The changing returns to the long workweek and the trends in the aggregate hours worked

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Abstract

The average length of the workweek and the prevalence of long work hours has risen over the past decades. I point out that this empirically well-documented trend is compatible with a simple model of the labor market where workers use education and hours of work for signaling. I demonstrate that the long hours premium, i.e. the additional compensation for an hour of work over a certain threshold, has increased for the respondents of the National Longitudinal Survey of Youth between the two cohorts (1979 and 1997) of the survey.

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Contents

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1 Introduction and motivation

While it is typically the responsiveness of the hours of work to some other factors (most notably, the wage) that has been examined by labor economists, the change in the total number of work hours is also an economically important phenomenon. The often cited prediction of John Maynard Keynes about the 15-hour workweek has certainly not come true in any of the industrialized nation and the discontent with seemingly endless and expanding workweeks has found its way even to the popular press (e.g. Eyres, 2013; Kolbert, 2014).

In this paper I show how the phenomenon of the expanding workweek is compatible with a model where long work hours are used as a signaling device. If college graduation increases secularly (for example, due to skill-biased technological change or to the growing ease of gathering information and financing higher education), this may lead to a drop in the average quality of the graduating cohort – either because the marginal college student is of lower ability than before or because the increased use of scarce educational resources (Carneiro and Lee, 2011, especially section V).[1] Given a drop in the average quality of college graduate, more employees may find profitable to put in longer hours, thereby signaling her own higher ability. This may explain why the return of putting in long hours has increased recently.

This paper is related to several strands in the literature. First, it attempts at providing a framework to understand the historical changes in work hours. In general, the average amount of time spent with working has been decreasing over time during the past century mildly. However, while the trend in the aggregate number of hours has more or less flattened out, this masks a large reallocation of the time spent with working, most notably from men to women, whose labor force participation grew dramatically over the least decades. Additionally, younger cohorts seem to work less, but this is offset by the additional education they tend to take (Ramey and Francis, 2009). The general falling trend in work hours seems to have stopped and reversed to some extent, especially in a couple of segments of the labor market. Kuhn and Lozano (2008) devote an entire paper for this phenomenon. They show

[1] Hendricks and Schoellman (2014) also find important compositional changes in the US higher education over the last century.

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that the fraction of salaried full-time men working more than 50 hours a week increased from 24% to 32% between 1979 and 2000. (Kuhn and Lozano, 2008, Table 1). They also highlight that what happened was not only a shift in the total number of hours worked, change in the characteristics of employees working longer than average hours. Most notably, higher educated, well-paid young and middle-aged men seem to have increased their working time the most. While in the past it was mostly the lower-skilled and lower-payed workers who put in longer hours, recently it is the highly-skilled and well-payed employees who choose to supply more labor in a given week or year than before. The share of full-time salaried men working more than 50 hours a week increased the most in the highest earnings quintile, where it rose from 15% to about 30% between 1979 and 2000. In contrast, the lowest income quintile registered a smaller but still pronounced drop from 22% to 15%.

Historical data also exhibits similar characteristics: the annual work hours of a contemporary professional is closer to the work hours of a 19th century laborer than to those of a 20th century worker. (Fogel, 1994, 385). This trend is more pronounced if one takes a larger time horizon. Costa (1998) uses data from the end of the 19th century to show that while in the 1890's the ratio between the daily work hours of a man at the 90th and a man in the 10th percentile of the hourly wage distribution was 0.81, it has increased to 1.08 by 1991.[2] Costa (2000) revisits the data and puts forward some tentative explanations why this may be the case, citing (among others) the possibly greater returns for working in prime age. These papers also provide support for the observation that a large chunk of these changes went on between the 1970's and the 1990's.

Secondly, this paper is closely related to studies analyzing the effect of work hours on wages. Some well-known theoretical contributions are more than two decades old, such as the paper of Landers, Rebitzer and Taylor (1996), who model a law firm where associates with heterogeneous preferences toward leisure can be promoted to partners, therefore eligible for profit sharing. To avoid free-riding (that is, to reach a separating equilibrium), associates work longer than optimal hours to differentiate

[2] Going back to the 18th century, Vries (1994) hypothesizes that it is the increase of family labor supply, together with changing consumption pattern in the period, that accounts for much of what we think of as industrial revolution, therefore the term industrious revolution therefore would be more in order.

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themselves from leisure-loving agents.

A more recent empirical study (Gicheva, 2013) using data from a survey taken by GMAT participant finds that there exists a cutoff of weekly working hours above which the length of the workweek and long-term annual wage-growth are positively correlated. This relationship is not present at lower, "normal" workweeks (that is, under the cutoff). She uses model in which employees are characterized by both learning-by-doing and heterogeneous preferences towards leisure which results in a sorting of workers between career-oriented jobs (with high hours) and normal jobs (with regular hours). To tell the two effects apart, she compares the premium of long workweeks between the employed and self-employed workers, finding that an additional hour of work has larger positive impact on the long-run salary growth for employed than for self-employed workers.

Goldin (2014) also highlights the importance of long hours as a factor behind the gender wage gap. She studies the evolution of the gender wage differences and concludes that the final closure of the gender wage gap is hindered not by the lack of bargaining power of women or by the fact that females tend to be less competitive for promotions; but it mainly persists because in some sectors workers have a payment scheme that is convex in hours (i.e. the last hour comes with a larger marginal wage than the first hours). This practice is more wide-spread in occupations where employees interact with clients or colleagues, or they take up managerial roles (business and law), as opposed to fields where these job traits are less common (technology or health). Heterogeneity among jobs is a central feature of Mansour (2012), who shows that the extent of employer learning, measured by the growth of variance of wage residuals (after controlling for basic demographic characteristics) differs widely among occupations. His results give back roughly the same classification of jobs as Goldin (2014).

