Cheap Thrills: the Price of Leisure and the Decline of Work Hours

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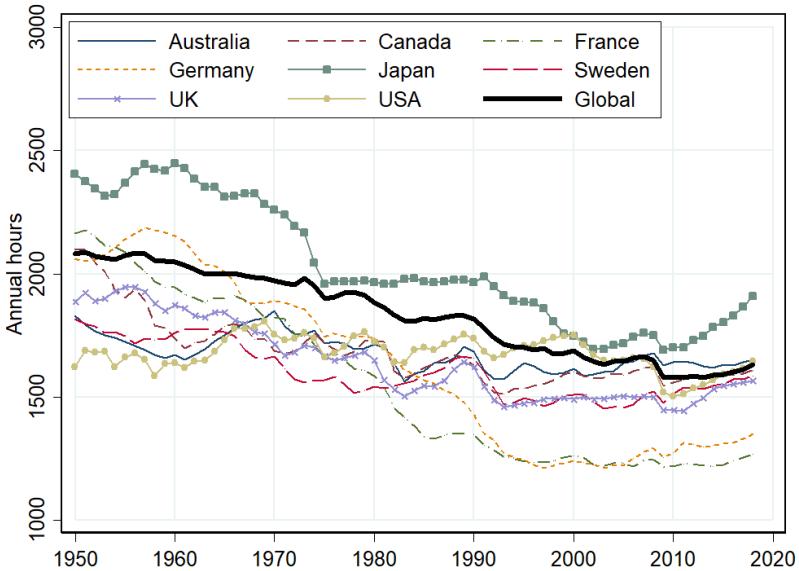
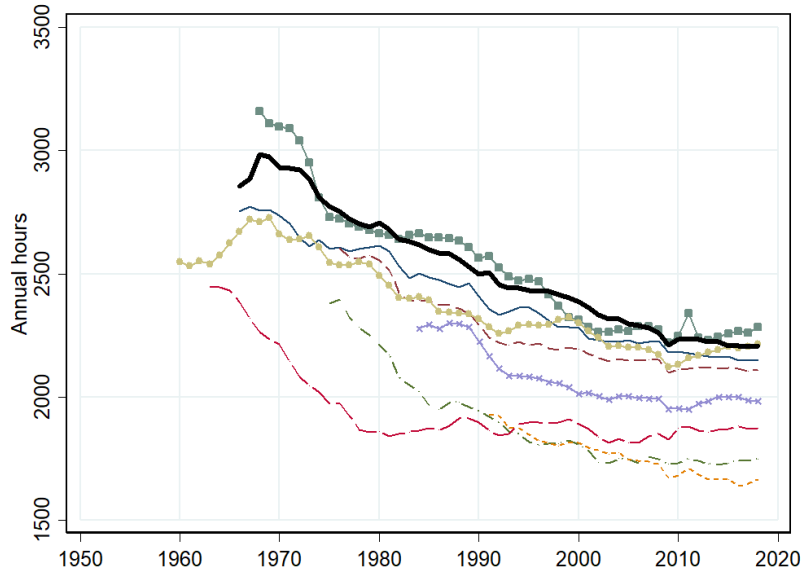
Motivation

- Large decline in hours worked in a cross-section of 42 countries
  - Hours per capita: average growth -0.37% per year
  - Hours per worker: average growth -0.60% per year

(a) Hours per capita



(b) Hours per worker

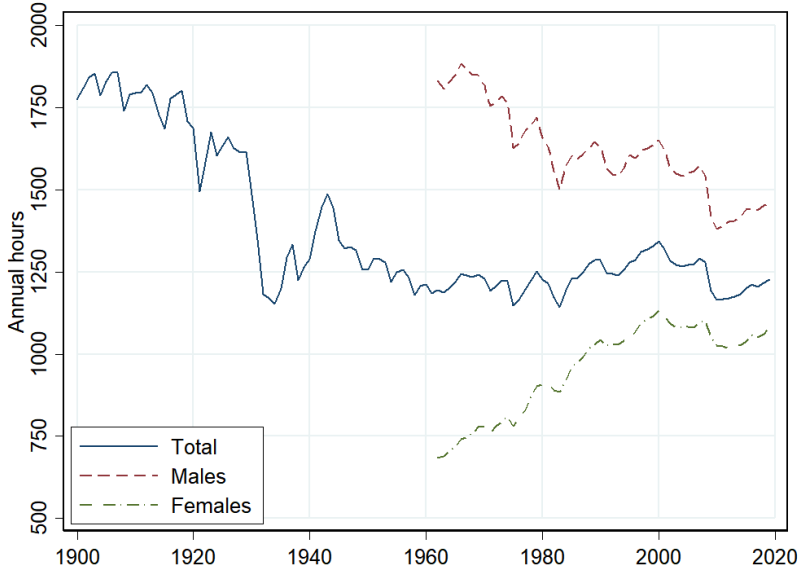


Bold black lines are year FEs from regressions on a set of country and year FEs, with all countries included. Regressions are weighted by total hours. Levels are normalized to all-country weighted averages in 2015. Panel (a): Annual hours worked over population between 25 and 64 years old. Panel (b): Annual hours worked over number of employed between 25 and 64 years old. Source: Total Economy Database and OECD.

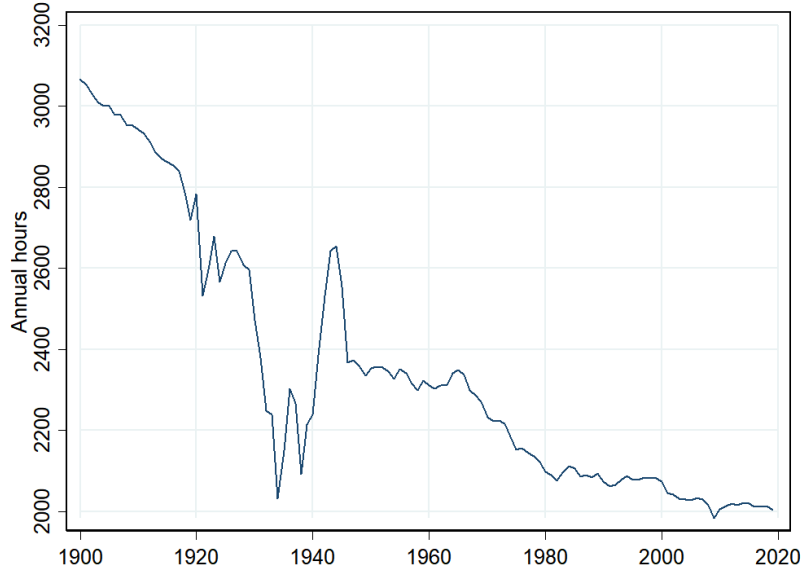
▸ All countries

Motivation: Closer look at the U.S.

(a) Hours per capita



(b) Hours per worker



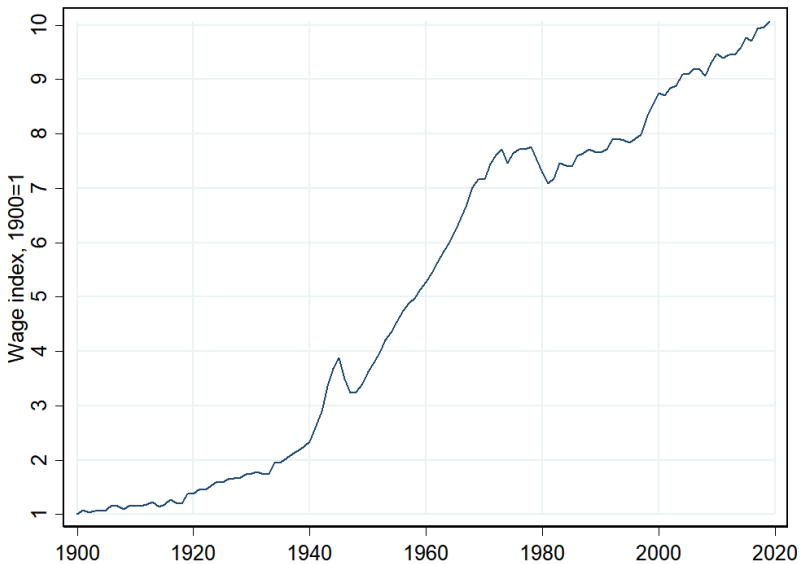
Panel (a): Annual hours worked over population of 20 years and older. Source: Kendrick et al., 1961 (hours, 1990-1947); Kendrick et al., 1973 (hours, 1948-1961); U.S. Census (population, 1900-1961); ASEC (total, male and female hours per capita, 1962-2019). Panel (b): Annual hours worked over number of employed. Source: Bureau of the Census, 1975 (1900-1947); FRED (1947-2019).

