



Measuring Hours Worked by the Unincorporated Self-employed Using the CPS and ATUS

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Paper Prepared for the IARIW 33rd General Conference

Rotterdam, the Netherlands, August 24-30, 2014

Session 7A

Time: Friday, August 29, Morning

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This Version: July 23, 2014

Abstract: To measure nonfarm business sector labor productivity, the U.S. Bureau of Labor Statistics (BLS) combines estimates of hours worked by the unincorporated self-employed, which are derived from data in their household survey (CPS), with estimates of hours worked by wage and salary workers, which are derived primarily from their establishment survey, the Current Employment Statistics program (CES). Historically, hours worked by the self-employed have varied considerably each quarter, and this volatility is a source of much of the quarterly movement in overall labor productivity. In this paper, I examine how closely the volatility in the self-employment hours series correlates with the business cycle over the 1979–2013 period and compare average weekly hours worked by the unincorporated self-employed estimated from replies to CPS questions to those estimated using time diaries from the 2003–2012 American Time Use Survey (ATUS). Results based on the CPS suggest that self-employment hours are procyclical, but diary reports suggest that self-employed workers have difficulty reporting their hours accurately.

Keywords: Self-employment; Business cycle; Time use

Acknowledgements: The views expressed in this paper are those of the author and not necessarily those of the U.S. Bureau of Labor Statistics. I thank Shawn Sprague, Lucy Eldridge, Michael Harper, Marilyn Manser, Peter Meyer, Phyllis Otto, Larry Rosenblum, and Cindy Zoghi for helpful discussions about the data.

I. Introduction

To measure nonfarm business sector labor productivity, the U.S. Bureau of Labor Statistics (BLS) combines estimates of hours worked by wage and salary employees, as measured primarily from the BLS' establishment survey, the Current Employment Statistics program (CES), with estimates of hours worked by non-employees from its household survey, the Current Population Survey (CPS).¹ Non-employees include unincorporated self-employed workers (also, referred to as nonfarm proprietors), unpaid family workers, and workers at government enterprises, with unincorporated self-employed workers contributing the majority of hours to estimates of hours worked by non-employees. The incorporated self-employed are considered employees of their own businesses and thus are already included in wage and salary hours estimates from the CES. Using the CPS, Hipple (2010) finds that of all self-employed persons on their main job, nearly two-thirds are unincorporated.

Historically, hours worked by the unincorporated self-employed have varied considerably each quarter, and this volatility is a source of much of the quarterly movement in overall labor productivity. Is this volatility just noise due to the smaller sample size in the CPS, the inability of the self-employed to accurately report their hours, or co-movement with the business cycle? The purpose of this paper is twofold: 1) to examine how closely the volatility in the unincorporated self-employment hours series

¹ Using the CES, production and nonsupervisory employee hours worked are calculated as the product of their employment, their average weekly hours, and a ratio of hours-worked-to-hours-paid from the National Compensation Survey (NCS) while nonproduction and supervisory employee hours worked are calculated as the product of their employment, average weekly hours worked by production and nonsupervisory employees, the NCS ratio of hours-worked-to-hours-paid, and a ratio of average weekly hours worked by nonproduction and supervisory employees to average weekly hours worked by production and nonsupervisory employees from the CPS, referred to as the CPS ratio.

correlates with the changes in macroeconomic conditions over the 1979–2013 period; and 2) to compare average weekly hours worked by the unincorporated self-employed estimated from replies to CPS questions with average weekly hours estimated from time diaries using the 2003–2013 American Time Use Survey (ATUS).

Preliminary estimates suggest that short-run changes in either the log level of real GDP or the unemployment rate and a time trend can explain a great deal of the variation in log level of unincorporated self-employment hours. These hours are procyclical. In addition, in a first-differences specification, I find that the growth rate in hours is also procyclical. However, results from the ATUS-CPS comparison suggest that the self-employed have greater difficulty reporting their hours accurately than do wage and salary workers.