In a similar fashion, career interruptions can also explain some part of the gender wage gap, since they also translate into a relative lack of time spent at the workplace. Bertrand, Goldin and Katz (2010) study the evolution of the gender wage among business school graduates. They find that males and females earn quite similarly at the start of their career, however about a decade after graduation female MBA

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holders reduce their labor supply significantly both on the intensive and on the extensive margin, which in the long run leads to a slowly growing wage gap between males and females.

First, I present a simple model which illustrates the main idea of the paper. Next, I estimate long-hours premium using the two waves of the National Longitudinal Survey of Youth. Using the differences between employed and self-employed workers I show how the long hours premium changed between the two surveys and how it is compatible with the phenomenon of expanding workweeks.

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2 Model

In the following, I present a simple model that shows how under imperfect information workers may use work hours as signaling device. Suppose that every worker i is born with an ability a_i, drawn from a common distribution $F(.)$. Before entering the labor market, they can decide to invest in education or not. Educated workers will have a productivity $a_i + e$, while workers without education do not get any additional productivity. The cost of education for worker i is $\gamma - a_i$.

Educated workers can choose between two effort levels: "high" and "low". Workers without education always exert low effort. Employers observe the education and the effort decision of employees. In the first period, every employee is paid the expected value of her productivity (conditional on the observables), while in the second period she is paid her true productivity.

Workers have quasilinear utilities: $u(w_i, l_i) = w_i + \log(l_i)$, where l is leisure, which equals to 1 if the effort chosen by the worker is high, and 2 if the effort is low. It is known before the first period that the pay for skilled work is larger by the factor of g for both periods.

Worker i therefore has three choices: get education, exert high effort; get education, exert low effort, do not get education but work for all three periods and exert low effort. I assume for simplicity that once the true productivity is revealed for an agent, she does not want to exert high effort any more. In other words, there is no reaction to wages on the intensive margin, once the productivity of the agent is known – more intensive work does not pay more. The corresponding lifetime utilities are:

$$u^{\mathrm{H}} = -(\gamma - a) + g \cdot u(E(w|\text{high effort, education}), 1) + g \cdot u(a + e, 2) \tag{1}$$

$$u^{\mathrm{L}} = -(\gamma - a) + g \cdot u(E(w|\text{low effort, education}), 2) + g \cdot u(a + e, 2) \tag{2}$$

$$u^{\mathrm{NE}} = u(E(w|\text{no education}), 2) + 2 \cdot u(a, 2). \tag{3}$$

Let $\underline{a}$ be the ability level at which the worker is indifferent between no education and education with low effort. Similarly, let $\overline{a}$ be the cutoff between employees choosing

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education and exerting low versus high effort. Then the expected abilities are $F(\underline{a})$, $F(\overline{a}-\underline{a})$ and $1-F(\overline{a})$ for no education, low effort and high effort groups, respectively.

Equating (1) with (2) and (2) with (3) give the indifference conditions for $\overline{a}$ and $\underline{a}$, respectively:

$$
\begin{aligned}
1 - F(\overline{a}) &= F(\overline{a}) - F(\underline{a}) + \frac{\log 2}{g} \\
F(\underline{a}) &= \frac{gF(\overline{a}) - \gamma + g \cdot e}{g+1}.
\end{aligned}
$$

Solving the system for $F(\overline{a})$ and $F(\underline{a})$ yields

$$
\begin{aligned}
\overline{a} &= F^{-1}\left(\frac{(e+1)g^2 + g(e - \gamma - \log 2 + 1) - \log 2}{g(g+2)}\right) \\
\underline{a} &= F^{-1}\left(\frac{2e(g+1) + g - 2\gamma - \log 2}{g+2}\right),
\end{aligned}
$$

assuming that the inverse of the cdf exists.

The partial derivative of $\overline{a}$ is negative with respect to g, the growth of the college premium and positive with respect to γ, the autonomous component of college costs. Therefore if the college wage gap goes up (say, due to skill-biased technological change) or the costs of attending college go down, more people find it profitable to go to college, and the ability of the marginal (and hence, the average) college student will go down. In parallel, the marginal worker who exerts high effort will also have a lower value of ability, therefore a larger portion of the skill of distribution will work longer hours, leading to a longer average workday in the economy. Working more, however, comes with a higher lifetime earning. (Note that a positive partial derivative of $\overline{a}$ means that *fewer* people choose to go to college and provide high effort on the job). The partial derivatives of $\underline{a}$ behave substantially in the same manner.

This framework can qualitatively explain the recent rise in the number of work hours, since it establishes a causal link between the expansion of higher education and the growing prevalence of long work hours as a signaling device. This expansion can take place both from the supply side (a fall in γ) or from the demand side (a growth in g). In some sense, it is analogous to models where the growing demand

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for reliable education signals is satisfied by obtaining an additional degree (e.g. getting a M.A. degree instead of just a B.A., etc). Here I shut this channel down and concentrate solely on the hours of work as a mean for sending signals to the employer.

Since this admittedly simple model has only two periods, it is not rich enough to capture wage dynamics: in fact, it may predict *slower* wage increase for the high-effort group than for the low-effort group, since the starting wages of the high-effort groups are higher. One could assume that both type of workers start at the same type job earning the same wage: then sorting based on the hours would begin only in the third period (after education and entry-level jobs), leading to a higher wage increase for workers putting in longer hours. Naturally, adding more, potentially infinite periods would allow for a more realistic dynamics (such as the slowing rate of wage increases as time passes). Furthermore, it does not allow workers with less than college education to choose between effort levels. Implementing these features would lead to a wider and richer conclusions that could be validated empirically.