- Decline in market + nonmarket work hours for men and women also visible in time use survey data (Aguiar and Hurst, 2007) ▸ ATUS

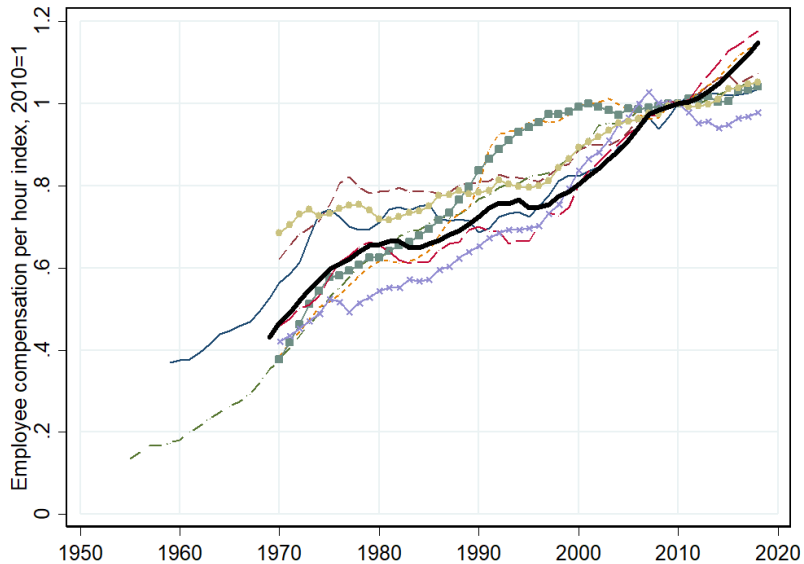
Motivation

- One explanation: Higher wages lead to fewer hours worked (Keynes, 1930)
  - Average growth rate: 2.45% per year
  - Boppart and Krusell (2020)

(a) Real wage, U.S.



(b) Real wage, cross-country

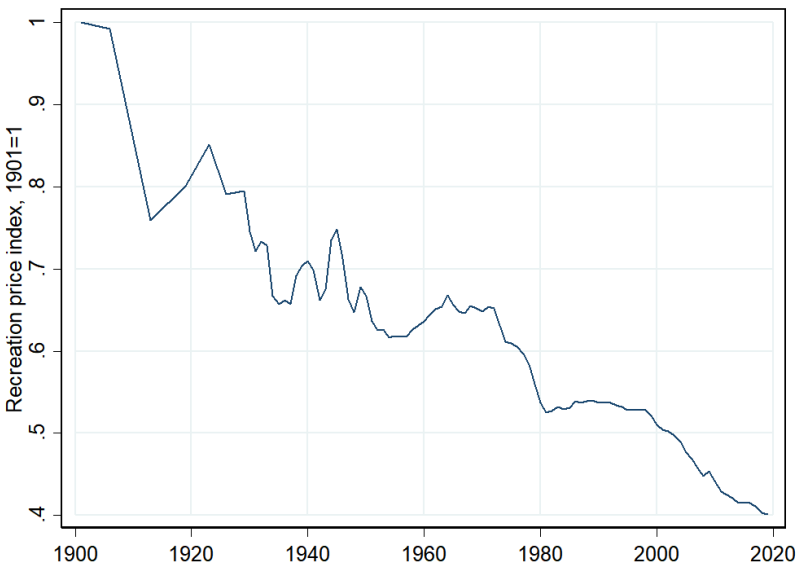


Panel (a): Real wage index for the U.S. Source: Kendrick et al., 1961 (real gross national product divided by hours, 1900-1929); FRED (real compensation of employees, divided by hours and CPI, 1929-2019). Panel (b): Real compensation of employees divided by hours worked. Bold black line is year FEs from regression on a set of country and year FEs, with all countries included. Regressions are weighted by total hours. Source: OECD and Total Economy Database.

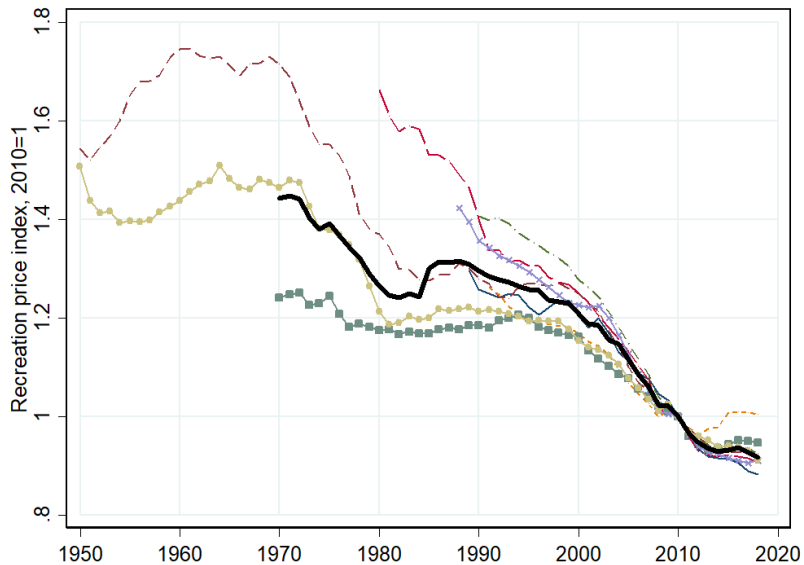
Motivation

- Alternative/complementary explanation: Leisure gets cheaper and better
  - Average growth rate of real recreation price: -1.48% per year

(a) Real recreation price, U.S.



(b) Real recreation price, cross-country



Panel (a): Real price of recreation goods and services for the U.S. Source: Owen, 1970 (real recreation price, 1900-1934); Bureau of the Census, 1975 (real price of category 'Reading and recreation', 1935-1966); BLS (real price of category 'Entertainment', 1967-1992); BLS (real price of category 'Recreation', 1993-2019). Panel (b): Price of OECD consumption category "Recreation and culture", normalized by price index for all consumption items. Bold black line is year FEs from regression on a set of country and year FEs, with all countries included. Regressions are weighted by total hours. Source: OECD, national statistical agencies.

Reduced form evidence: Cross-country

- Cross-country regression: $\Delta \log h_i = \beta_0 + \beta_p \Delta \log p_i + \beta_w \Delta \log w_i + \gamma X_i + \varepsilon_i$

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: Growth in hours per capita				
$\Delta \log p$	0.290**	0.291**	0.266**	0.291**	0.281**
	(0.109)	(0.110)	(0.106)	(0.110)	(0.110)
$\Delta \log w$					
GDP per hour	0.035			0.043	0.027
	(0.073)			(0.072)	(0.079)
Empl. comp. per hour		0.020			
		(0.065)			
GDP per capita			0.123**		
			(0.046)		
Female LF participation				0.068	
				(0.125)	
Share of young male					0.062
					(0.148)
R^2	0.124	0.118	0.256	0.134	0.129
Observations	42	42	42	42	42

Robust standard errors are in parentheses. *,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. All variables are in growth rates. Growth rates are annual averages over all years except for 2008 and 2009. Population includes individuals between 25 and 64 years old.

▸ Hours per worker ▸ 20 to 74 years old

Reduced form evidence: U.S.

- Simple OLS regressions might be subject to endogeneity issues
- Use disaggregated U.S. data to construct shift-share instruments for wages and recreation prices
- Standard Bartik IV for wages ▸ Details-1 ▸ Details-2
- Recreation price IV: variation in *types* of recreation items consumed across demographic groups together with *national* price movements of these items
  - Example: young less educated individuals consume a lot of audio-video items; decline in the national price of these items affects them disproportionately
- Data:
  - Census/American Community Survey data on wages and hours across 34 industries, 15 education/age groups, 741 commuting zones
  - CE Surveys data on recreation consumption (7 categories of recreation items, 15 education/age groups)
  - BLS data on recreation prices by categories

