.93	25.68	28.29	29.38
- Core Home Production	12.61	11.80	10.96	12.79	7.14	10.58
- Home Ownership Activities	6.82	7.47	7.02	5.13	8.07	6.76
- Obtaining Goods and Services	7.95	6.61	7.41	8.14	9.10	9.20
- Others Care	3.91	3.78	3.53	-0.38	3.95	2.83
Leisure	49.76	51.09	52.05	63.31	56.75	54.36
- TV Watching	12.19	12.35	13.40	13.63	19.19	11.83
- Socializing	3.85	3.24	2.47	3.20	7.77	5.22
- Sleeping	20.55	19.42	19.33	23.91	12.19	14.25
- Eating and Personal Care	-2.28	-1.81	-1.38	0.77	0.87	4.75
- Other Leisure	15.44	17.89	18.22	21.77	16.71	18.28
Other	11.86	12.68	12.90	2.85	9.91	10.21
- Education	5.07	6.44	7.67	-1.07	6.19	6.04
- Civic and Religious Activities	1.97	2.14	1.66	3.68	-1.70	2.44
- Own Medical Care	4.82	4.09	3.55	0.24	5.43	1.72

Notes: The Table presents the estimated coefficients β^j from regression (2). All coefficients are multiplied by 100. All columns include the time trends D_t in the specification. Column 1 presents estimates when there are no other controls in the regression. Column 2 presents estimates when demographic controls are included in the regression. Column 3 presents estimates when demographic and economic controls are included in the regression. Column 4 presents estimates when demographic and economic controls are included in the regression but the underlying state level sample is constructed using only women. Column 5 presents estimates when demographic and economic controls are included in the regression but the underlying state level sample is constructed using only men. Column 6 presents estimates when demographic and economic controls are included in the regression but the underlying state level sample is constructed using only employed individuals.

Table 6: State Sample: Results by Sub-Periods

Time Use Category	2010/09 Estimate	2008/07 Estimate	2006/05 Estimate	10/09 vs. 06/05 p-value	10/09 vs. 08/07 p-value
Other Income-Generating Activities	2.94	0.03	-1.92	0.045	0.002
Job Search	0.19	-0.99	1.09	0.584	0.674
Child Care	8.28	7.17	-2.79	0.813	0.022
Non-Market Work	36.20	16.27	34.88	0.019	0.902
- Core Home Production	12.17	12.61	6.20	0.945	0.351
- Home Ownership Activities	4.67	-0.00	17.21	0.396	0.017
- Obtaining Goods and Services	13.46	1.07	9.91	0.027	0.583
- Others Care	5.88	2.58	1.54	0.379	0.285
Leisure	44.30	64.52	42.46	0.079	0.893
- TV Watching	5.75	25.89	1.43	0.027	0.673
- Socializing	6.54	-4.90	8.49	0.086	0.822
- Sleeping	15.31	27.03	13.24	0.390	0.878
- Eating and Personal Care	0.57	-4.39	5.63	0.366	0.466
- Other Leisure	16.11	20.90	13.64	0.598	0.799
Other	8.07	12.98	26.32	0.484	0.033
- Education	2.11	10.61	17.92	0.179	0.041
- Civic and Religious Activities	-1.51	3.06	4.83	0.246	0.112
- Own Medical Care	7.46	-0.69	3.56	0.011	0.357

Notes: The Table presents the estimated coefficients β^j from regression (2) in different sub-periods. All columns include the demographic and economic controls. Column 1 presents estimates using the change in time use categories only between 2008/07 and 2010/09. Column 2 presents estimates using the change in time use categories only between 2006/05 and 2008/07. Column 3 presents estimates using the change in time use categories only between 2004/03 and 2006/05. Column 4 presents the p-value associated with the null hypothesis that the estimated coefficients in columns 1 and 3 are not different from each other. Column 5 presents the p-value associated with the null hypothesis that the estimated coefficients in columns 1 and 2 are not different from each other. All p-values are based on statistical tests using robust standard errors.

Table 7: Calibration

	Parameter	Version 1	Version 2
γ	curvature of utility function	1.00	1.00
β	discount factor	0.99	0.99
α_m	elasticity of market output with respect to capital	0.36	0.36
α_h	elasticity of home output with respect to capital	0.08	0.08
δ	depreciation rate	0.025	0.025
σ_m	standard deviation of innovations of market technology	0.007	0.007
σ_h	standard deviation of innovations of home technology	0.007	0.007
η	correlation of innovations of market and home technology	0.66	0.66
ρ_m	persistence of market technology	0.95	0.95
ρ_h	persistence of home technology	0.95	0.95
ϵ	elasticity of substitution between market and home goods	5.00	5.00
a	preference for home goods parameter	0.6284	0.6284
b	preference for leisure parameter	0.3884	0.6615

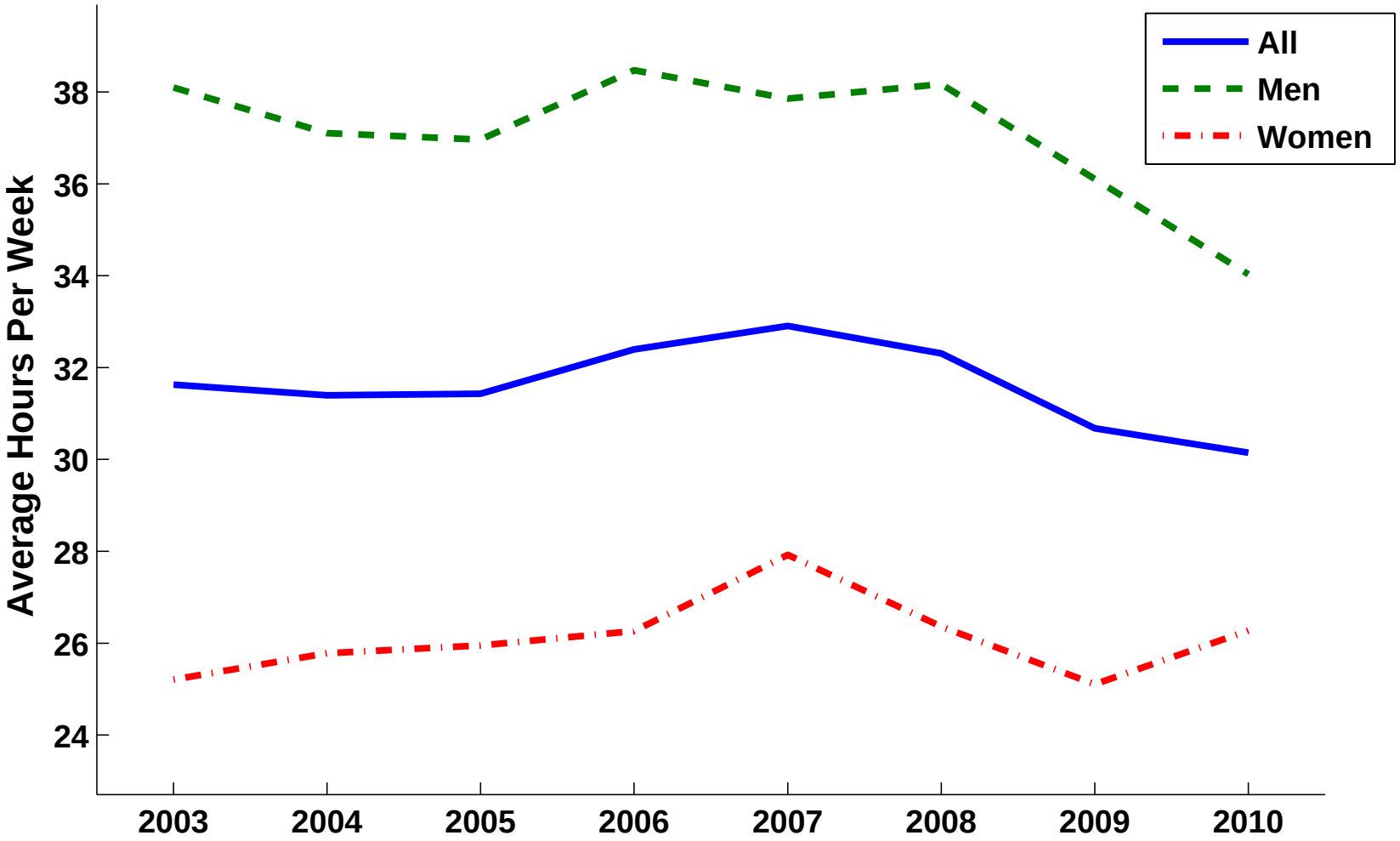
Notes: The Table shows the parameter values for the model of Section 5. Version 1 refers to the version of the model in which leisure does not include sleep, eating and personal care. Version 2 refers to the version of the model in which leisure includes these activities.