Finally, one could argue that the expansion of higher education may lead to an increasing level of differentiation between institutions, which would allow employers to screen their employees before entry better, thereby weakening the effect of the Bayesian updating based on working hours alone, as it is outlined above. Hoxby (2009) presents some evidence that in the period in question most of the colleges did not become more selective; sorting only grew stronger at the institutions at very top and the very bottom of the distribution. Furthermore, she also shows how some costs associated with going to college decreased rapidly in the past decades.

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3 Data and estimation

3.1 Model specification

A useful specification to estimate a flexible relationship between working hours would be a model that allows "short" and "long" working hours to have different effect on hourly wage or on the growth of hourly wage rates.[3] Such specification would be

$$(\ln W_{i4} - \ln W_{i2})/2 = \gamma_0 + \gamma_1 \min(\text{Hours}_{i1}, k) + \gamma_2 \max(\text{Hours}_{i1} - k, 0) + Z_i\beta + \epsilon_i \tag{4}$$

where the k is the value which separates long and short hours (workdays, workweeks, etc.), γ_1 is the marginal effect of work hours under k on the outcome variable and γ_2 is the marginal effect of the work hours over the limit k. This assumes that wage growth is a piecewise linear function of total number of hours worked, with a kink at k. The outcome variable here is the annualized change of hourly wages in log points between two future periods in time.

Since in practice hourly wages are rarely observed directly, they are often calculated by dividing the total wage or work compensation with the total number of hours worked. People may find it hard to remember exactly the number of hours they worked over a specific period, therefore they may often misreport the length of their workweek or workday (The problem is exacerbated if work hours are extrapolated from some other aggregate, e.g. using the number of weekly work hours to estimate the length of a workday). If work hours are used on both sides of the equation (once in itself and once in the denominator of a fraction), the phenomenon called “division bias” may emerge, that can lead to biased estimates of the parameters of interest, as demonstrated by Borjas (1980). In the model described above this would most likely introduce an upward bias. (see appendix A) If one assumes that measurement errors are serially uncorrelated, it is possible to use lagged hours

[3] The following section lifts heavily from Gicheva (2013, 2010), including the specification of equation (4)

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of work to overcome this problem – this explains the fact that while on the left-hand side we have the difference between period 4 and 2, on the right hand side values from period 1 are used.

Equation 4 can not be estimated by OLS, instead, non-linear least squares can be used, which allows to get $\hat{k}$, the estimate for the kink in the work hours-wage schedule. However, for the sake of simplicity and to avoid running into local instead of global optima I use a simplified version of the model above and I impute the value of k before the estimation procedure, therefore I estimate

$$(\ln W_{i4} - \ln W_{i2})/2 = \gamma_0 + \gamma_1 \min(\text{Hours}_{i1}, \overline{k}) + \gamma_2 \max(\text{Hours}_{i1} - \overline{k}, 0) + Z_i\beta + \epsilon_i \tag{5}$$

where $\overline{k}$ is the imputed value.

Obviously, this may lead to misspecification and bias in either $\hat{\gamma}_1$ or $\hat{\gamma}_2$. Using a k smaller than its true value would not lead to bias in the estimation of γ_1 but would bias γ_2. Only if the preassigned value of k is larger than its true value would lead to an upward bias in $\hat{\gamma}_2$ if $\gamma_2 > \gamma_1$ (that is, the function is convex) and to a downward bias if $\gamma_2 < \gamma_1$ (that is, the function is concave), assuming that $\gamma_2, \gamma_1 \geq 0$.

It follows from this specification that an estimate for the wage growth that is due to working long hours (on the margin), by calculating $\gamma_2 - \gamma_1$. This value would show that what is the additional value of one hour if it is over k compared to if it is put in before the employee reaches the kth hour. Clearly, if this difference is positive, than the work hours wage schedule can be considered convex, if it is zero, the schedule is linear, and if the difference is negative, the schedule is concave.

Here the objective is to tell the effects human capital accumulation and signaling apart. For this I use the distinction between employees and self-employed workers. Since self-employed workers do not have to send costly signals to their employees which are correlated with their abilities, their wage growth would be theoretically attributable solely to human capital formation through increased work hours. This insight has been used for long to the partial out the effect of signaling from the effect of other factors, such as work experience or years of schooling. Probably Lazear and Moore (1984) were one of the first to point out differences between the behavior of

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payed employees and self-employed workers, although they concentrated mostly on the different necessity for supervision between the type of employment. Heywood and Wei (2004) provide an extensive literature review in the topic. They find that more than twenty papers were published that use self-employed workers to tell the effect of signaling apart from human capital accumulation or changing productivity. Using Hong Kong data they document that education has lower returns for self-employed workers than for paid employees. They also show that the sheepskin effect is significantly larger for paid as opposed to self-employed workers. Such difference in the returns of education is not detectable if they consider only attempted but unfinished degrees. This is consistent with the evidence that the value of a degree comes from both increased human capital and signaling.

In that case, one could obtain an estimate of the additional wage growth due to signaling by calculating

$$(\gamma_2^e - \gamma_1^e) - (\gamma_2^{se} - \gamma_1^{se}).$$

A positive number would mean that an hour in addition to the normal workweek (which is assumed to be k hours long) is rewarded more for employed than for self-employed workers, which, if the assumptions are true, is due only to signaling.