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Recreation price instrument

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$$\Delta \log p^{IV}_{g,1990-2016} = \sum_j \overbrace{\frac{c_{jg,1980}}{\sum_i c_{ig,1980}}}^{\text{initial shares}} \Delta \log p^{US}_{j,1990-2016}$$

  where c_{jg} is consumption of recreation of item j by demographic group g

- The shares are over 1980-1988; growth rates are between 1990 and 2016

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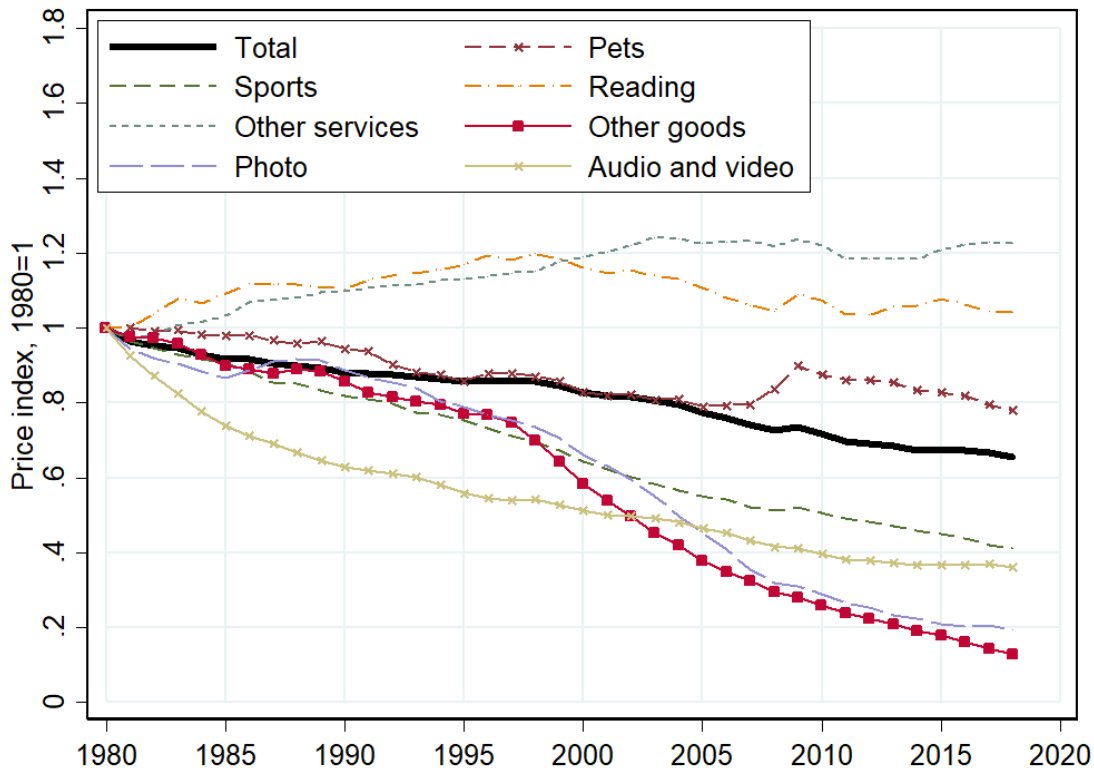
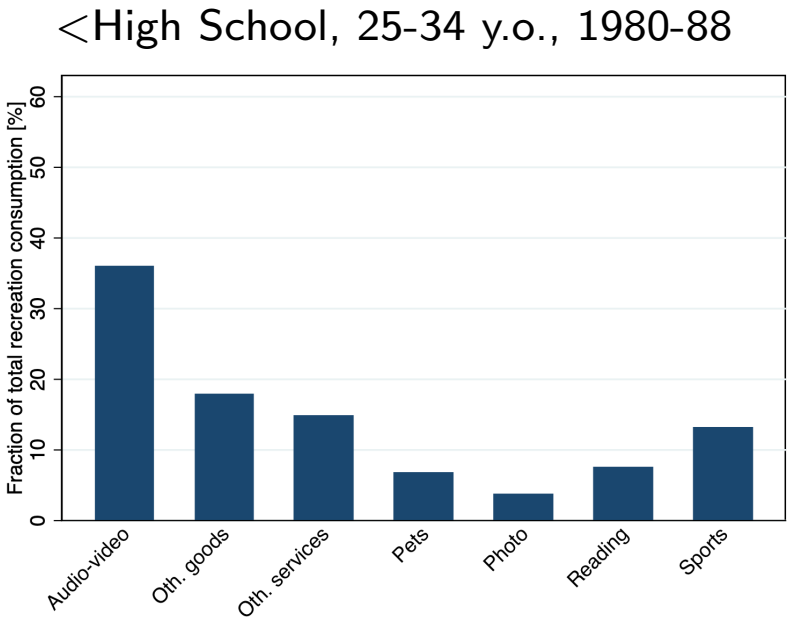
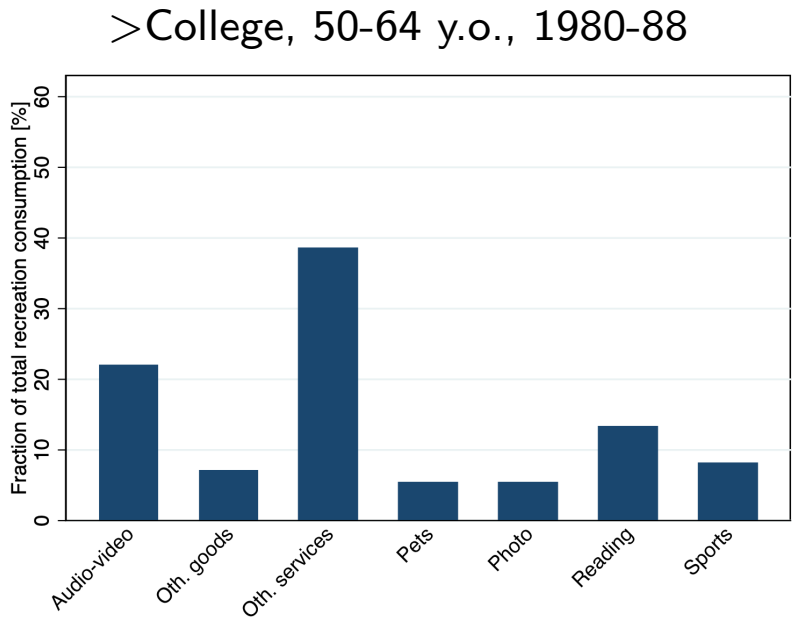


Real nationwide prices of various recreation goods and services. Source: BLS.

▸ Recreation items

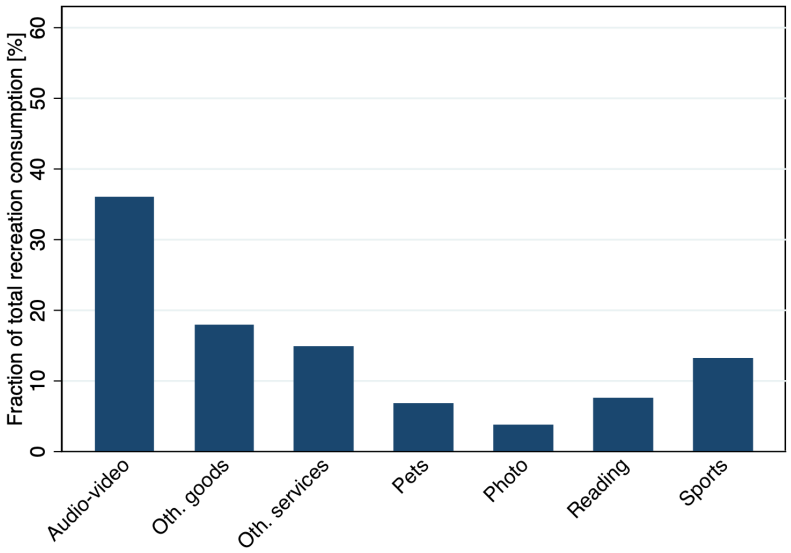
Recreation good bundles across groups, CE Surveys



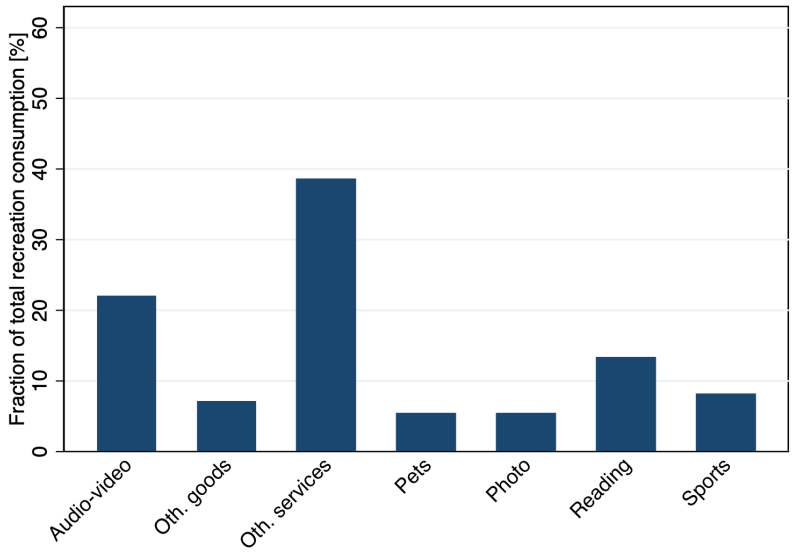


Recreation good bundles across groups, CE Surveys

<High School, 25-34 y.o., 1980-88



>College, 50-64 y.o., 1980-88



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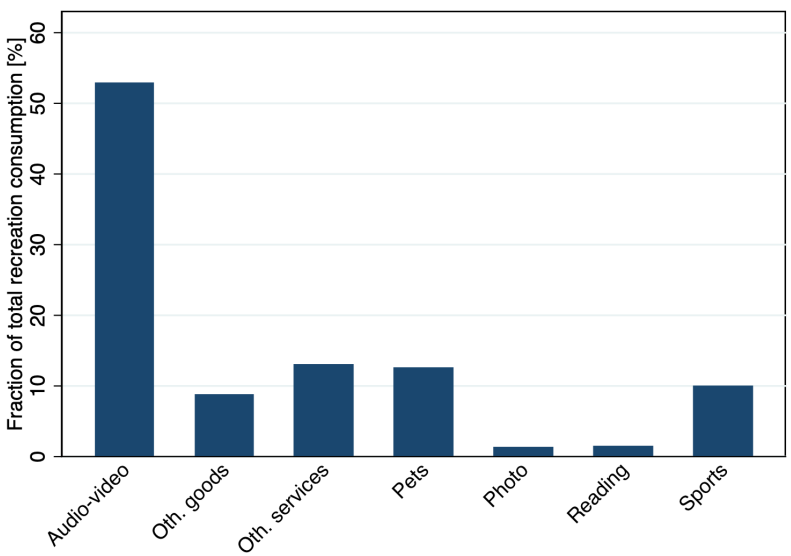