II. Theory on Business Cycles and Self-Employment

There are two competing theories of entry into self-employment: “push” and “pull”. The “push” theory assumes that self-employment is chosen when it is difficult to find a job as an employee (i.e. unemployment is high and GDP is not growing). This theory suggests that self-employment numbers would be countercyclical.² The “pull” theory assumes that entrepreneurs have certain abilities that make them particularly suited for self-employment but that there is less incentive for these individuals to start up a business when there is a higher risk of failure.³ This theory suggests that self-employment numbers would be procyclical. If these are the main forces at work, the

² Using a panel from the CPS, Fairlie (2013) shows that transitions into self-employment are greater in locations where there are higher local unemployment rates.

³ See, for example, Lin, Picot, and Compton (2000).

direction of the change in the self-employment rate when GDP decreases depends upon whether the “push” or “pull” factor is stronger.

A paper by Carrington, McCue, and Pierce (1996) compared the average annual hours volatility for male self-employed workers to the hours of male wage and salary workers in both the CPS and Panel Study of Income Dynamics (PSID). They found that hours were procyclical (using either the log of GNP or the unemployment rate as a business cycle indicator), and that there were few differences in annual hours volatility between the two groups of workers for the period 1967–1992.

III. Data and Descriptive Statistics

Hours worked data for the unincorporated self-employed are calculated from the CPS. The CPS is a monthly household survey. Household respondents aged 15 and older report actual hours worked on their main job and then hours on their secondary jobs. In order to determine the class of worker on each job, employed respondents are asked “Last week, were you employed by government, by a private company, a nonprofit organization, or were you self-employed?” Those who respond that they were self-employed are asked, “Is this business incorporated?” BLS classifies incorporated self-employed as wage and salary workers. Prior to the 1994 CPS redesign, however, respondents were not asked their class of worker, industry, or occupation on their second job and thus could not be classified as self-employed on a second job. For productivity purposes, BLS converts CPS responses to a jobs basis to be compatible with the employee hours series from the CES. Thus, monthly hours for the unincorporated self-employed since 1994 include reports on actual hours worked in a main job if the

respondent's class of worker was unincorporated self-employed. They also include actual hours worked on a second job if the respondent's class of worker for the second job was unincorporated self-employed. BLS seasonally adjusts monthly hours estimates prior to averaging these monthly estimates in each quarter. In addition, the Office of Productivity and Technology (OPT) at BLS produces unofficial estimates of the number of unincorporated self-employed based upon the sum of the number of self-employed on main jobs and other jobs (Sprague 2009). BLS applied a level adjustment to the unincorporated self-employment hours series pre-1994 in order to account for the lack of information from multiple jobholders.

The percentage of unincorporated self-employment hours out of all nonfarm business worker hours has been slowly declining over the past 3 decades from a high of 10 percent in 1979. In the last quarter of 2013, unincorporated self-employed hours accounted for approximately 8 percent of nonfarm business worker hours. Figure 1 shows the log level of hours of the nonfarm unincorporated self-employed from 1979 through the end of 2013, along with recessions. From 1979 to the early 1990s, hours trended upward, then remained relatively stable in the 1990's and early 2000's before falling sharply beginning in 2007 with the recession but continuing to trend downward in the subsequent weak recovery period. The stability in hours during the 1990's and early 2000's occurred simultaneously with a rapid increase in real GDP (Figure 2).⁴ Figure 3 shows the unincorporated self-employment rate for all jobs in the nonfarm business sector over the same period. Since the early 1990s, the self-employment rate has declined from a high of 11.7 percent in the third quarter of 1991 to about 8.5 percent in

⁴ Quarterly real GDP obtained from the U.S. Bureau of Economic Analysis is reported as the natural logarithm of billions of chained 2009 dollars and is seasonally adjusted.

the fourth quarter of 2013. In the last two recessions, the self-employment rate declined sharply, whereas in previous recessions the self-employment rate rose.