To see if the importance of signaling has changed between time period 1 and 2, one can simply use the DDD:

$$[(\gamma_2^e - \gamma_1^e) - (\gamma_2^{se} - \gamma_1^{se})]_{t=2} - [(\gamma_2^e - \gamma_1^e) - (\gamma_2^{se} - \gamma_1^{se})]_{t=1}\,. \tag{6}$$

Being self-employed, however, is probably endogenous. If there is some unobserved skill that is correlated with being self-employmd and it also affects wages then it may bias the estimates for the wage levels. However, since I consider only how the change in wages differ between the two cohorts, it can mitigate this problem. While the estimates will be biased, calculating the difference between the estimates for the two cohorts may decrease this bias. On the other hand, Hamilton (2000) finds no evidence of lower-ability workers self-selecting into unemployment using U.S. data from the 1980s. (This is in contrast with the results of Heywood and Wei (2004), cited above). In appendix B I present some exploratory probit estimates

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of the data (Table 3). I find that nonwhite status is associated strongly negatively with self-employment status in both cohorts, albeit less so in the later wave of the survey. Furthermore, age seems to be strongly positively with self-employment in the 1997 cohort.

3.2 Descriptive statistics

Observing past working hours of individuals is necessary to estimate the previously laid out model, therefore I am somewhat restricted in the choice of data: the surveys used should follow individuals for longer periods (ideally a decade or more) and there should be at least two cohorts followed in such a way. Therefore, I use the two waves of the National Longitudinal Survey of Youth (NLSY79 and NLSY97), a dataset that tracks several thousand US individuals throughout their lifetime. I restrict my analysis to males, since the labor supply decision of women is usually a more complicated issue – both on the external and on the intensive margin. I also remove all observations from the dataset where the respondent has not worked at least 15 hours a week on average in a given year. I top code average weekly hours at 90 hours. As additional control variables, I include a quadratic in age, race, marital status, educational levels, number of children and year dummies. I also define a self-employment dummy.

The first two panels of Figure 1 show the evolution of working hours for employed and self-employed workers for both cohorts. Eyeballing the graphs confirms two general trends outlined by the literature cited above. First, the average number of work hours in a week does not seem to change dramatically between cohorts: the average weekly work hour is about 47-48 for the employed workers at the end of the sample period. Secondly, the small changes in the average level mask a more pronounced change in the distribution of hours: the share of workers working more than 47 hours increased dramatically between the two cohorts.

Looking at how the numbers changed over time within cohorts also highlights two interesting feature of the data. First, self-employed workers tend to put in more hours on average than employed workers in both cohorts. Secondly, the relative frequency of long workweeks among self-employed workers is also larger than among

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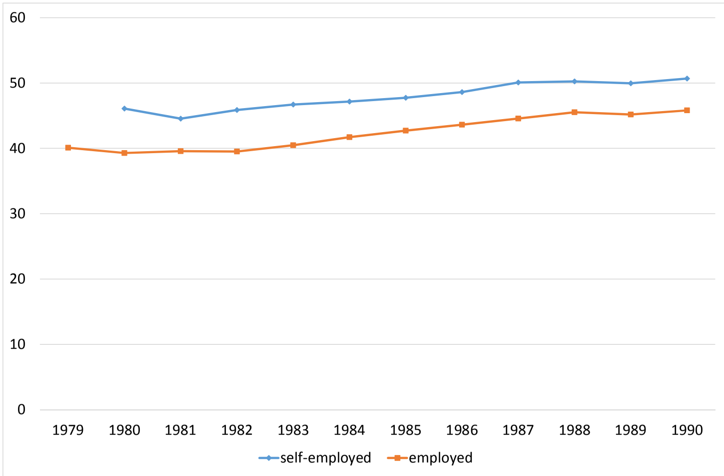
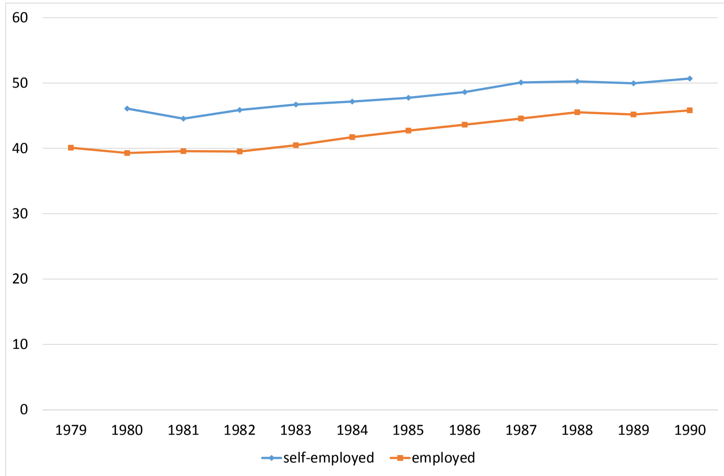
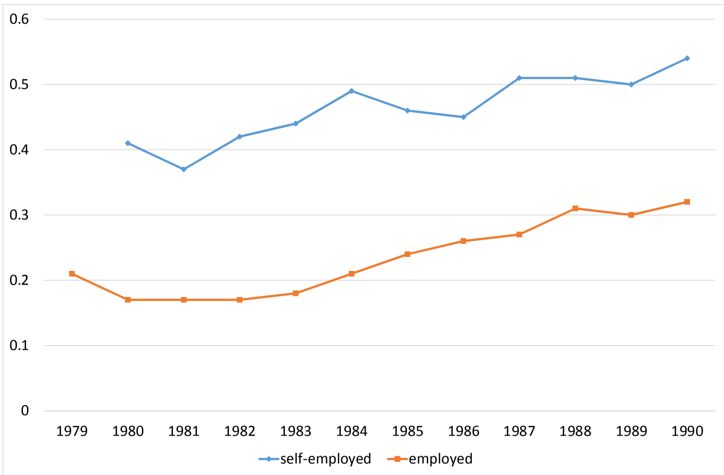