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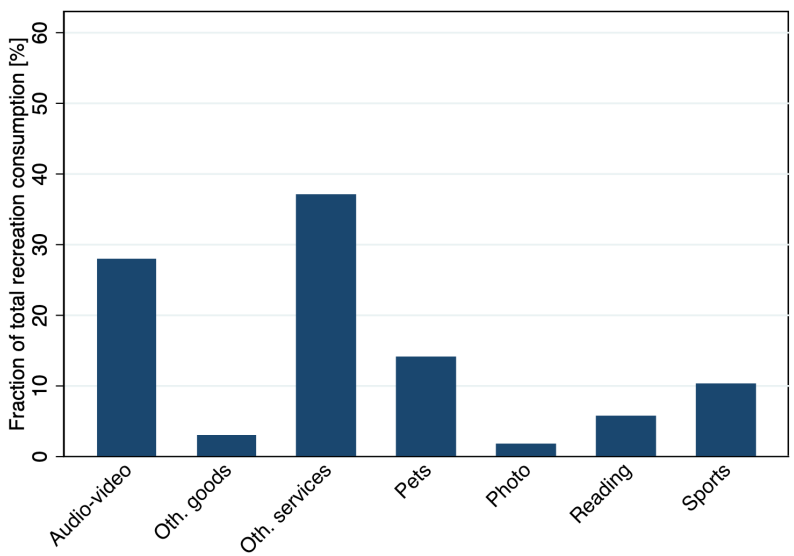
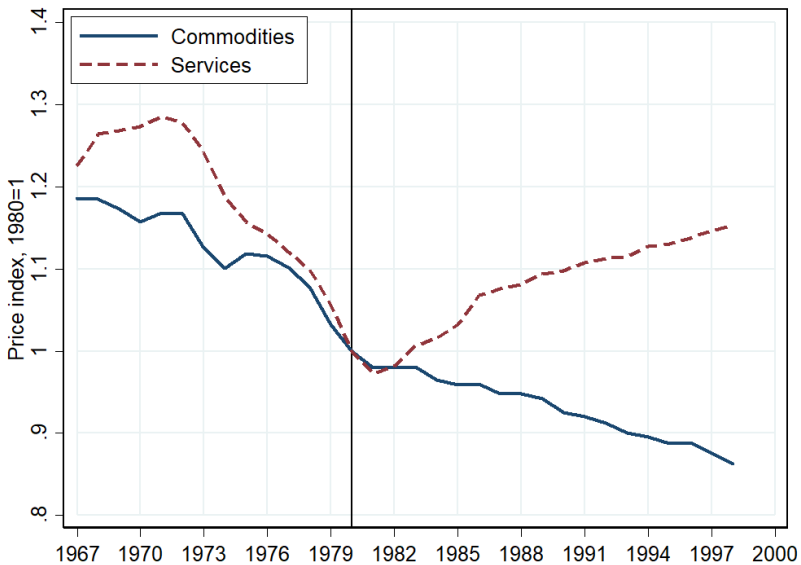
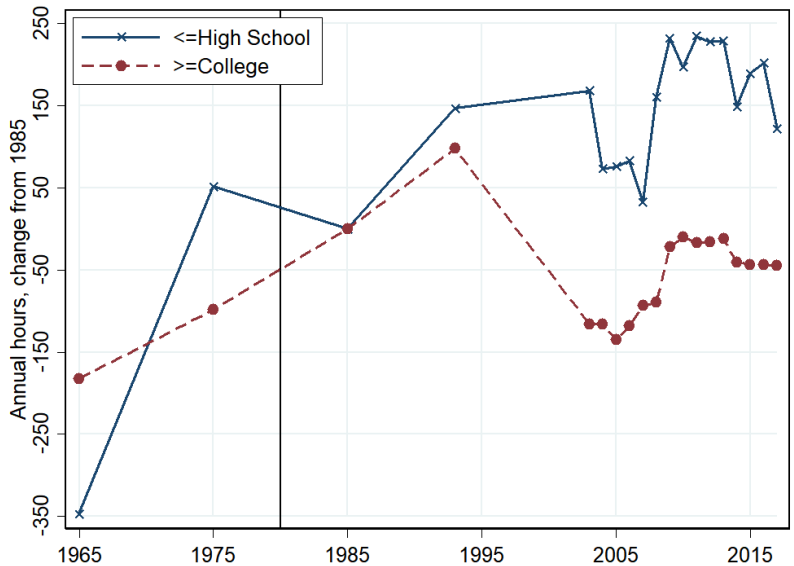


Pre-trends

(a) Recreation prices: Services vs Commodities



(b) Leisure hours by education



Vertical black lines denote the start of the detailed consumption and price data. Panel (a): Real U.S.-wide price of recreation commodities and services. Source: BLS. Panel (c): Leisure annual hours for individuals with no more than high school diploma and at least four years of college. Sample includes people between 16 and 64 years old who are not full-time students. Source: ATUS, Aguiar and Hurst (2007) and Aguiar, Bils, Charles, and Hurst (2017).

▸ Market hours

United States: IV regression

- Instrumental variable estimation in the cross-section only

$$\Delta \log h_{gl} = \beta_0 + \beta_p \Delta \log p_g + \beta_w \Delta \log w_{gl} + \gamma X_{gl} + \varepsilon_{gl}$$

  - g is demographic group, l is locality
  - X_{gl} include share of males, whites, married, people with disabilities

	(1): OLS	(2): OLS	(3): IV	(4): IV
	Dependent variable: Growth in hours per capita			
$\Delta \log p$	0.474***	0.204***	0.761***	0.466***
	(0.036)	(0.041)	(0.062)	(0.066)
$\Delta \log w$	−0.093***	−0.094***	−0.539***	−0.529***
	(0.013)	(0.013)	(0.070)	(0.068)
1980 manuf. hours		−0.285***		−0.286***
		(0.023)		(0.025)
Locality F.E.	Y	Y	Y	Y
Addtl. dem. cont.	Y	Y	Y	Y
F-statistics	—	—	124.7	124.8
R^2	0.452	0.469	—	—
Observations	10,469	10,469	10,469	10,469

Standard errors clustered at the locality level in parentheses. *,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. F-statistics are Kleibergen-Paap.

▸ Wage only ▸ Price only ▸ Household heads

Model: Setting

- Why do we need a model?
  - Are we estimating the correct relationships? How to interpret the coefficients?
  - Can we use other data to identify the coefficients more precisely?
- We build on a balanced growth path framework. Household solves

$$\max \sum_{t=0}^{\infty} \beta^t u\left(c_t, d_t, h_t\right)$$

$$\text{s.t. } c_t + p_t d_t + a_{t+1} = w_t h_t + a_t\left(1 + r_t\right)$$

c_t is non-recreation consumption, d_t is recreation consumption, p_t is (relative) recreation price, and h_t is hours worked

  - BGP assumptions on primitives:
    - p_t and w_t grow at constant rates γ_p and γ_w
    - interest rate $r_t > 0$ is constant
  - BGP outcomes: c_t, d_t and h_t grow at constant (but perhaps different) rates

▸ BGP U.S. ▸ Consumption shares ▸ Production

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Model: Main result

Proposition 1

The utility function $u(c, h, d)$ consistent with a BGP has to take the form

$$u(c,h,d) = \begin{cases} \frac{1}{1-\sigma}\left(c^{1-\varepsilon} d^{\varepsilon} v\left(c^{1-\eta-\tau} d^{\tau} h^{\eta}\right)\right)^{1-\sigma} & \text{if } \sigma \neq 1, \\ \log\left(c^{1-\varepsilon} d^{\varepsilon}\right) + \log\left(v\left(c^{1-\eta-\tau} d^{\tau} h^{\eta}\right)\right) & \text{if } \sigma = 1, \end{cases}$$

where v is an arbitrary function and where $\eta > 0$ and $\tau > 0$.