Table 8: Results from the Model

	Model-Generated β^h	Estimated β^h (Pooled Sample)	Estimated β^h (Recession Sample)
Version 1:			
$\epsilon = 5$	74%	50%	57%
$\epsilon = 2$	46%	50%	57%
Version 2:			
$\epsilon = 5$	48%	39%	47%
$\epsilon = 2$	20%	39%	47%

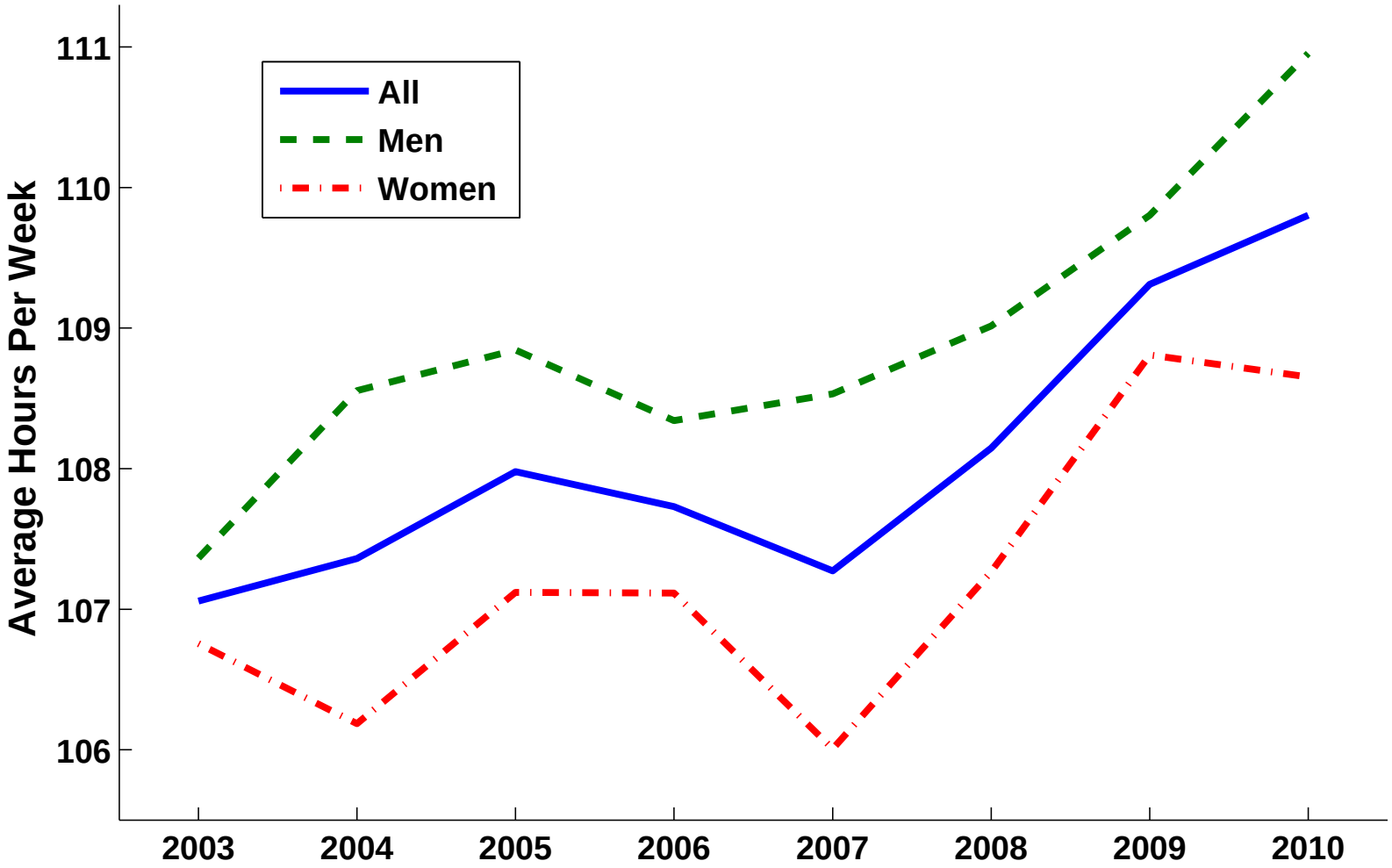
Notes: Column 1 shows the fraction of time allocated to home production in response to foregone market work time in the model (measured by the coefficient β^h estimated by regression (14) with model-generated data). The statistic is shown for two different values of the elasticity of substitution between market-produced and home-produced goods ($\epsilon = 1/(1-\rho)$). Column 2 shows the target β^h estimated from the full sample (Table 5, column 1). Column 3 shows the target β^h estimated from the sample of the recent recession (i.e. when we restrict the specification of column 1 of Table 5 only to the recent period). Version 1 refers to the version of the model in which leisure does not include sleep, eating and personal care. Version 2 refers to the version of the model in which leisure includes these activities.