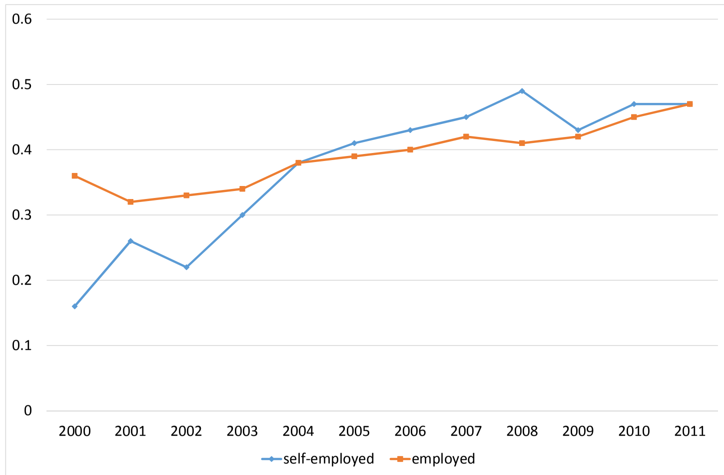
(a) NLSY79



(b) NLSY97



(c) NLSY79



(d) NLSY97

Figure 1: Evolution of the length of the average workweek (upper row) and the share of employees working more than 47 hours a week (bottom row) in the sample by the type of employment and cohorts. (males, working more than 15 hours a week on average)

employees in most of the surveyed years. This is not necessarily a trivial finding, since self-employment is often thought of (sometimes wrongly) as an alternative to high-pressure corporate jobs, where less effort and time is needed from the employee than in the case of larger firms, which can be attractive for those who prefer lower work hours on various grounds. (high utility from leisure, family or health reasons, etc.). Furthermore, being self-employed can provide flexibility in both the organization of the working day and even in the declaration of earnings (Chetty, Friedman and Saez, 2013).

It is also important to observe how the self-employed/employed gap in the share of long workweeks seems to have closed between the cohorts. While the fraction of employed workers putting in long hours hardly ever surpassed 30% in the '79 cohort, it hovers between 35% and 50% in most of time in the '97 sample. This can also lend some credibility to the hypothesis that longer work hours became more important over the the past decades.

A caveat is in order here: the graphs are organized along years which may distort some of the values since they may not capture individuals at the same points in their careers. Even though constructing effective experience for all individuals would mitigate this problem, it would ignore other year-specific factors, such as shocks to labor demand, changes in the income tax structure, etc. Plus, the change in the share of long working hours is so large that it cannot possibly be attributed to such errors. Furthermore, since the sample used in the construction of these graphs contains only working males, it may be subject to self-selection. For example, during recessions many employees can be laid off, and the remaining workers might be exactly the ones who supply more labor than average (or given the adverse labor market conditions, remaining employees start exerting more effort in order to avoid being made redundant). While this also distorts the average workweek upwards, there is no clear indication in the figures that this might be the case: we cannot see any large bumps at the economic crises recorded in this period.

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3.3 Estimation results

In this section I estimate the model described by equation 5:

$$(\ln W_{i4} - \ln W_{i2})/2 = \gamma_0 + \gamma_1 \min(\text{Hours}_{i1}, \overline{k}) + \gamma_2 \max(\text{Hours}_{i1} - \overline{k}, 0) + Z_i\beta + \epsilon_i.$$

I choose $\overline{k} = 47$, since this is consistent with the results of Gicheva (2010). Later I show that the estimates are not sensitive to the choice of $\overline{k}$ within a sensible range.

According to the theory and previous empirical results, my hypotheses are:

1. The earnings function is positive in "long" hours: $\gamma_2 > 0$ (working more is associated with higher expected ability).

2. Both coefficient on hours will be larger for employed worker in contrast with self-employed ones, because some part of the estimate of γ's picks up the effect of signaling, which is absent for the self-employed.

3. The difference between the returns of an hour under and over the limit $\overline{k}$ is larger for the more recent ('97) cohort than for the '79 cohort given the expansion of higher education that took place in the period.

Table 1 shows the estimation results. It is immediately apparent that the estimate of γ_2 is strongly positive for employees in both cohort (columns 1 and 3) and it is insignificant for the self-employed workers (columns 2 and 4). However, for the workers in the earlier cohort the estimate of γ_1 are small but negative. Gicheva (2013), who estimates similar models for the NLSY79 data puts down these findings to the effect of schooling: students who work while studying typically have low hours and make little, however after graduation they start with a relatively high wage, at least compared to their previous part-time earnings. This may introduce spurious negative relationship between hours and wage growth.[4]

Note that as the first two terms on the right-hand side of 5 are additive, a negative estimate γ_1 would lead to a counterintuitive situation: more work (up to a point) would lead to lower wage increase, something that workers would start to compensate only by the first working hour over the cutoff. In other words, the

[4] However, after stating that idea the paper glosses over it and does not address this issues in any of the tables.