- Along the BGP, growth rates are related as follows

$$\log g_c = \eta \log \gamma_w + \tau \log \gamma_p$$
$$\log g_d = \eta \log \gamma_w + (\tau - 1) \log \gamma_p$$
$$\log g_h = (\eta - 1) \log \gamma_w + \tau \log \gamma_p$$

  - η and τ are **preference parameters**
  - Additional equations impose discipline on the estimation
  - These relations are invariant to a broad class of utility functions
    - King, Plosser, and Rebelo (1988) and Boppart and Krusell (2020) are special cases

▸ Definition ▸ Details ▸ Elasticities

Model: Main result

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▸ Definition ▸ Details ▸ Elasticities

Three equations: Cross-country

- Estimate the three-equation system implied by the model via GMM
- Allow for nonzero intercepts to capture factors that are omitted from the model (e.g. women labor force participation)

$$\Delta \log c_i = \alpha^c + \eta \Delta \log w_i + \tau \Delta \log p_i + \varepsilon_i^c$$
$$\Delta \log d_i = \alpha^d + \eta \Delta \log w_i + (\tau - 1) \Delta \log p_i + \varepsilon_i^d$$
$$\Delta \log h_i = \alpha^h + (\eta - 1) \Delta \log w_i + \tau \Delta \log p_i + \varepsilon_i^h$$

	(1)	(2)	(3)
τ	0.258***	0.225***	0.177**
	(0.078)	(0.080)	(0.074)
$\eta - 1$	−0.430***	−0.253***	−0.366***
	(0.071)	(0.052)	(0.052)
Wages	GDP per hour	Empl. comp. per hour	GDP per capita
Observations	41	41	41

Iterative GMM is used. Robust standard errors in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively. Variables are constructed using all years except for 2008 and 2009. Work hours are measured in per capita terms. Population includes individuals between 25 and 64 years old.

▸ Hours per worker ▸ 20 to 74 years old

Three equations: U.S.

- We can use shift-share instruments to estimate the three-equation system in a cross-section of U.S. households

$$\Delta \log c_g = \alpha^c + \eta \Delta \log w_{gl} + \tau \Delta \log p_g + \varepsilon^c_{gl}$$
$$\Delta \log d_g = \alpha^d + \eta \Delta \log w_{gl} + (\tau - 1) \Delta \log p_g + \varepsilon^d_{gl}$$
$$\Delta \log h_{gl} = \alpha^h + (\eta - 1) \Delta \log w_{gl} + \tau \Delta \log p_g + \varepsilon^h_{gl}$$

  - g is demographic group, l is locality

	(1)	(2)
τ	0.360^{***}	0.387^{***}
	(0.044)	(0.047)
$\eta - 1$	-0.629^{***}	-0.276^{***}
	(0.009)	(0.080)
Instruments	N	Y
Observations	10,469	10,469

Iterative GMM is used. Standard errors account for an arbitrary correlation within education-age groups and regions. They are reported in parentheses. *,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. Column (2) uses Bartik-like instruments for wages and recreation prices.

▸ Household heads

Literature

- **Trends in hours and leisure:** Prescott (2004), Greenwood and Vandenbroucke (2005), Rogerson (2006), Aguiar and Hurst (2007, 2009), Ramey (2007), Ramey and Francis (2009), Attanasio, Hurst, and Pistaferri (2014), Aguiar, Bils, Charles, and Hurst (2017), Boerma and Karabarbounis (2020)

- **Recreation prices and hours:** Owen (1971), Gonzalez-Chapela (2007), Vandenbroucke (2009), Kopecky (2011)

- **Balanced growth path with declining hours:** Ngai and Pissarides (2008), Boppart and Ngai (2017), Boppart and Krusell (2020)

Conclusion

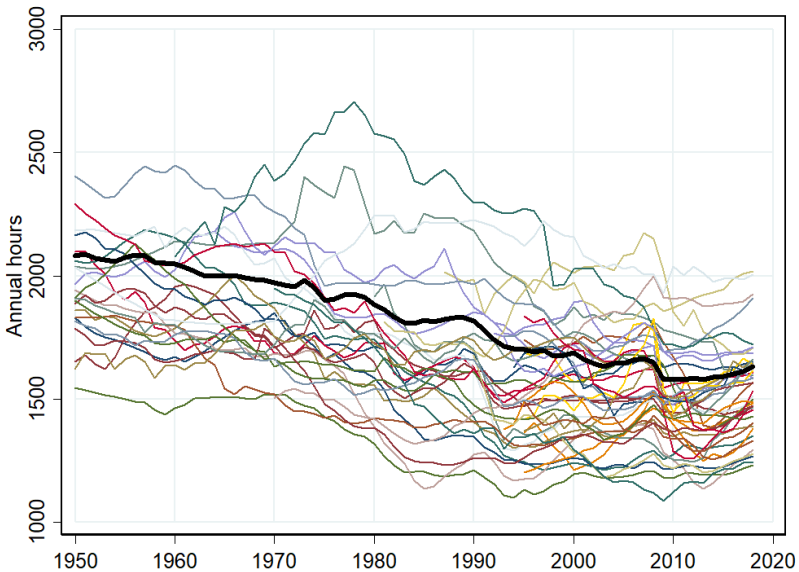
- We show that the decline in recreation prices is strongly associated with the decline in hours worked (reduced form and model estimation)
  - Dominating income effect in most specification
- We derive the general form that a utility function must take to be consistent with a BGP
- Our results are consistent with both cross-sectional facts (increase in leisure inequality) and long-run aggregate trends