Figure 1: Market Work



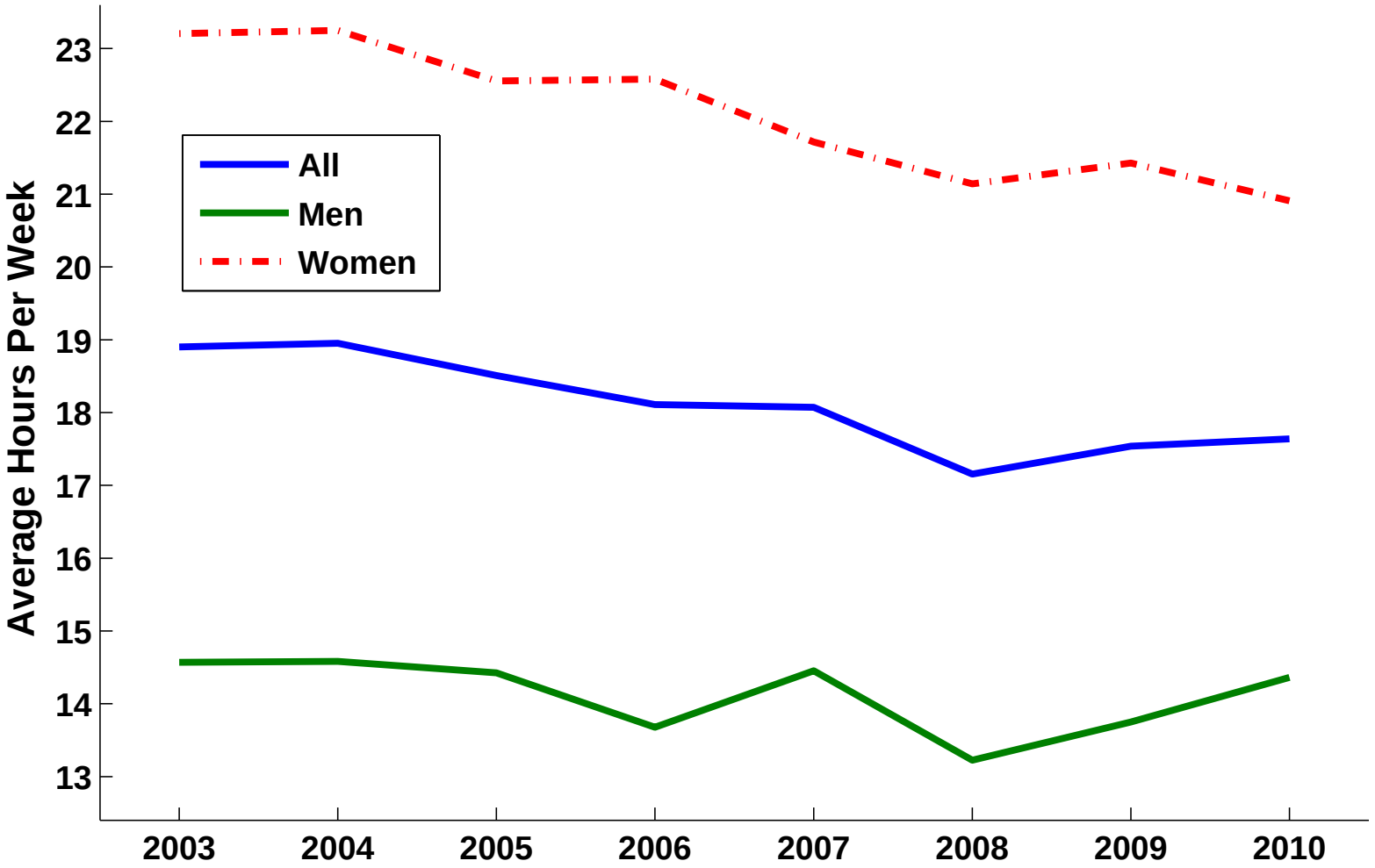
Notes: The Figure shows year-to-year estimates for average market work time for the whole sample, the sample of men and the sample of women. The sample consists of all respondents between 18 and 65 who completed the interview and whose activities could be classified by the ATUS staff.

Figure 2: Leisure



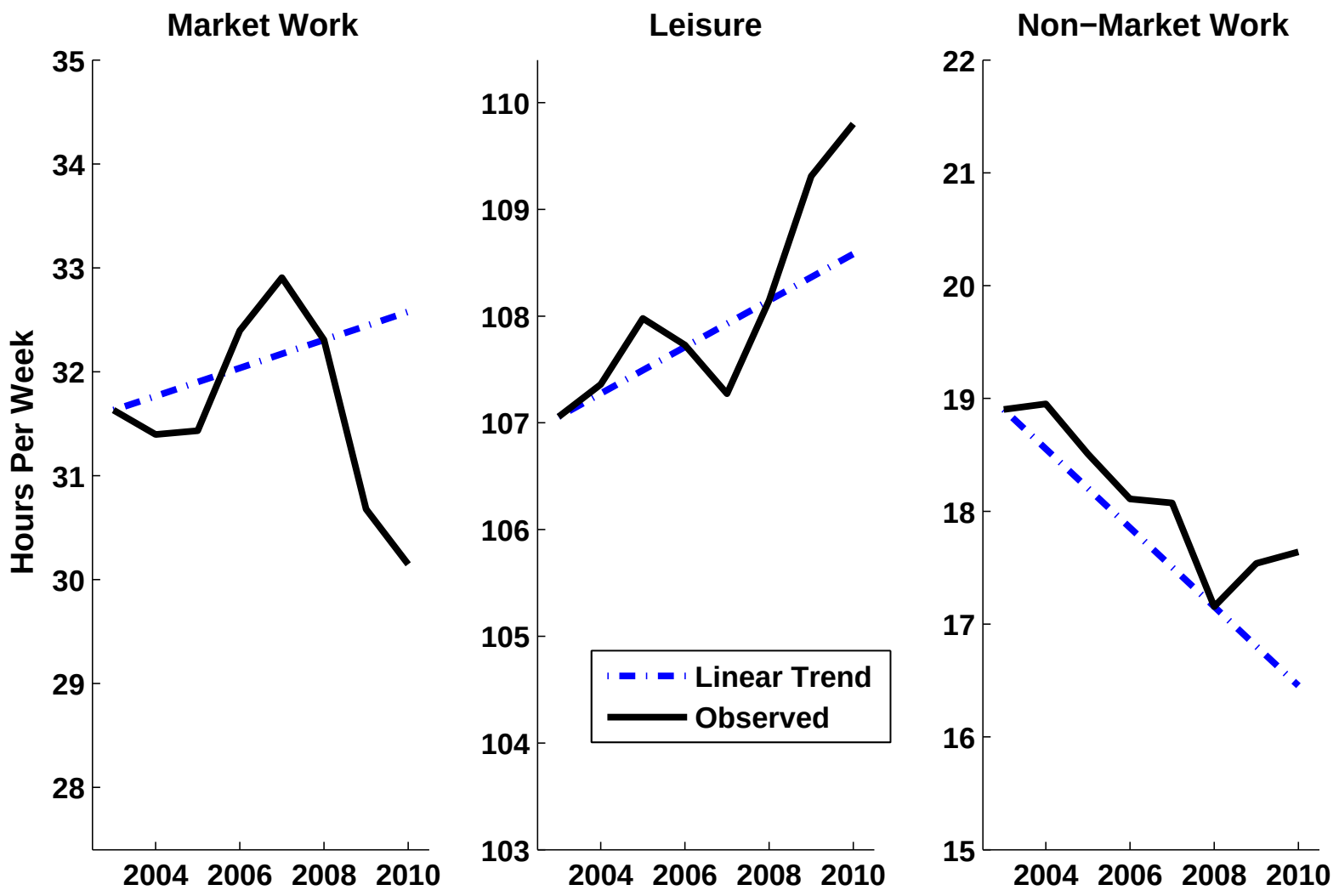
Notes: The Figure shows year-to-year estimates for average leisure time for the whole sample, the sample of men and the sample of women. The sample consists of all respondents between 18 and 65 who completed the interview and whose activities could be classified by the ATUS staff.