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	1979 employed	1979 self-employed	1997 employed	1997 self-employed
min(hours,$\overline{k}$)	-0.0008	-0.0006	-0.0018	0.0013
(γ_1)	-3.16	-0.34	-2.68	0.52
max(hours-$\overline{k}$,0)	0.0007	-0.0003	0.0026	0.0004
(γ_2)	3.23	-0.32	3.53	0.22
age	-0.0275	0.0035	-0.0996	-0.1881
	-4.98	0.07	-3.29	-1.18
age^2	0.0004	-0.0001	0.0017	-0.0033
	4.01	-0.07	2.63	0.99
nonwhite	-0.0090	-0.0213	0.0059	0.0377
	-3.60	-0.82	0.68	0.97
marriage	-0.0042	-0.0175	0.0294	0.0450
	-1.93	-0.92	-0.59	1.23
# of kids	0.0002	0.0101	-0.0013	0.0092
	0.25	1.33	-0.59	1.07
N	33655	1516	13983	1151
R^2	0.016	0.015	0.021	0.043

Table 1: Estimation of Equation 5 on the employed and self-employed subsamples of NLSY79 and NLSY97 for work hours>15. Coefficients for year, education dummies are not shown. Clustered standard errors on the individual level, corresponding t-values displayed under the coefficient estimates.

minimum of the workhour-wage increase schedule would be at the cutoff $\overline{k}$, and given that $\hat{\gamma}_1$ and $\hat{\gamma}_2$ are quite close to each other in columns 1 and 3, an average employee would have to work almost 47 to offset the effect of the term $\gamma_1 \cdot \min(\text{Hours}, \overline{k})$.

Furthermore, given that the estimates of γ_1 are negative, it may be meaningless to carry out the proposed diff-in-diff estimation correctly. To rectify the problem of possible spurious correlation between hours and later wage increase, I restrict the sample to workweeks more than 35 hours. This should rule out any part time job during college. Estimates are shown in table 2. The estimates of γ_1 are nowhere near significant, while the $\hat{\gamma}_2$'s are virtually unchanged: both their size and significance are very similar to those in table 1. From the sample size it is clear that observations where the average workweek fell between 15 and 35 constituted a relatively small minority of the cases.

Hypothesis 1 in confirmed, since the wage increase as a function of weekly work hours is flat under the limit of 47 hours, but positive above it. This is not affected by the fact that on a less restricted sample the estimates of γ_1 are biased downwards.

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	1979 employed	1979 self-employed	1997 employed	1997 self-employed
min(hours,$\bar{k}$)	-0.0007	-0.0021	-0.0008	-0.0050
(γ_1)	-1.40	-0.54	-0.47	-0.82
max(hours-$\bar{k}$,0)	0.0007	-0.0002	0.0024	0.0011
(γ_2)	2.81	-0.15	3.10	0.54
age	-0.0289	0.0042	-0.0932	0.0010
	-4.33	0.07	-2.40	0.01
age^2	0.0005	-0.0000	0.0016	-0.0005
	3.55	-0.04	1.94	0.12
nonwhite	-0.0089	-0.0364	0.0137	0.0382
	-3.13	-1.17	1.38	0.91
marriage	-0.0034	-0.0149	0.0274	0.0371
	-1.53	-0.70	6.85	0.92
# of kids	-0.0001	0.0086	-0.0200	0.0115
	-0.09	1.00	-0.82	1.27
N	27894	1299	10465	874
R^2	0.012	0.015	0.019	0.040

Table 2: Estimation of Equation 5 on the employed and self-employed subsamples of NLSY79 and NLSY97 for work hours>35. Coefficients for year, education dummies are not shown. Clustered standard errors on the individual level, corresponding t-values displayed under the coefficient estimates.

For self-employed workers (columns 2 and 4) there is no significant estimate for either of the work hour variables (or any of the other variables displayed, for that matter). This means, although somewhat trivially, the hypothesis 2 ($\gamma_i^e > \gamma_i^{se}, i = 1, 2$) cannot be rejected: the payoff for an additional hour is larger for employed workers than for self-employed ones. Note that this result is driven by $\gamma_2^e > \gamma_2^{se}$, since the estimate of the under-the-cutoff hours are statistically not different from zero. This means that working long hours is associated with faster wage increases only for the employed workers. Plus, putting in hours less than the cutoff (47 hours in this specification) does not affect future wage growth.

Probably the most important hypothesis of the paper is hypothesis 3, i. e. the long hours premium (relative to the under-the-cutoff hours and the the value for self-employed workers) has increased over time for workers starting their careers. This is again, as in the case of hypothesis 2, trivially true, as the only significant estimates are $\hat{\gamma}_2^e$'s and for the 1997 cohort it is more than three times larger (0.0007 versus 0.0024). Given that these coefficient estimates are quite precise, the 95 % confidence

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intervals do not overlap. This makes the diff-in-diff framework discussed in the previous section (see equation 6) somewhat superfluous and error-prone Calculating only with the significant point estimates ($0.0024 - 0.0007 > 0$) clearly shows that the returns of working long hours has increased over time.

As mentioned above, the results do not seem to be sensitive to the choice of the cutoff. I reestimate the models for alternative values of $\overline{k}$ (45, 50 and 52 in addition to the initial value of 47). Results are shown in tables 4 and 5 appendix B. Coefficient estimates are very close to each other within a cohort, both in terms of size and significance. Estimates for γ_2 seem to grow slightly with $\overline{k}$, however it is well within the confidence intervals. If it is due to misspecification (i.e., an incorrectly picked value for the cutoff) it would mean that a too low $\overline{k}$ was chosen, so the cutoff lies above 47 hours per week. The uniformity of the results is also reassuring if one thought that the true value of the cutoff changed between the two cohorts, therefore only at least one of the estimates can be correct.