▸ Back-of-the-envelope exercise

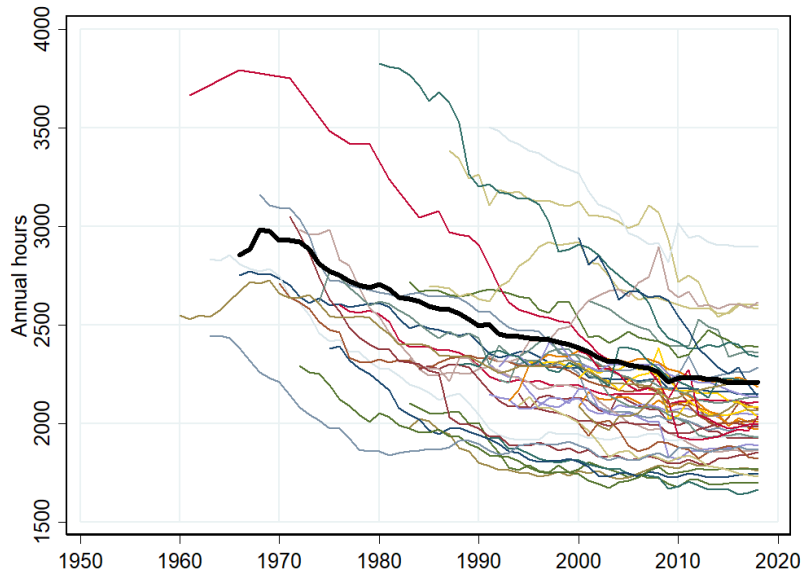
Appendix

Hours in all countries

(a) Hours per capita



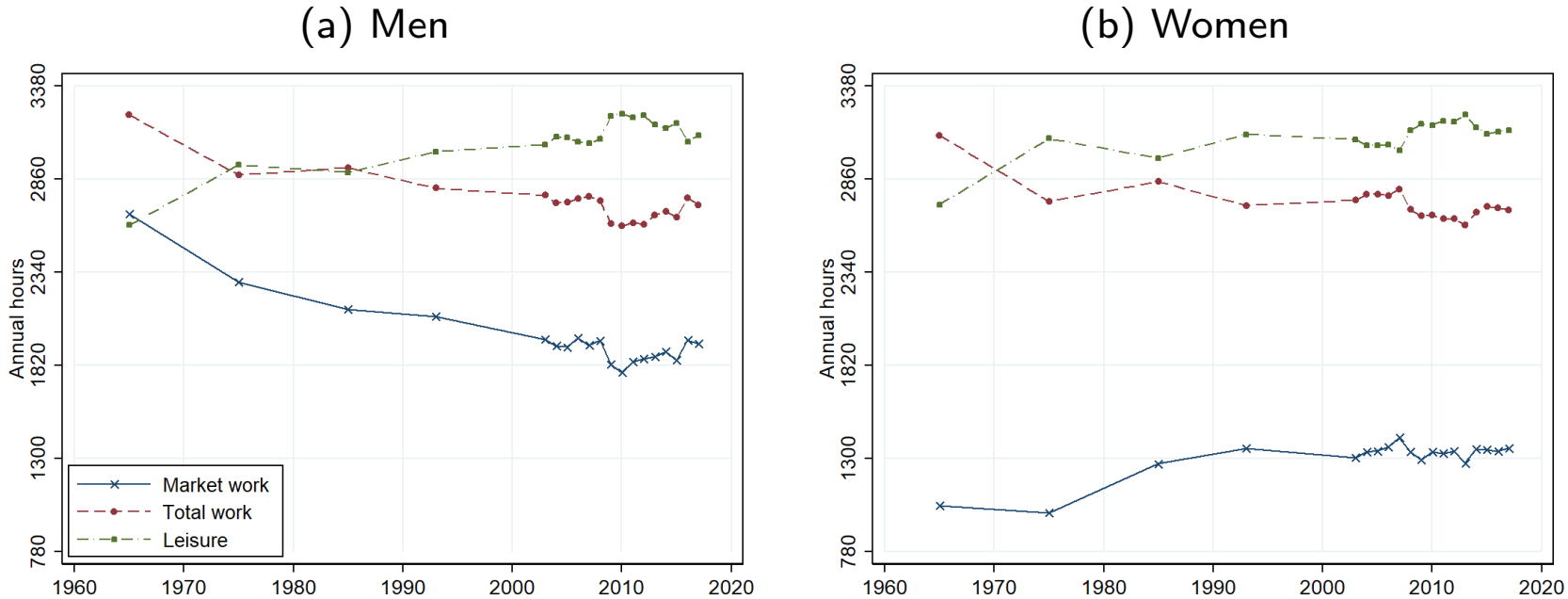
(b) Hours per worker



Bold black lines are year FEs from regressions on a set of country and year FEs, with all countries included. Regressions are weighted by total hours. Levels are normalized to all-country weighted averages in 2015. Panel (a): Annual hours worked over population between 25 and 64 years old. Panel (b): Annual hours worked over number of employed between 25 and 64 years old. Source: Total Economy Database and OECD.

◂ Back

American Time Use Surevy



Annual hours spent on market work, total work and leisure. Market work includes any work-related activities, travel related to work, and job search activities. Total work includes market work, home production, shopping, and non-recreational childcare. Leisure is any time not allocated to market and nonmarket work, net of time required for fulfilling biological necessities (8 hours per day). Sample includes people between 16 and 64 years old who are not full-time students. Source: ATUS, Aguiar and Hurst (2007) and Aguiar et al. (2017).

◂ Back

Cross-country evidence: Hours per worker

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: Growth in hours per worker				
$\Delta \log p$	0.128	0.127	0.136	0.130	0.146
	(0.106)	(0.109)	(0.110)	(0.103)	(0.109)
$\Delta \log w$					
GDP per hour	−0.049			−0.080**	−0.034
	(0.041)			(0.039)	(0.051)
Empl. comp. per hour		−0.025			
		(0.031)			
GDP per capita			−0.002		
			(0.031)		
Female LF participation				−0.274**	
				(0.103)	
Share of young male					−0.118
					(0.180)
R^2	0.072	0.051	0.040	0.334	0.104
Observations	41	41	41	41	41

Robust standard errors are in parentheses. *,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. All variables are in growth rates. Growth rates are annual averages over all years except for 2008 and 2009. Population includes individuals between 25 and 64 years old.

◂ Back

Cross-country evidence: Population between 20 and 74 years old

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: Growth in hours per capita				
$\Delta \log p$	0.234**	0.240**	0.210**	0.277**	0.229**
	(0.109)	(0.109)	(0.101)	(0.110)	(0.110)
$\Delta \log w$					
GDP per hour	0.071			0.063	0.069
	(0.074)			(0.075)	(0.075)
Empl. comp. per hour		0.051			
		(0.066)			
GDP per capita			0.148***		
			(0.043)		
Female LF participation				0.150	
				(0.206)	
Share of young male					0.039
					(0.222)
R^2	0.110	0.096	0.290	0.153	0.111
Observations	42	42	42	42	42

Robust standard errors are in parentheses. *,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. All variables are in growth rates. Growth rates are annual averages over all years except for 2008 and 2009. Population includes individuals between 20 and 74 years old.

◂ Back

Wage instrument

- Wage instrument: use variation in industry composition in location/demographic groups together with *national* movement in industry wages (Bartik, 1991)
- Example:
  - 25-34 years old with advanced degree in Ithaca work disproportionately in Education (not in Hong Kong or Philadelphia)
  - National movements in Education wages will affect their wages
- The instrument is

$$\Delta \log w_{gl}^{IV} = \sum_i \underbrace{\frac{e_{igl}^0}{\sum_j e_{jgl}^0}}_{\text{initial shares}} \Delta \log e_{ig}^{US} - \sum_i \underbrace{\frac{h_{igl}^0}{\sum_j h_{jgl}^0}}_{\text{initial shares}} \Delta \log h_{ig}^{US}$$

  where e is earnings, h is hours worked, i is an industry, g is a demographic group, and l is a locality

- Shares are computed in 1980; growth rates are computed between 1990 and 2016

◂ Back

Details for wage instrument

- Hours and earnings at the locality-demographic-industry level: data from the U.S. Census (years 1980 and 1990) and the Census' American Community Surveys (2014-2018 five-year sample, which we refer to as 2016)

- Individuals between the ages of 25 and 64. Split into 15 demographic groups based on age (25-34 years old, 35-49 years old, 50-64 years old) and education (less than high school, high school, some college, four years of college, more than college)

- 34 industries. We construct initial industry shares (the base year) using the data for 1980; growth rates are then constructed by comparing 1990 outcomes to their 2016 counterparts

◂ Back

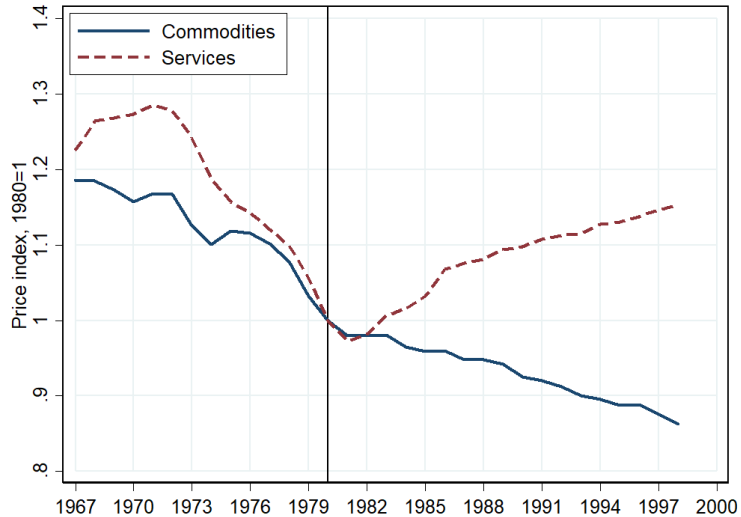
BLS: Basket of recreation goods and services

- **Video and audio**
  - Televisions; cable and satellite television service; other video equipment; video discs and other media; including rental of video; audio equipment; recorded music and music subscriptions
- **Pets, pet product and services**
  - Pets and pet products; pet services including veterinary
- **Sporting goods**
  - Sports vehicles including bicycles; sports equipment
- **Photography**
  - Photographic equipment and supplies; photographers and photo processing
- **Other recreational goods**
  - Toys; sewing machines, fabric and supplies; music instrument and accessories
- **Other recreation services**
  - Club membership for shopping clubs, fraternal, or other organizations, or participant sports fees; admissions; fees for lessons or instructions
- **Recreation reading materials**
  - Newspapers and magazines; recreational books