Figure 3: Non-Market Work



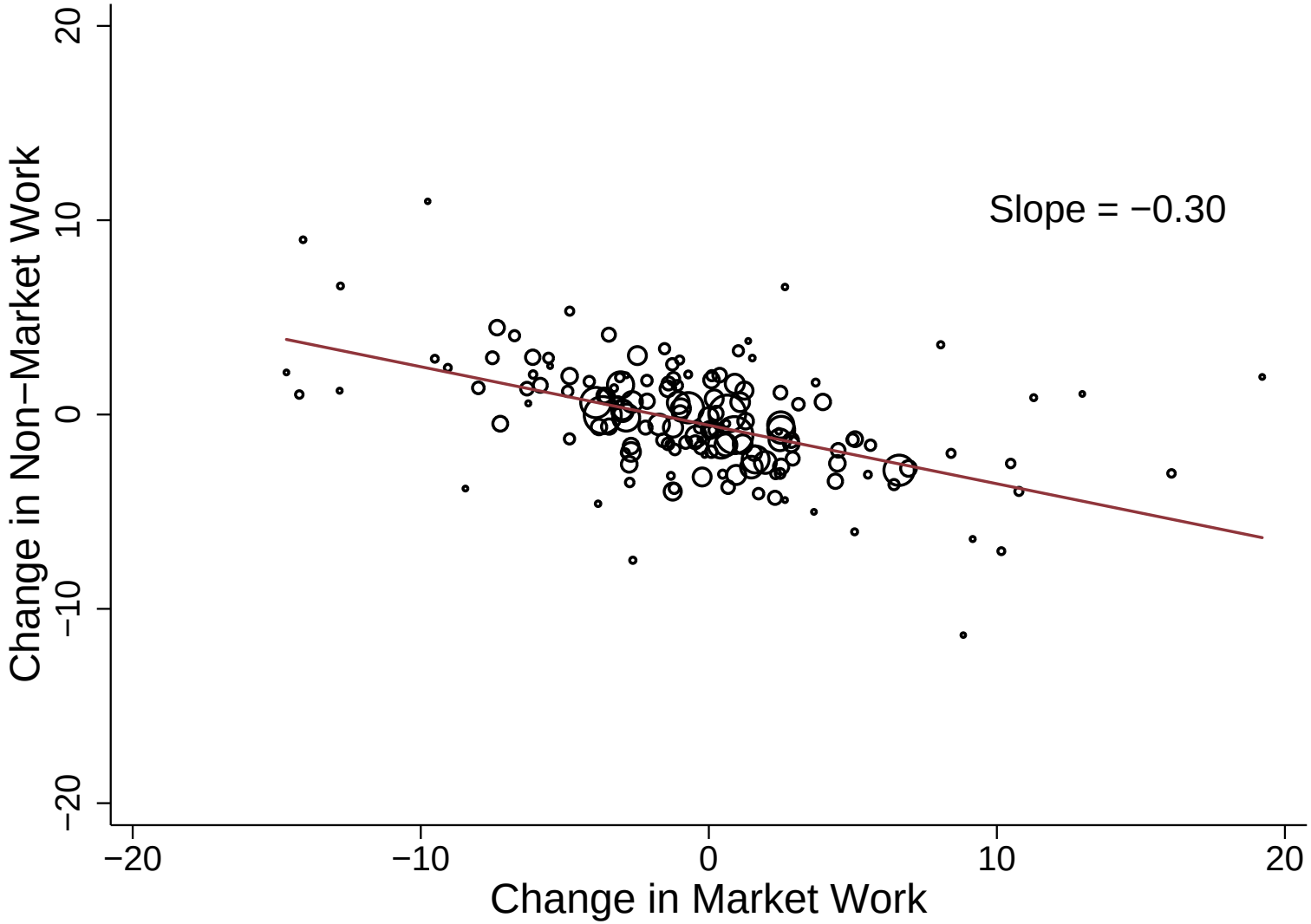
Notes: The Figure shows year-to-year estimates for average non-market work time for the whole sample, the sample of men and the sample of women. The sample consists of all respondents between 18 and 65 who completed the interview and whose activities could be classified by the ATUS staff.

Figure 4: Observed Time Use and Linear Trend of Time Use



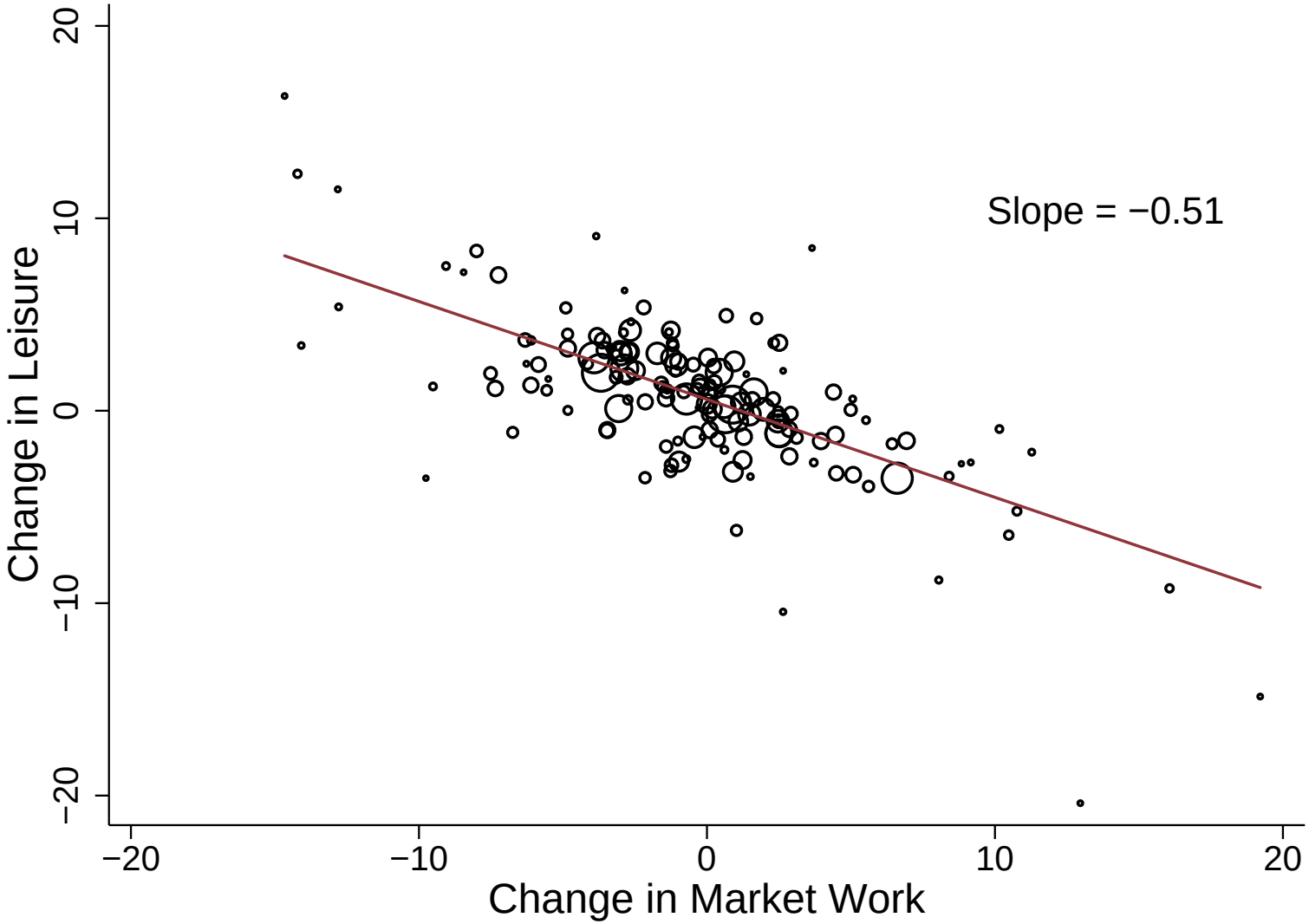
Notes: The solid line shows the year-to-year estimates for average market work, leisure and non-market work from the ATUS sample. The dashed line shows the linear trends in these time use categories. Specifically, we calculate a linear trend for each time use category based on the 2003-2008 period and then we extrapolate linearly to periods 2009 and 2010.