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4 Discussion

Even though college graduates stand in the focus of this paper, unfortunately it is not possible to carry out the analysis for them separately. Estimating the same models for college graduates does not lead to reliable estimates, especially for the more recent cohort, because of the low sample size (this problem is particularly true for self-employed college grads, who are hardly represented in the surveys). Since the model relies on observing the work hours and wages in a repeated cross-section, this can not be mitigated by using repeated cross sections, such as the CPS. The only possibility would be to use some administrative dataset, where sample size is rarely an issue.

Waiting for longer datasets to be published would not give a solution for this problem either; as the proposed mechanism of this paper is mainly signaling, observing more time periods is unlikely to be much of a help. On the other hand, using a longer time series from the NLSY97 would help to decide whether the estimates presented here are driven by the first years of the career or if they hold for later years as well. Gicheva (2010) shows that her results, using a very similar specification for the 1979 cohort, depend crucially on the first ten years a respondent of the survey spends on the labor market. This makes sense if the mechanism in action is truly some sort of signaling.

Even though racial discrimination is not the in focus of the paper, it is interesting to observe that the coefficient on the nonwhite dummy changed signs between the two cohorts: while in the earlier survey it was negative and significant, in the model estimated on the 1997 sample it is positive (although insignificant on the usual levels), implying that on average nonwhite workers increased their wages slower in the 1979 cohort than white workers. This result might suggest a change in how nonwhite workers are discriminated against in the labor market. While nonwhite employees may have been subject to discrimination due to some taste for discrimination (closed out of high-payed career tracks or hit a "glass ceiling" while climbing the job ladder), nonwhite employees in the 1997 cohort may have more opportunities to access high-payed positions. This seems to be supported by the findings of

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Arcidiacono, Bayer and Hizmo (2010), who claim that black college graduates do not face statistical discrimination on the labor market, since by completing a college degree they nearly perfectly reveal their ability. Since they only deal with college educated blacks and I use the entire male population in this paper, it is hard to compare these results, however it is worth mentioning that they use total wages as an outcome variable instead of hourly wages which partially ignores the effect of longer work hours.

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5 Conclusion

While getting a true causal effect from the employed versus self-employed distinction is not necessarily possible, nevertheless the change in the returns for working long hours is quite large. The main contribution of the paper is to show that empirical result is consistent with a model of imperfect information and signaling. This mechanism may partially account for the recent rise in working hours among the more educated and more affluent workers which is a clear tendency in the last third of the 20th century (and which may possibly continue even today).

There are certainly many other channels through which the geographical or temporal variation in working hours can emerge. To understand the well-known stylized fact that US employees tend to work significantly more than workers in the EU, many mechanisms have been proposed. Such as the role of taxation and its effect on skill formation (Prescott, 2004; Ohanian, Raffo and Rogerson, 2008), the importance of inequality in connection with promotion opportunities (Bell and Freeman, 2001) or the role of cultural norms where agents derive disutility not only from work but from the difference between their actual labor supply and the socially accepted custom (Burda, Hamermesh and Weil, 2006). These ideas may be applied to explain not only the spatial but the temporal differences in the number of work hours. It is the task of further research to show what role these factors play in driving the change in hours over time.

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Appendices

A Deriving the divison bias

Since Borjas (1980) deals with the problem of different framework (namely, one for the estimation of labor suppply functions), his results on the direction of the bias may not translated to other without modification: if the bias would be negative, testing some hypotheses with contemporaneous hours variable would still be somewhat informative.

Let the true model be univariate for simplicity:

$$\log \frac{W_2}{W_1} = \alpha + \beta H_1 + \eta,$$

where W is the hourly wage, H is the number of hours. The hourly wage is calculated by the dividing the reported total wage $\tilde{W}$ by the number of hours H: $W = \frac{\tilde{W}}{H}$. Suppose that the H is measured with error: $H^* = H \cdot \Phi$, where the error is independent of H and $\mathrm{E}(\Phi) = 1$. The the model will look like:

$$(w_2 - \phi_2) - (w_1 - \phi_1) = \alpha + \beta H_1 \Phi_1 + \eta,$$

where w is the log wage, and $\phi = \log \Phi$.

The estimate of β will therefore be:

$$\begin{aligned}
\hat{\beta} &= \frac{\operatorname{cov}\left((w_2 - \phi_2) - (w_1 - \phi_1), H_1 \Phi_1\right)}{\operatorname{var}\left(H_1 \Phi_1\right)} \\
&= \frac{\operatorname{cov}\left(\alpha + \beta H + \eta + \phi_2 - \phi, H\Phi\right)}{\operatorname{var}\left(H\Phi\right)} \\
&= \frac{1}{\operatorname{var}\left(H_1 \Phi_1\right)} \left[\beta \left(\mathrm{E}\left(H^2 \Phi\right) - \mathrm{E}(H)\,\mathrm{E}(H\Phi)\right) + \mathrm{E}(\phi\Phi) - \mathrm{E}(\phi)\,\mathrm{E}(\Phi)\right],
\end{aligned}$$

where in the last line we just applied the definition of covariance and subscripts are dropped for convenience in the last two lines. Using that Φ is independent of hours and that its expected value is 1 yields

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$$
\begin{aligned}
\hat{\beta} &= \frac{1}{\operatorname{var}\left(H_1\Phi_1\right)}\left[\beta\left(\mathrm{E}\left(H^2\right)-\mathrm{E}\left(H\right)^2\right)+\mathrm{E}\left(\phi\Phi\right)-\mathrm{E}\left(\phi\right)\right] \\
&= \beta\frac{\operatorname{var}\left(H\right)}{\operatorname{var}\left(H\Phi\right)}+\frac{\operatorname{cov}\left(\phi,\Phi\right)}{\operatorname{var}\left(H\Phi\right)}
\end{aligned}
$$

That is, the estimate of β will be a linear function of the true beta with a positive intercept and a positive slope, which is less than one. This means that for relatively "small" parameter values the estimate will have positive bias, while for relatively "large" β's the estimate will be biased downwards. Given that running the regression with contemporaneous hours yields estimates an order or magnitude larger for the hours than using the lagged values, probably the first case holds.