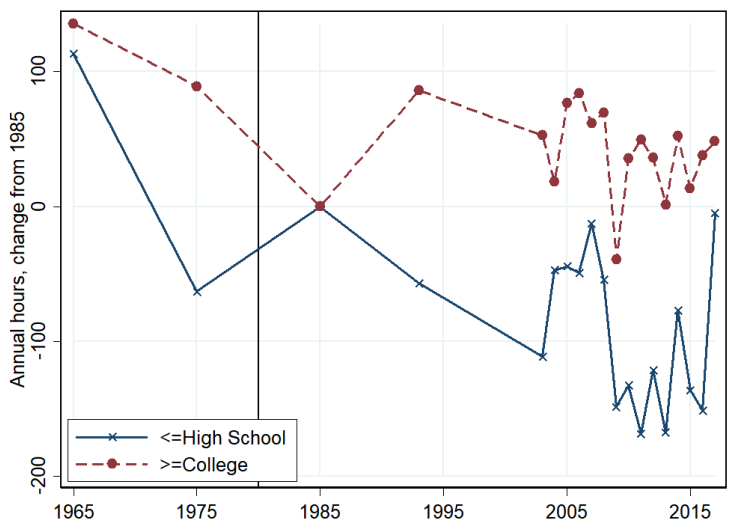
◂ Back

Pre-trends:Market hours

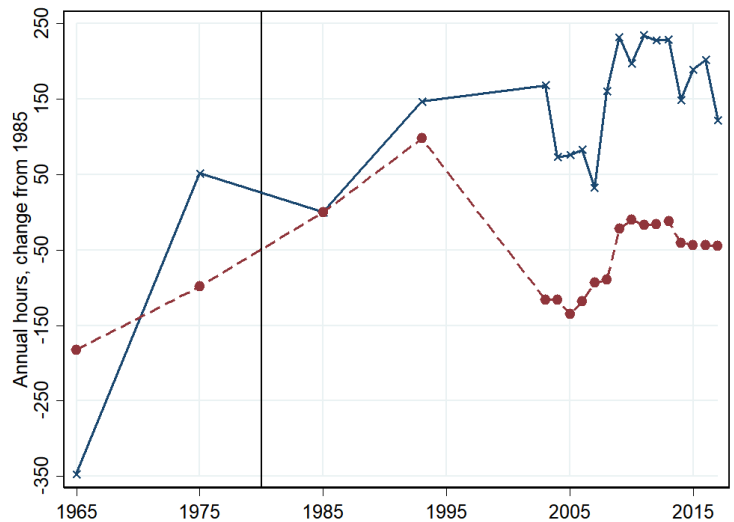
(a) Recreation prices:
Services vs Commodities



(b) Market work hours by education



(c) Leisure hours by education



Vertical black lines denote the start of the detailed consumption and price data. Panel (a): Real U.S.-wide price of recreation commodities and services. Source: BLS. Panels (b) and (c): Market and leisure annual hours for individuals with no more than high school diploma and at least four years of college. Sample includes people between 16 and 64 years old who are not full-time students. Source: ATUS, Aguiar and Hurst (2007) and Aguiar, Bils, Charles, and Hurst (2017).

◂ Back

Regressions with wage only

	(1): OLS	(2): OLS	(3): IV	(4): IV
	Dependent variable: Growth in hours per capita			
$\Delta \log w$	-0.063^{***}	-0.084^{***}	0.094^{***}	-0.196^{***}
	(0.013)	(0.013)	(0.042)	(0.046)
1980 manuf. hours		-0.336^{***}		-0.353^{***}
		(0.019)		(0.021)
Locality F.E.	Y	Y	Y	Y
Addtl. dem. cont.	Y	Y	Y	Y
F-statistics	—	—	379.4	320.9
R^2	0.435	0.467	—	—
Observations	10,469	10,469	10,469	10,469

Standard errors clustered at the locality level in parentheses. *,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. F-statistics are Kleibergen-Paap.

◂ Back

Regressions with recreation price only

	(1): OLS	(2): OLS	(3): IV	(4): IV
	Dependent variable: Growth in hours per capita			
$\Delta \log p$	0.420***	0.151***	0.494***	0.226***
	(0.035)	(0.041)	(0.037)	(0.043)
1980 manuf. hours		−0.284***		−0.264***
		(0.023)		(0.023)
Locality F.E.	Y	Y	Y	Y
Addtl. dem. cont.	Y	Y	Y	Y
F-statistics	—	—	>1,000	>1,000
R^2	0.446	0.463	—	—
Observations	10,469	10,469	10,469	10,469

Standard errors clustered at the locality level in parentheses. *,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. F-statistics are Kleibergen-Paap.

◂ Back

Regressions on the household-head level

	(1): OLS	(2): IV	(3): OLS	(4): IV
	Dependent variable: Growth in hours per capita			
	All household heads		Married only	
$\Delta \log p$	0.350***	0.533***	0.491***	0.593***
	(0.034)	(0.065)	(0.028)	(0.041)
$\Delta \log w$	−0.080***	−0.343***	−0.066***	−0.232***
	(0.013)	(0.067)	(0.012)	(0.051)
1980 manuf. hours	−0.126***	−0.169***	−0.099***	−0.124***
	(0.020)	(0.025)	(0.019)	(0.022)
Locality F.E.	Y	Y	Y	Y
Addtl. dem. cont.	Y	Y	Y	Y
F-statistics	—	82.8	—	103.2
R^2	0.409	—	0.393	—
Observations	9.458	9,458	8,233	8,233

Standard errors clustered at the locality level in parentheses. *,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. F-statistics are Kleibergen-Paap.

◂ Back

Production

The model is agnostic about how prices are determined in equilibrium. One way to close the model:

- Two competitive industries producing non-leisure c and leisure d goods

$$\max_{k_{jt}, l_{jt}} p_{jt} A_{jt} l_{jt}^{\alpha} k_{jt}^{1-\alpha} - w_t l_{jt} - R_t k_{jt}$$

  - $p_{ct} = 1$: non-leisure good is numeraire

- Competitive industry produces investment goods

$$\max_{k_{it}} \underbrace{p_{it} A_{it} k_{it}}_{=y_{it}} - R_t k_{it}$$

- Law of motion of aggregate capital: $K_{t+1} = y_{it} + (1 - \delta) K_t$

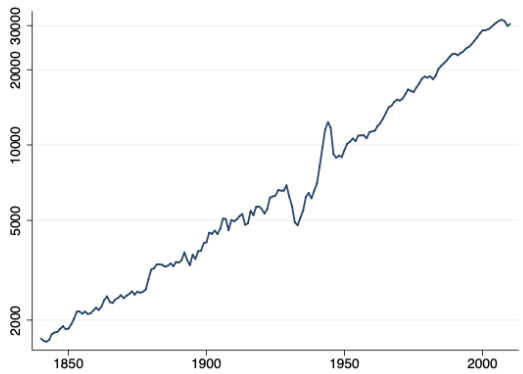
Proposition 2

The growth rates of p_{dt} and w_t are

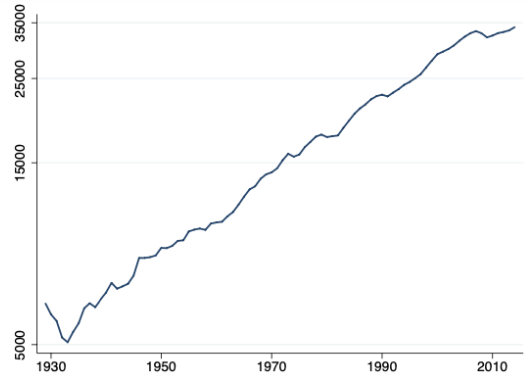
$$\log \gamma_p = \log \gamma_{A_c} - \log \gamma_{A_d},$$
$$\log \gamma_w = \alpha \log \gamma_{A_c}.$$

◂ Back

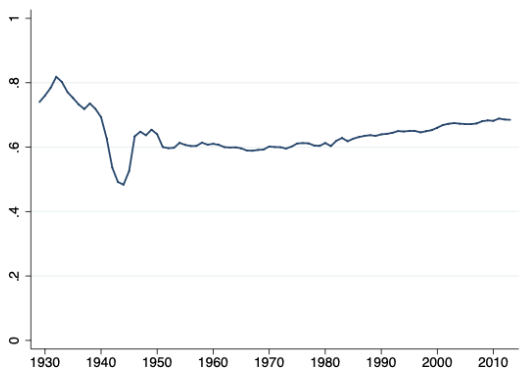
BGP facts: U.S.



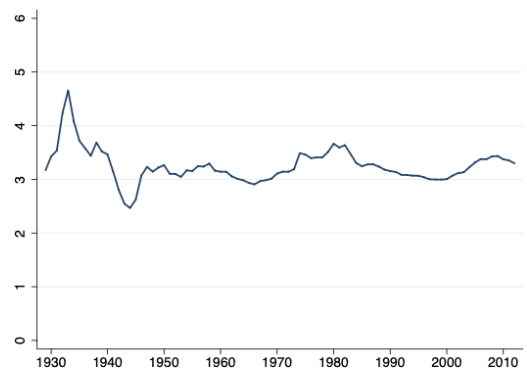
(a) GDP per capita



(b) Consumption per capita



(c) Consumption-output ratio



(d) Capital-output ratio

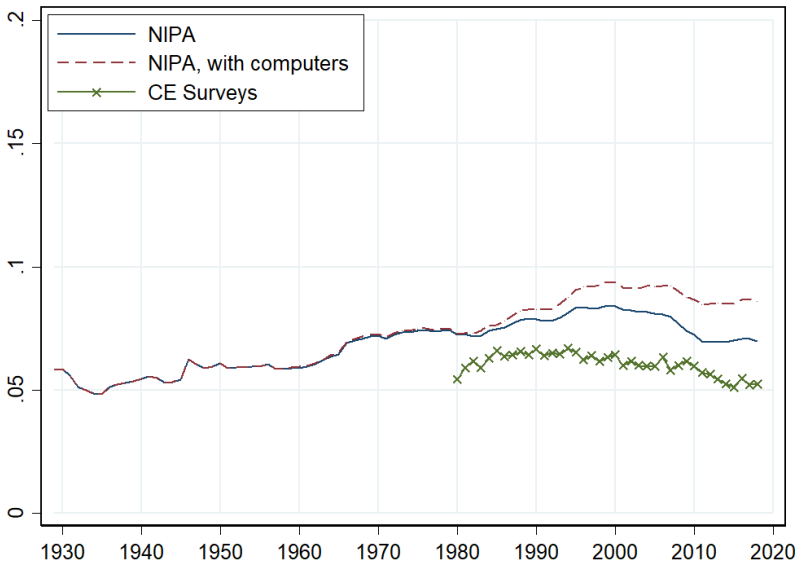
Source: Boppart and Krusell (2020), BEA and Maddison project.