Figure 5: Cross State Variation: Non-Market Work vs. Market Work



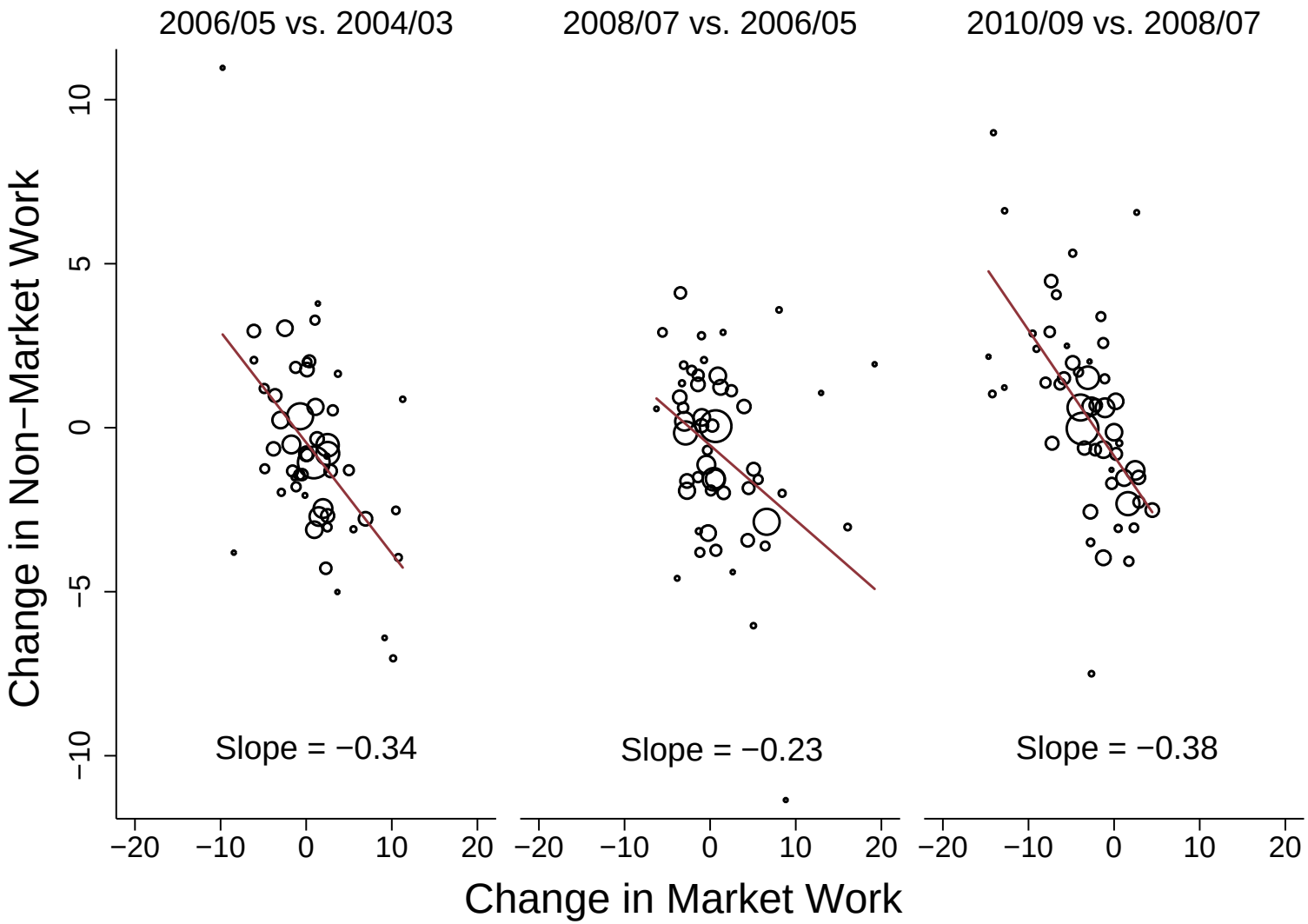
Notes: The horizontal axis shows changes in non-market work hours in the pooled sample of states. The vertical axis shows changes in market work hours in the pooled sample of states. States are weighted by population size.

Figure 6: Cross State Variation: Leisure vs. Market Work



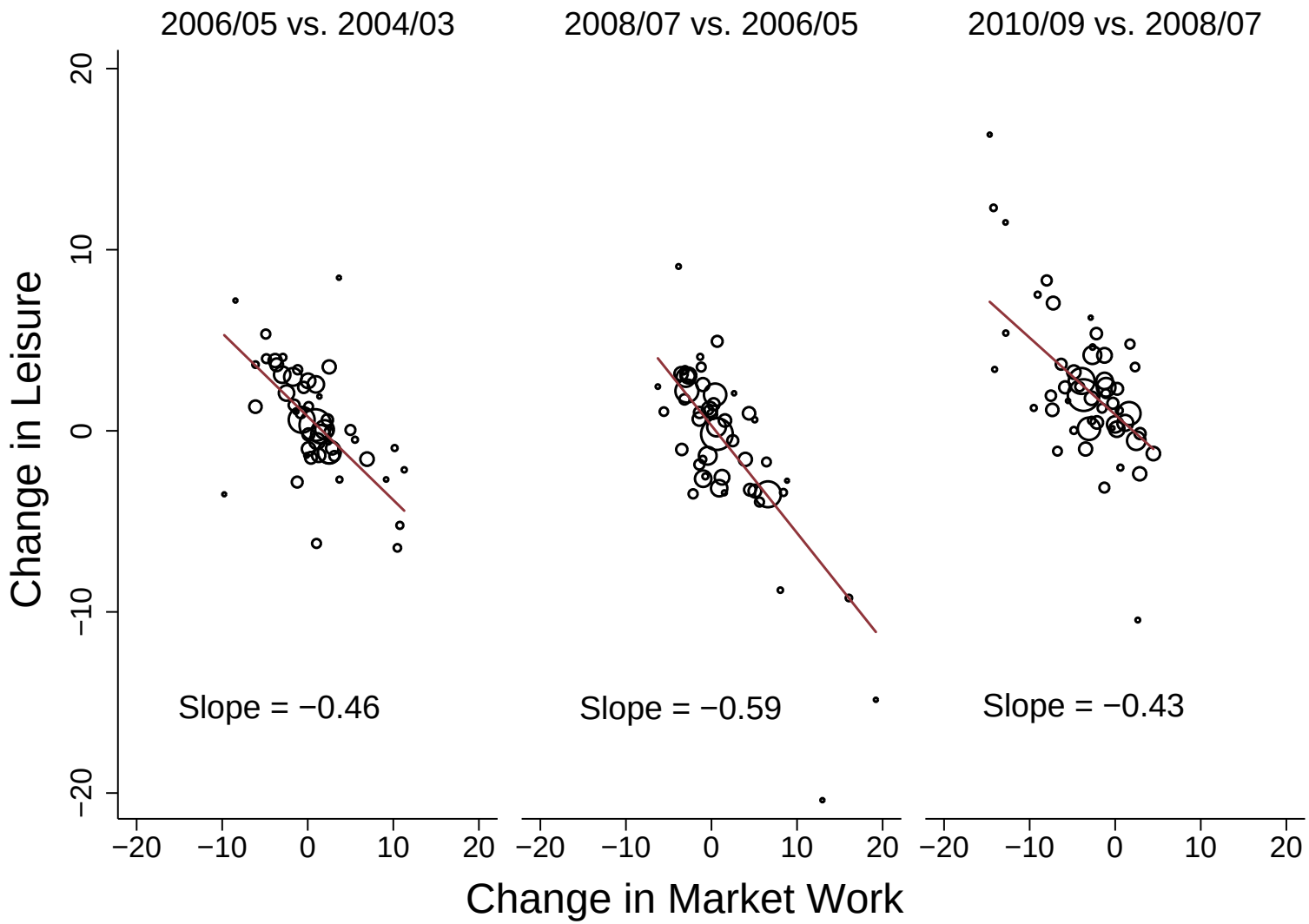
Notes: The horizontal axis shows changes in leisure hours in the pooled sample of states. The vertical axis shows changes in market work hours in the pooled sample of states. States are weighted by population size.