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B Estimation results for robustness check

	1979	1997
age	0.0658	0.3491
	1.00	4.67
age^2	-0.0002	-0.0058
	-0.15	-3.76
nonwhite	-0.3390	-0.1659
	-6.84	-4.14
marriage	-0.0131	0.1628
	-0.45	15.59
# of kids	0.0387	0.0094
	2.61	1.16
N	36932	36584

Table 3: Probit estimates for self-employment status for work hours>35. Coefficients for years and education dummies are not shown. Clustered standard errors on the individual level, corresponding t-values displayed under the coefficient estimates.

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employment type	employed	self-employed	employed	self-employed	employed	self-employed	employed	self-employed
$\overline{k}$	45	45	47	47	50	50	52	52
min(hours,$\overline{k}$)	-0.0009	-0.0027	-0.0007	-0.0021	-0.0006	-0.0013	-0.0004	-0.0008
(γ_1)	-1.30	-0.53	-1.40	-0.54	-1.45	-0.46	-1.22	-0.32
max(hours-$\overline{k}$,0)	0.0006	-0.0002	0.0007	-0.0002	0.0008	-0.0002	0.0009	-0.0003
(γ_2)	2.67	-0.20	2.81	-0.15	3.00	-0.19	2.92	-0.28
age	-0.0290	0.0042	-0.0289	0.0042	-0.0289	0.0041	-0.0289	0.0041
	-4.33	0.07	-4.33	0.07	-4.33	0.07	-4.34	0.07
age^2	0.0005	-0.0000	0.0005	-0.0000	0.0005	-0.0000	0.0005	-0.0000
	3.55	-0.04	3.55	-0.04	3.55	-0.04	3.56	-0.04
nonwhite	-0.0088	-0.0365	-0.0089	-0.0364	-0.0090	-0.0361	-0.0090	-0.0358
	-3.10	-1.17	-3.13	-1.17	-3.17	-1.16	-3.16	-1.16
marriage	-0.0034	-0.0150	-0.0034	-0.0149	-0.0034	-0.0148	-0.0035	-0.0148
	-1.53	-0.70	-1.53	-0.70	-1.52	-0.69	-1.54	-0.69
# of kids	-0.0001	0.0086	-0.0001	0.0086	-0.0001	0.0085	-0.0001	0.0083
	-0.10	1.00	-0.09	1.00	-0.08	0.98	-0.08	0.97
N	27894	1299	27894	1299	27894	1299	27894	1299
R^2	0.012	0.015	0.012	0.015	0.012	0.015	0.012	0.015

Table 4: Estimation of Equation 5 on the employed and self-employed subsamples of NLSY79 for work hours>35 and different cutoff levels. Coefficients for years, education dummies are not shown. Clustered standard errors on the individual level, corresponding t-values displayed under the coefficient estimates.

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employment type	employed	self-employed	employed	self-employed	employed	self-employed	employed	self-employed
$\overline{k}$	45	45	47	47	50	50	52	52
min(hours,$\overline{k}$)	-0.0012	-0.0038	-0.0008	-0.0050	-0.0006	-0.0038	-0.0005	-0.0032
(γ_1)	-0.60	-0.51	-0.47	-0.82	-0.52	-0.80	-0.46	-0.75
max(hours-$\overline{k}$,0)	0.0023	0.0006	0.0024	0.0011	0.0028	0.0014	0.0030	0.0016
(γ_2)	3.24	0.28	3.10	0.54	3.14	0.59	3.05	0.61
nonwhite	0.0137	0.0370	0.0137	0.0382	0.0135	0.0379	0.0135	0.0379
	1.39	0.88	1.38	0.91	1.37	0.90	1.36	0.90
age	-0.0934	-0.0019	-0.0932	0.0010	-0.0929	-0.0010	-0.0927	-0.0012
	-2.40	-0.01	-2.40	0.01	-2.39	-0.01	-2.38	-0.01
age^2	0.0016	-0.0004	0.0016	-0.0005	0.0016	-0.0004	0.0016	-0.0004
	1.95	-0.10	1.94	-0.12	1.94	-0.11	1.93	-0.10
# of kids	-0.0020	0.0115	-0.0020	0.0115	-0.0019	0.0115	-0.0019	0.0115
	-0.83	1.27	-0.82	1.27	-0.81	1.27	-0.80	1.27
married	0.0274	0.0363	0.0274	0.0371	0.0274	0.0376	0.0274	0.0377
	6.84	0.91	6.85	0.92	6.83	0.94	6.83	0.94
N	10465	874	10465	874	10465	874	10465	874
R^2	0.019	0.039	0.019	0.040	0.019	0.040	0.019	0.040

Table 5: Estimation of Equation 5 on the employed and self-employed subsamples of NLSY97 for work hours>35 and different cutoff levels. Coefficients for year, education dummies are not shown. Clustered standard errors on the individual level, corresponding t-values displayed under the coefficient estimates.

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