IV. The Relationship between Self-Employment Hours and Macroeconomic Conditions

Similar to Carrington, McCue, and Pierce (1996), I first examined the relationship between the log level of hours worked by the unincorporated self-employed and a business cycle indicator. Specifically, using Ordinary Least Squares (OLS), I initially regressed the log of quarterly unincorporated self-employed hours on either the log level of real GDP or the unemployment rate, a linear time trend, a separate time trend for the period following the CPS redesign (1994–2013), and a constant term.⁵ The time series includes one hundred and forty quarterly observations. In each regression, I could reject the hypothesis that the residuals are uncorrelated, as the value of the Durbin-Watson statistic (DW-statistic) was much lower than the lower bound for the significance of the statistic. This would indicate that the errors are autocorrelated or that the value of the DW-statistic may have resulted from specification error (Kennedy 1993). Therefore, I re-estimated the regressions using a Prais-Winsten transformation to correct for first-order serially-correlated residuals. Results from these latter regressions indicate that self-employment hours are procyclical and that 97 percent of the variation in hours is explained when using real GDP as a proxy for the business cycle (Table 1).

⁵ The unemployment rate used in this study is the seasonally-adjusted quarterly national unemployment rate. In the Appendix, I present results for specifications using lagged values of the business cycle indicators. I note that the unemployment rate is already considered a lagging indicator of the business cycle. Results are similar for the log level specification, but nothing is significant in the first-differences model. I also tried including a quadratic time trend, but results were insignificant.

Because labor productivity is reported in growth rates and is the difference between the growth in output and the growth in hours, I next re-estimated the specifications in Table 1 using first-differences in hours and the business cycle measures (Table 2). The value of the Durbin-Watson statistic is much higher than the upper bound for the significance of the statistic in each case using OLS. These specifications indicate that the growth rate in self-employment hours is also procyclical. These specifications, however, fail to explain much of the variation in the growth in self-employment hours. In the specification using the change in the unemployment rate, only 18 percent of the variation in the self-employment hours growth rate series is explained.

The theory described in section II explains how the level of self-employment varies over the business cycle but does not explain what will happen to the hours of these workers. Total self-employment hours are determined by both the level of employment and the average number of hours these persons are working per week. It may be that the level of employment is countercyclical but the number of hours of each of these workers is procyclical. One could easily postulate that some workers leave their own businesses during hard times and that those who stick it out work harder. Consequently, it may be difficult to observe a direct relationship between total hours and a cyclical indicator. Therefore, it may be beneficial to examine also the relationships between both the log of the number of self-employed and a cyclical indicator and the log of the average hours worked by the self-employed and a cyclical indicator. Results for regressions examining these relationships are in Table 3. Again, the Durbin-Watson statistics suggest that a correction for autocorrelation may be appropriate in both cases. I find that both the number of self-employed and their average hours worked are procyclical. Almost all of

the variation in self-employment and average hours worked by the self-employed can be explained by the specifications using the Prais-Winsten transformation.

V. Evaluating CPS Reports of Self-employment Hours using ATUS Hours Data

In this section, I analyze the accuracy of CPS actual weekly hours worked reports by comparing them to hours estimates from the ATUS. Time-diary estimates are generally considered to be more accurate than estimates from summary questions about activities done over the previous week, for several reasons. First, the recall task is usually easier. In the ATUS, respondents are asked to report on activities in the previous day, while in the CPS, respondents are asked to report hours worked in the previous week. Second, respondents to time diaries need to account for all uses of their time over a 24-hour period of time. Third, they do not have to worry about aggregating all episodes of work since they report each episode sequentially (Juster, Ono, and Stafford 2003). This may be particularly important when examining the self-employed, who are more likely to work at home in the evening or on weekends and more likely to take long breaks between work episodes than are wage and salary workers (Hyytinen and Ruuskanen 2007; U.S. Bureau of Labor Statistics 2014).