Figure 7: Cross State Variation by Period: Non-Market Work vs. Market Work



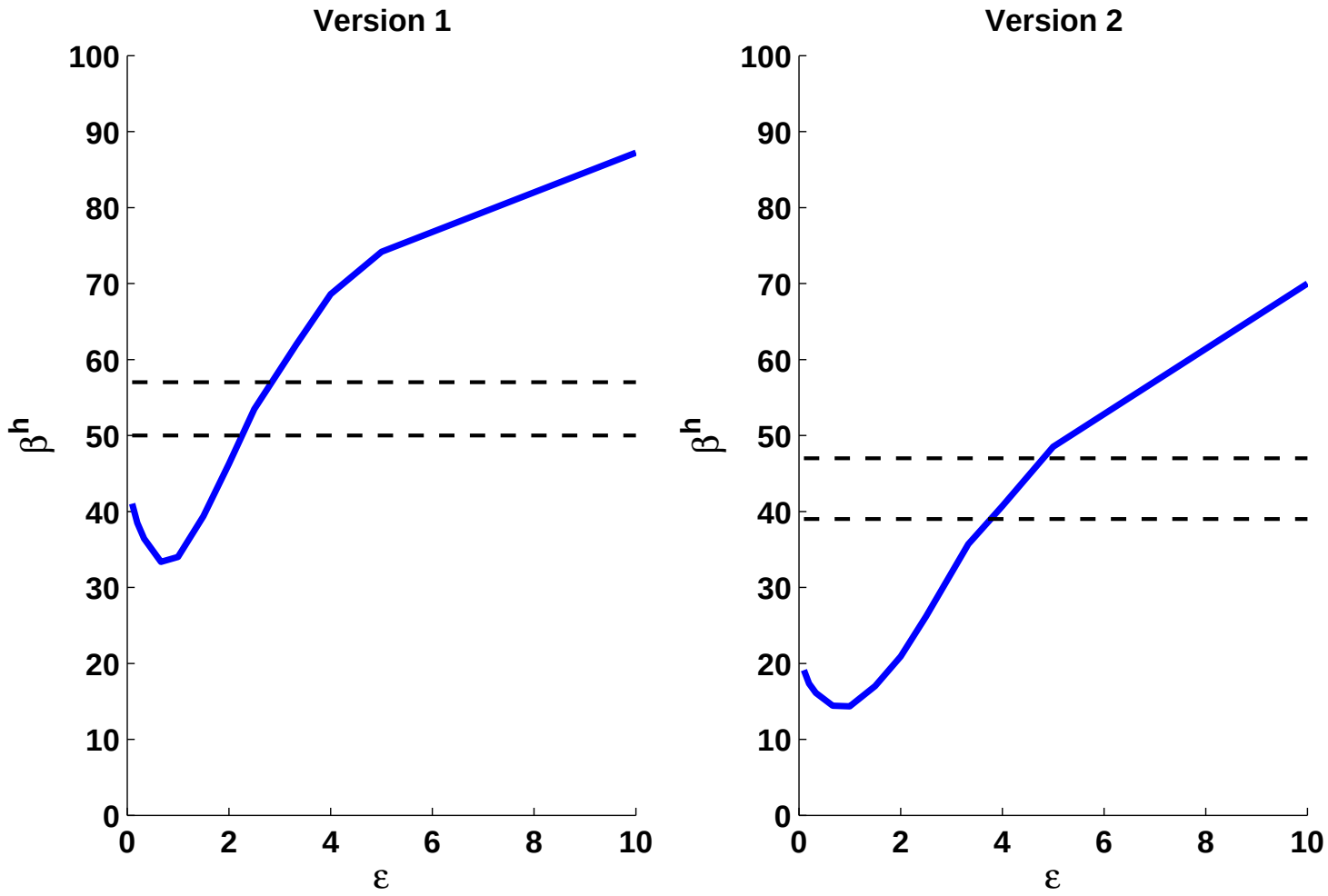
Notes: The horizontal axis shows changes in non-market work hours. The vertical axis shows changes in market work hours. Each panel represents a different time period. States are weighted by population size.

Figure 8: Cross State Variation by Period: Leisure vs. Market Work



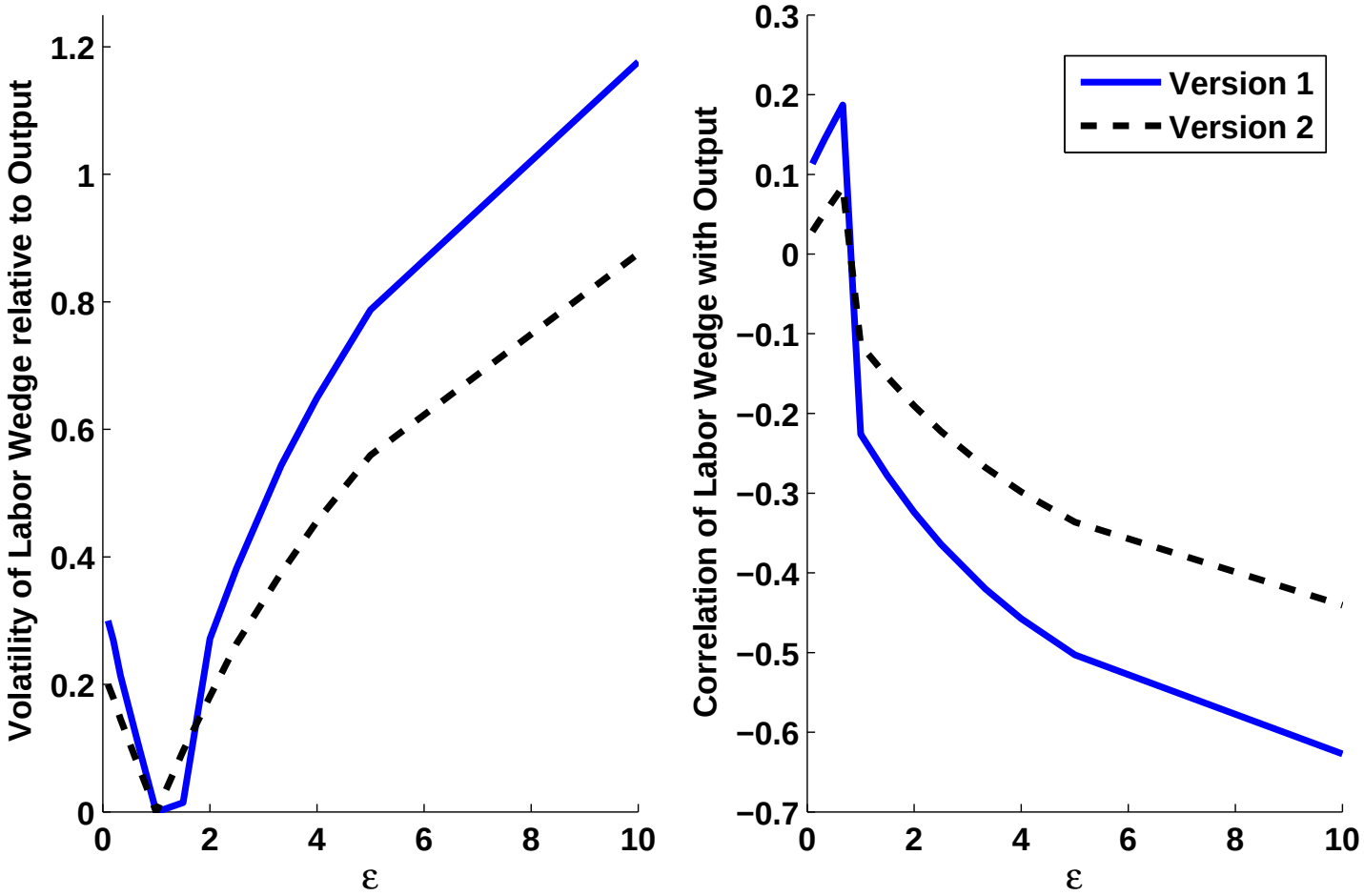
Notes: The horizontal axis shows changes in leisure hours. The vertical axis shows changes in market work hours. Each panel represents a different time period. States are weighted by population size.