◀ Back

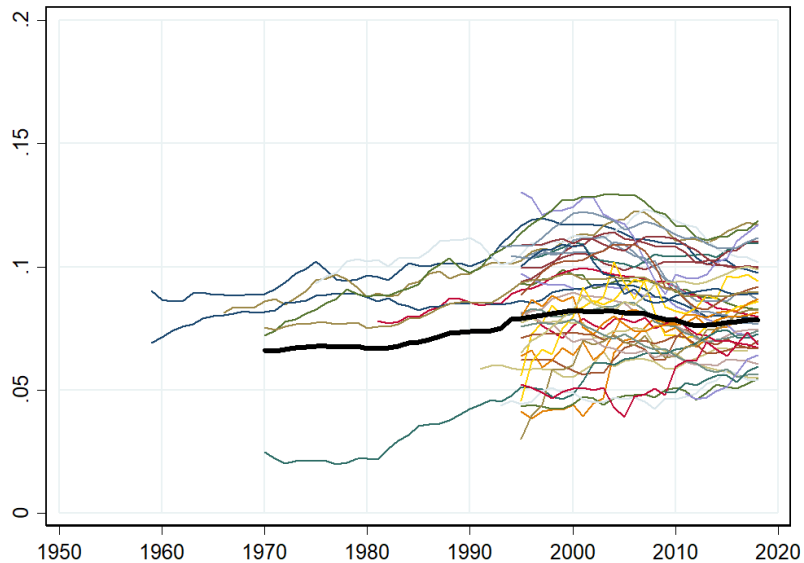
BGP facts: Recreation consumption share

- In addition to standard BGP assumptions, our model implies constant recreation consumption shares

(a) Recr. cons. share, U.S.



(b) Recr. cons. share, cross-country



Panel (a): Fraction of recreation consumption in total consumption for the United States. Source: NIPA and CE Surveys. Panel (b): Fraction of recreation consumption in total consumption in the international sample. Bold black line is year FEs from regression on a set of country and year FEs, with all countries included. Regressions are weighted by total hours. Level is normalized to all-country weighted average in 2015. Source: OECD.

◂ Back

Definition 1 (Balanced-growth path preferences)

The utility function u is consistent with a balanced-growth path if it has the following properties: for any $w > 0$, $p_d > 0$, $c > 0$, $\gamma_w > 0$ and $\gamma_{p_d} > 0$, there exist $h > 0$, $d > 0$ and $r > -1$ such that for any t

$$-\frac{u_h\left(c\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau}\right)^t, h\left(\gamma_w^{\eta-1}\gamma_{p_d}^{\tau}\right)^t, d\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau-1}\right)^t\right)}{u_c\left(c\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau}\right)^t, h\left(\gamma_w^{\eta-1}\gamma_{p_d}^{\tau}\right)^t, d\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau-1}\right)^t\right)} = w\gamma_w^t,$$

$$\frac{u_d\left(c\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau}\right)^t, h\left(\gamma_w^{\eta-1}\gamma_{p_d}^{\tau}\right)^t, d\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau-1}\right)^t\right)}{u_c\left(c\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau}\right)^t, h\left(\gamma_w^{\eta-1}\gamma_{p_d}^{\tau}\right)^t, d\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau-1}\right)^t\right)} = p_d\gamma_{p_d}^t,$$

$$\frac{u_c\left(c\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau}\right)^t, h\left(\gamma_w^{\eta-1}\gamma_{p_d}^{\tau}\right)^t, d\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau-1}\right)^t\right)}{u_c\left(c\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau}\right)^{t+1}, h\left(\gamma_w^{\eta-1}\gamma_{p_d}^{\tau}\right)^{t+1}, d\left(\gamma_w^{\eta}\gamma_{p_d}^{\tau-1}\right)^{t+1}\right)} = \beta\left(1+r\right),$$

where $\eta > 0$ and $\tau > 0$.

Back

Elasticities

- Frisch elasticity is constant along the BGP

$$\epsilon = \frac{1}{h} \frac{u_h u_{cc}}{u_{hh} u_{cc} - u_{hc}^2} = f\left(c^{1-\eta-\tau} h^{\eta} d^{\tau}\right)$$

Back

Model

- The budget constraint

$$c_t + p_{dt} d_t + a_{t+1} = w_t h_t + a_t (1 + r_t)$$

  imposes restrictions on growth rates

$$g_c = \gamma_{p_d} g_d = \gamma_w g_h$$

- Another restriction must come from preferences
  - King et al. (1988): $g_c = \gamma_w$
  - Boppart and Krusell (2020): $g_c = \gamma_w^{1-\nu}$
  - Here: $g_c = \gamma_w^{\eta} \gamma_{p_d}^{\tau}$, where η and τ are constants

- Putting the restrictions together:

$$\begin{aligned} g_c &= \gamma_w^{\eta} \gamma_{p_d}^{\tau}, \\ g_h &= \gamma_w^{\eta-1} \gamma_{p_d}^{\tau}, \\ g_d &= \gamma_w^{\eta} \gamma_{p_d}^{\tau-1}. \end{aligned}$$

◂ Back

Three equations: Cross-country with hours per worker

	(1)	(2)	(3)
τ	0.454***	0.558***	0.121
	(0.154)	(0.165)	(0.109)
$\eta - 1$	−0.388***	−0.211***	−0.531***
	(0.058)	(0.041)	(0.055)
α^h	0.008***	0.006***	0.005***
	(0.002)	(0.002)	(0.002)
Wages	GDP per hour	Empl. comp. per hour	GDP per capita
Observations	40	40	40

Iterative GMM is used. Robust standard errors in parentheses. *,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. Variables are constructed using all years except for 2008 and 2009. Work hours are measured in per worker terms. Population includes individuals between 25 and 64 years old.

◂ Back

Three equations: Cross-country with population between 20 and 74 years old

	(1)	(2)	(3)
τ	0.246^{***}	0.165^{**}	0.183^{**}
	(0.084)	(0.075)	(0.081)
$\eta - 1$	-0.426^{***}	-0.205^{***}	-0.382^{***}
	(0.068)	(0.042)	(0.053)
α^h	0.012^{***}	0.006^{***}	0.010^{***}
	(0.002)	(0.002)	(0.002)
Wages	GDP per hour	Empl. comp. per hour	GDP per capita
Observations	41	41	41

Iterative GMM is used. Robust standard errors in parentheses. * ,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. Variables are constructed using all years except for 2008 and 2009. Work hours are measured in per capita terms. Population includes individuals between 20 and 74 years old.

◂ Back

Three equations: U.S. on the household-head level

	(1)	(2)	(3)	(4)
	All household heads		Married only	
τ	0.424***	0.379***	0.493***	0.500***
	(0.100)	(0.101)	(0.104)	(0.107)
$\eta - 1$	−0.635***	0.200***	−0.669***	−0.596***
	(0.007)	(0.098)	(0.014)	(0.099)
α^h	0.003	0.003	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Instruments	N	Y	N	Y
Observations	9,458	9,458	8,233	8,233

Iterative GMM is used. Standard errors account for an arbitrary correlation within education-age groups and regions. They are reported in parentheses. *,** ,*** indicate significance at the 10%, 5%, and 1% levels, respectively. Columns (2) and (4) use Bartik-like instruments for wages and recreation prices.

◂ Back

Back-of-the-envelope calculation

- Preference parameters: $\tau \approx 0.2$, $\eta \approx 0.7$
- Cross-country average growth rates: $\log \gamma_p = -1.48\%$ and $\log \gamma_w = 2.45\%$
- Predicted hours growth rate: $\log \hat{g}_h = 0.2 \times (-1.48\%) + (1 - 0.7) \times 2.45\% = -1.03\%$
- In the data, $\log g_h^{\text{per capita}} = -0.37\%$ and $\log g_h^{\text{per worker}} = -0.60\%$
- Other factors: women in the labor force, demographic changes, etc.

◂ Back

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