The ATUS began interviewing in 2003 and is an ongoing survey of how Americans spend their time. The ATUS sample is drawn from households who have completed their final month-in-sample in the CPS and is representative of the U.S. civilian population. ATUS respondents are interviewed approximately 2-5 months following their final CPS interview. ATUS interviews are conducted every day throughout the year except for major holidays. Thus, some days before major holidays

are missed; however, survey weights are adjusted for the missing days. Respondents are asked to report their activities between 4:00 A.M. on their diary day and 4:00 A.M. on their interview day. After completing a time diary, respondents are asked whether any of the activities that they did not identify as paid work were actually done as part of their job or business. This is particularly important for reporting work activities by those who do not punch the time clock each day, such as the self-employed. Beginning in 2004, respondents were also asked to report breaks of 15 minutes or longer when a work episode exceeded 4 hours. This is important to capture eating at work, which may or may not be considered productive time (see Hamermesh 1990), and probably is also important for the self-employed, who have more work episodes throughout the day.

My comparison follows most closely the comparison done by Frazis and Stewart (2004), who found that hours reports from the two surveys were identical for all workers on average during reference weeks and very close for non-reference weeks if holiday diary days were excluded. Even though respondents in general may report their hours accurately, it is not necessarily true for workers in all segments of the economy. Frazis and Stewart (2004) found that college-educated workers significantly overreport hours, while less educated workers underreport hours to CPS. Eldridge, Pabilonia, and Stewart (2013) found that nonproduction and supervisory workers also overreport hours to the CPS.

I compare average weekly hours worked on the main job for nonfarm self-employed workers aged 15+ who likely had the same job and hours at the times of their

ATUS and final CPS interviews.⁶ The sample includes workers who reported being unincorporated self-employed in both surveys and for whom ATUS and CPS usual work hours were within 5 hours of each other (exclusive). Those whose usual hours varied were excluded from the sample.⁷ I also exclude those diaries that fell on a holiday, those covering the period from December 23rd through January 2nd, and the day after Thanksgiving. Given the small sample sizes, it is not possible to restrict the sample to only reference weeks. The pooled sample from 2003 to 2013 includes 1,442 unincorporated self-employed workers.⁸

In the ATUS, I defined hours worked as time spent in activities coded in the time diary as paid work on the main job plus breaks less than 15 minutes and work-related travel (but not commuting).⁹ This definition of hours worked is most consistent with the concept applied for productivity measurement (Frazis and Stewart 2004). Responses were re-weighted so that each day of the week received equal weight in each of our subsamples. Daily time diary measures from ATUS were multiplied by 7/60 and averaged to estimate average weekly hours.

Over the entire sample, self-employed workers overreported hours in the CPS by only 0.6 hours (Table 4), and the difference is not statistically significant. However, the

⁶ I do not include hours on secondary jobs, because the ATUS does not collect data on class of worker for these jobs.

⁷ These latter two restrictions on usual hours are similar to Frazis and Stewart (2004).

⁸ Before restrictions were made, there were 6,016 ATUS respondents who were classified as nonfarm unincorporated self-employed workers on their main job. Of those, 4,790 were working in the final month of the CPS, 4,347 were a self-employed worker in both surveys, 1,628 of these continuously self-employed workers reported usual hours within 5 hours (exclusive), 1,485 had usual hours that didn't vary, and 1,442 were not interviewed on a holiday.

⁹ I assume that all work-related travel is done for the main job, although the ATUS diaries do not specify whether any work-related activities were done for the main job or for second jobs.

story changes when I examine separately years prior to the Great Recession and years during the Great Recession and the subsequent weak recovery. In years prior to the Great Recession, I find that CPS respondents overreported hours by 1.4 hours on average, while after the recession began, CPS respondents underreported hours worked by only 0.3 hours. Except for 2003, where reports are nearly identical, annual estimates are highly variable in the extent of over- or underreporting hours worked in the CPS, albeit the sample sizes are very small. How hours change over the business cycle is more relevant for productivity measurement than hours levels. Taking percentage changes in these hours and assuming the ATUS reports are more accurate than CPS reports, I find that average weekly hours increased by a greater amount between 2006–2007, just prior to the recession, than the CPS would have estimated, while during the recession between 2008 and 2009, hours for the self-employed fell by a greater amount. However, the annual differences, especially around large cyclical changes, could also be a result of the 2–5 month difference in survey dates. In a future draft, I will examine averages for those who were continuously self-employed over all CPS months as opposed to those who were newly self-employed in the Great Recession.