Figure 9: Fraction of Foregone Market Time Allocated to Home Production vs. Elasticity of Substitution



Notes: The Figure shows the relationship between the fraction of time allocated to home production in response to foregone market work time in the model (measured by the coefficient β^h estimated by regression (14) with model-generated data) and the elasticity of substitution between market-produced and home-produced goods ($\epsilon = 1/(1-\rho)$). The left panel shows the first version of the model (i.e. when leisure excludes sleep, eating and personal care) and the right panel shows the second version of the model (i.e. when leisure includes these activities). The two horizontal dashed lines in each panel show the estimated β^h in the data. In particular, the lines correspond to the β^h estimated from the full sample (Table 5, column 1) and the sample of the recent recession (i.e. repeating the specification of column 1 of Table 5 only to the recent period).

Figure 10: Properties of the Labor Wedge in the Model



Notes: The Figure shows the relationship between the volatility of the model-generated labor wedge (vertical axis of left panel), the contemporaneous correlation of the model-generated labor wedge with output (vertical axis of right panel) and the elasticity of substitution between market-produced and home-produced goods ($\epsilon = 1/(1-\rho)$; in the horizontal axis). The relationship is shown both for first version of the model (i.e. when leisure excludes sleep, eating and personal care) and the second version of the model (i.e. when leisure includes these activities).

A Appendix

A.1 Definitions of Time Use Categories

In this Appendix we describe in detail how we classify the different activities into the time use categories used in the paper. To describe the categories we use the classifications in the American Time Use Survey (ATUS) Activity Lexicon. The Lexicon classifies activities into three tiers. The first tier includes broad categories of activities. The second tier includes sub-categories of the first tier and the third tier includes sub-categories of the second tier.

We use the following notation. When we say that some time use category includes all activities in "x-y-z," we mean that the time category includes all activities classified under the first tier "x," the second tier "y" and the third tier "z." When we say that some time category includes all activities in "x-y," we mean that the time category includes all activities classified under the first tier "x" and the second tier "y" (i.e. all third tier sub-categories of "y" are included). For example, our time use category "Other Income-Generating Activities" includes all activities in 05-03. This means that the user can find this time use under the first tier 05 ("Working and Work-Related Activities") and the second tier 03 ("Other Income-Generating Activities"). Since, for this particular time use category, we don't specify the third tier, this means that all third tier categories are included. In this specific example there are 5 third tier classifications. These are: 01: "Income-generating hobbies, crafts, and food"; 02: "Income-generating performances"; 03: "Income-generating services"; 04: "Income-generating rental property activities"; 99: "Other income-generating activities, n.e.c.."

There are some minor changes in the classification of the activities across the yearly surveys. With the exception of traveling time, these changes concern some additions or eliminations of activities classified in the third tier. These changes do not affect the codes reported below. Here we report the codes for the various time use categories using the 2010 Lexicon. For the 2003-2004 Lexicons, the user can find the travel categories under the first tier 17.

1. **Market Work:** Includes the codes 05-01, 05-02, 05-99, 18-05-01, 18-05-02, and 18-05-99.
2. **Other Income-Generating Activities:** Includes the codes 05-03, and 18-05-03.
3. **Job Search:** Includes the codes 05-04, and 18-05-04.
4. **Child Care:** Includes the codes 03-01, 03-02, 03-03, 04-01, 04-02, 04-03, 18-03-01, 18-03-02, 18-03-03, 18-04-01, 18-04-02, and 18-04-03.
5. **Non-Market Work:** This is the sum of the following sub-categories:

(a) **Core Home Production:** Includes the codes 02-01, 02-02, 02-03 excluding 02-03-01, 02-07, 02-08, 02-09 excluding 02-09-03 and 02-09-04, 02-99, 18-02-01, 18-02-02, 18-02-03, 18-02-07, 18-02-08, 18-02-09, and 18-02-99.

(b) **Home Ownership Activities:** Includes the codes 02-03-01, 02-04, 02-05, 18-02-04, and 18-02-05.

(c) **Obtaining Goods and Services:** Includes the codes 07, 08 excluding 08-04, 09, 10, 18-07, 18-08 excluding 18-08-04, 18-09, and 18-10.

(d) **Others Care:** Includes the codes 03-04, 03-05, 03-99, 04-04, 04-05, 04-99, 18-03-04, 18-03-05, 18-03-99, 18-04-04, 18-04-05, and 18-04-99.

6. **Leisure:** This is the sum of the following sub-categories:

(a) **TV Watching:** Includes the codes 12-03-03, and 12-03-04.

(b) **Socializing:** Includes the codes 12-01, 12-02, 12-03-07, 12-05-01, 12-05-02, 16, 18-12-01, 18-12-02, and 18-16.

(c) **Sleep:** Includes the code 01-01.

(d) **Eating and Personal Care:** Includes the codes 01-02, 01-04, 01-05, 01-99, 11, 18-01, and 18-11.

(e) **Other Leisure:** Includes the codes 02-06, 02-09-03, 02-09-04, 12-03 excluding 12-03-03 and 12-03-04 and 12-03-07, 12-04, 12-05 excluding 12-05-01 and 12-05-02, 12-99, 13, 18-02-06, 18-12 excluding 18-12-01 and 18-12-02, and 18-13.

7. **Other:** This is the sum of the following sub-categories:

(a) **Education:** Includes the codes 06, and 18-06.

(b) **Civic:** Includes the codes 14, 15, 18-14, and 18-15.

(c) **Own Medical:** Includes the codes 01-03, 08-04, and 18-08-04

(d) **Unclassified:** Includes the codes 50, 18-18, and 18-19.

For our base results, the sample includes only respondents between ages 18 and 65 with non-positive recorded time in the category "Unclassified." In Table A.4 we show that our results do not change meaningfully when we include all respondents in the sample.

A.2 Additional Results

Table A.1 presents summary statistics from the ATUS sample (18-65, excluding those whose answers could not be classified by the ATUS stuff) for all periods and by gender. Table A.2 shows the p-values associated with the unconditional and conditional differences in the time use categories between 2006-2008 and 2009-2010 for the full sample and for the sample of men. Table A.3 reports the standard errors and the p-values from the base specification of Table 5, column 1. Finally, Table A.4 presents a series of robustness exercises, explained in more detail in the text and the Table.

Table A.1: Summary Statistics of Time Use by Gender, 2003 - 2010

Time Use Category	All (1)	Men (2)	Women (3)
Market Work	31.62	37.12	26.10
Other Income-Generating Activities	0.18	0.17	0.19
Job Search	0.28	0.38	0.19
Child Care	4.65	2.89	6.42
Non-Market Work	18.12	14.13	22.12
- Core Home Production	9.45	5.69	13.22
- Home Ownership Activities	2.24	3.05	1.44
- Obtaining Goods and Services	5.05	4.04	6.06
- Others Care	1.36	1.34	1.39
Leisure	108.05	108.90	107.21
- TV Watching	17.60	19.28	15.91
- Socializing	7.68	7.33	8.03
- Sleeping	59.60	58.86	60.34
- Eating and Personal Care	13.32	12.87	13.77
- Other Leisure	9.84	10.54	9.14
Other	5.06	4.38	5.75
- Education	2.08	1.81	2.35
- Civic and Religious Activities	2.00	1.75	2.25
- Own Medical Care	0.97	0.81	1.14

Notes: The Table presents estimates of the average hours per week spent on each time use category by gender. The sample consists of all respondents between 18 and 65 who completed the interview and whose activities could be classified by the ATUS staff.

Table A.2: p-Values for Unconditional and Conditional Differences

Time Use Category	Unconditional (All) (1)	Conditional (All) (2)	Unconditional (Men) (3)	Conditional (Men) (4)
Market Work	0.000	0.000	0.000	0.000
Other Income-Generating Activities	0.045	0.043	0.080	0.086
Job Search	0.002	0.002	0.019	0.019
Child Care	0.427	0.901	0.242	0.107
Non-Market Work	0.435	0.702	0.437	0.446
- Core Home Production	0.972	0.528	0.685	0.763
- Home Ownership Activities	0.596	0.657	0.918	0.969
- Obtaining Goods and Services	0.096	0.084	0.439	0.454
- Others Care	0.544	0.529	0.426	0.397
Leisure	0.000	0.000	0.004	0.010
- TV Watching	0.000	0.000	0.007	0.010
- Socializing	0.987	0.911	0.968	0.900
- Sleeping	0.003	0.001	0.115	0.129
- Eating and Personal Care	0.621	0.818	0.617	0.649
- Other Leisure	0.554	0.999	0.703	0.959
Other	0.115	0.147	0.038	0.042
- Education	0.315	0.389	0.061	0.057
- Civic and Religious Activities	0.077	0.095	0.291	0.289
- Own Medical Care	0.919	0.957	0.742	0.785

Notes: The Table presents the p-values for the unconditional and conditional differences in the time use categories between the 2006-2008 average and the 2009-2010 average for the full sample and for the sample of men. Specifically, column 1 shows the p-value associated with the difference presented in column 4 of Table 1, column 2 shows the p-value associated with the difference presented in column 5 of Table 1, column 3 shows the p-value associated with the difference presented in column 4 of Table 2, and column 4 shows the p-value associated with the difference presented in column 5 of Table 2. All p-values are based on robust standard errors.

Table A.3: Standard Errors

Time Use Category	Estimate	S.E. (Cluster)	p-value	S.E. (Robust)	p-value
Other Income-Generating Activities	0.56	0.71	0.435	0.63	0.376
Job Search	0.97	0.63	0.132	0.65	0.139
Child Care	5.52	2.32	0.021	2.05	0.008
Non-Market Work	31.30	3.72	0.000	3.45	0.000
- Core Home Production	12.61	2.12	0.000	2.35	0.000
- Home Ownership Activities	6.82	3.13	0.034	2.58	0.009
- Obtaining Goods and Services	7.95	2.44	0.002	2.25	0.001
- Others Care	3.91	1.74	0.030	1.43	0.007
Leisure	49.76	4.58	0.000	4.12	0.000
- TV Watching	12.19	3.48	0.001	3.61	0.001
- Socializing	3.85	3.07	0.215	2.79	0.169
- Sleeping	20.55	4.36	0.000	3.84	0.000
- Eating and Personal Care	-2.28	2.75	0.411	2.29	0.322
- Other Leisure	15.44	3.97	0.000	3.50	0.000
Other	11.86	3.08	0.000	3.07	0.000
- Education	5.07	2.98	0.095	2.63	0.056
- Civic and Religious Activities	1.97	1.78	0.274	1.56	0.210
- Own Medical Care	4.82	1.77	0.009	1.59	0.003

Notes: The Table presents the estimated coefficients β^j and their standard errors in the base regression of the first column of Table 5 (i.e. the specification with the time trend only and no other controls). In the second column the standard errors are clustered at the state level. The fourth column presents robust standard errors for the pooled sample. The corresponding p-values associated with the null hypothesis that the estimated coefficient is zero are presented in columns 3 and 5 respectively.

Table A.4: Robustness Results

Time Use Category	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Other Income-Generating Activities	0.56	-0.32	0.44	0.10	0.27	0.21	0.39	0.26	0.53	0.35
Job Search	0.97	0.55	1.28	0.99	1.00	0.89	1.03	0.66	0.64	0.53
Child Care	5.52	6.39	4.25	3.86	5.65	5.03	4.14	4.21	4.15	3.78
Non-Market Work	31.30	27.47	29.30	28.99	31.09	29.97	30.61	33.71	28.20	25.75
- Core Home Production	12.61	14.21	11.36	12.12	11.64	11.32	10.98	15.18	10.03	9.63
- Home Ownership Activities	6.82	5.36	7.72	6.97	6.91	6.76	8.11	7.62	7.11	6.91
- Obtaining Goods and Services	7.95	6.43	5.25	5.67	8.90	9.03	6.79	7.62	7.90	7.00
- Others Care	3.91	1.46	4.96	4.21	3.63	2.84	4.71	3.27	3.14	2.19
Leisure	49.76	54.06	50.51	51.36	49.54	51.77	46.29	46.30	51.76	54.71
- TV Watching	12.19	15.24	14.09	16.68	13.51	11.09	15.36	18.96	14.39	11.94
- Socializing	3.85	8.87	2.21	4.47	2.76	3.06	2.32	5.09	1.39	0.89
- Sleeping	20.55	19.67	24.15	23.16	19.62	22.75	21.01	19.17	18.77	23.38
- Eating and Personal Care	-2.28	-0.60	-4.81	-3.82	-1.37	-0.62	-4.31	-2.95	-0.42	0.12
- Other Leisure	15.44	10.88	14.86	10.85	15.01	15.48	11.90	6.01	17.63	18.63
Other	11.86	11.83	14.19	14.67	12.42	12.11	17.51	14.82	14.69	14.84
- Education	5.07	7.01	7.78	5.83	5.82	5.71	11.61	6.75	9.59	9.66
- Civic and Religious Activities	1.97	2.03	1.21	1.90	2.03	1.56	0.91	0.95	1.71	0.92
- Own Medical Care	4.82	2.78	5.20	3.54	4.56	4.83	4.99	2.30	3.38	4.25

Notes: The Table presents the estimated coefficients β^j from regression (2). All coefficients are multiplied by 100. Column 1 repeats the benchmark specification of the first column of Table 5. Column 2 repeats the specification of column 1, but by using one-year periods instead of two-year periods. Column 3 repeats the specification of column 1, but in the full ATUS sample (i.e. including those aged 15-17 and 66-85), excluding respondents with unclassified answers. Column 4 repeats the specification of column 1, but in the full ATUS sample, including respondents with unclassified answers. Column 5 repeats the specification of column 1, with the addition of state-specific fixed effects. Column 6 repeats the specification of column 1, with the addition of state-specific time trends. Column 7 repeats the specification of column 3, with the addition of the demographic and economic controls. Column 8 repeats the specification of column 4, with the addition of the demographic and economic controls. Column 9 repeats the specification of column 5, with the addition of the demographic and economic controls. Column 10 repeats the specification of column 6, with the addition of the demographic and economic controls.