VI. Conclusion

In this study, I examined how closely the volatility in the self-employment hours series correlates with the business cycle over the 1979–2013 period and compared average weekly hours worked by the unincorporated self-employed estimated from replies to CPS questions, with average weekly hours estimated using time diaries from the 2003–2012 ATUS. Results using either real GDP or the unemployment rate as a

proxy for macroeconomic conditions suggest that both the growth rate in hours worked and the log level of hours worked by the unincorporated self-employed are procyclical and not just random noise generated by the CPS sampling design. However, diary reports indicate that self-employed workers have difficulty reporting their hours accurately to the CPS: in some years they overreport hours, while in other years they underreport hours.

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Table 1. Regression Estimates for Log Hours Worked by the Unincorporated Self-Employed (1979–2013) (N = 140)

Variables	OLS (1)	OLS (2)	Prais-Winsten (3)	Prais-Winsten (4)
Log (real GDP)	0.868*** (0.067)		0.828*** (0.137)	
Unemployment rate		-0.021*** (0.002)		-0.018*** (0.004)
Time trend	-0.002*** (0.001)	0.005*** (0.000)	-0.001 (0.001)	0.005*** (0.000)
Time trend (1994–2013)		-0.021*** (0.002)		-0.018*** (0.004)
Constant	-4.805*** (0.535)	2.450*** (0.031)	-4.503*** (1.102)	2.391*** (0.068)
DW-statistic	0.52	0.48	2.11	2.21
R-squared	0.930	0.920	0.966	0.963

Notes: Robust standard errors are in parentheses. *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level.

Table 2. Regression Estimates for Difference in Log Hours Worked by the Unincorporated Self-Employed (1979–2013)

Variables	OLS (1)	OLS (2)	Prais-Winsten (3)	Prais-Winsten (4)
Δ Log (real GDP)	0.836*** (0.243)		0.808*** (0.213)	
Δ Unemployment rate		-0.016*** (0.006)		-0.017*** (0.004)
Time trend	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Time trend (1994–2013)	0.836*** (0.243)		0.808*** (0.213)	
Constant		-0.016*** (0.006)		-0.017*** (0.004)
DW-statistic	2.43	2.52	2.04	2.06
R-squared	0.136	0.113	0.169	0.177

Notes: N = 139. Robust standard errors are in parentheses. *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level.

Table 3. Regression Estimates for Log Self-Employment and Log Average Weekly Hours by the Unincorporated Self-Employed (1979–2013)

Variables	Ln(Self-Employment)				Ln(Average Weekly Hours)			
	OLS	OLS	Prais-Winsten	Prais-Winsten	OLS	OLS	Prais-Winsten	Prais-Winsten
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (real GDP)	0.355*** (0.067)		0.272* (0.142)		0.513*** (0.026)		0.516*** (0.044)	
Unemployment rate		-0.008*** (0.002)		-0.006* (0.004)		-0.012*** (0.001)		-0.012*** (0.001)
Time trend	0.003*** (0.001)	0.005*** (0.000)	0.004*** (0.001)	0.006*** (0.001)	-0.004*** (0.000)	-0.001*** (0.000)	-0.004*** (0.000)	-0.001*** (0.000)
Time trend (1994–2013)	-0.006*** (0.000)	-0.007*** (0.000)	-0.007*** (0.001)	-0.007*** (0.001)	0.000* (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Constant	-1.207** (0.539)	1.758*** (0.030)	-0.573 (1.141)	1.701*** (0.072)	-0.642*** (0.213)	3.648*** (0.010)	-0.666* (0.351)	3.642*** (0.019)
DW-statistic	0.35	0.34	2.06	2.10	0.91	0.77	2.18	2.25
R-squared	0.929	0.927	0.955	0.955	0.892	0.860	0.994	0.994

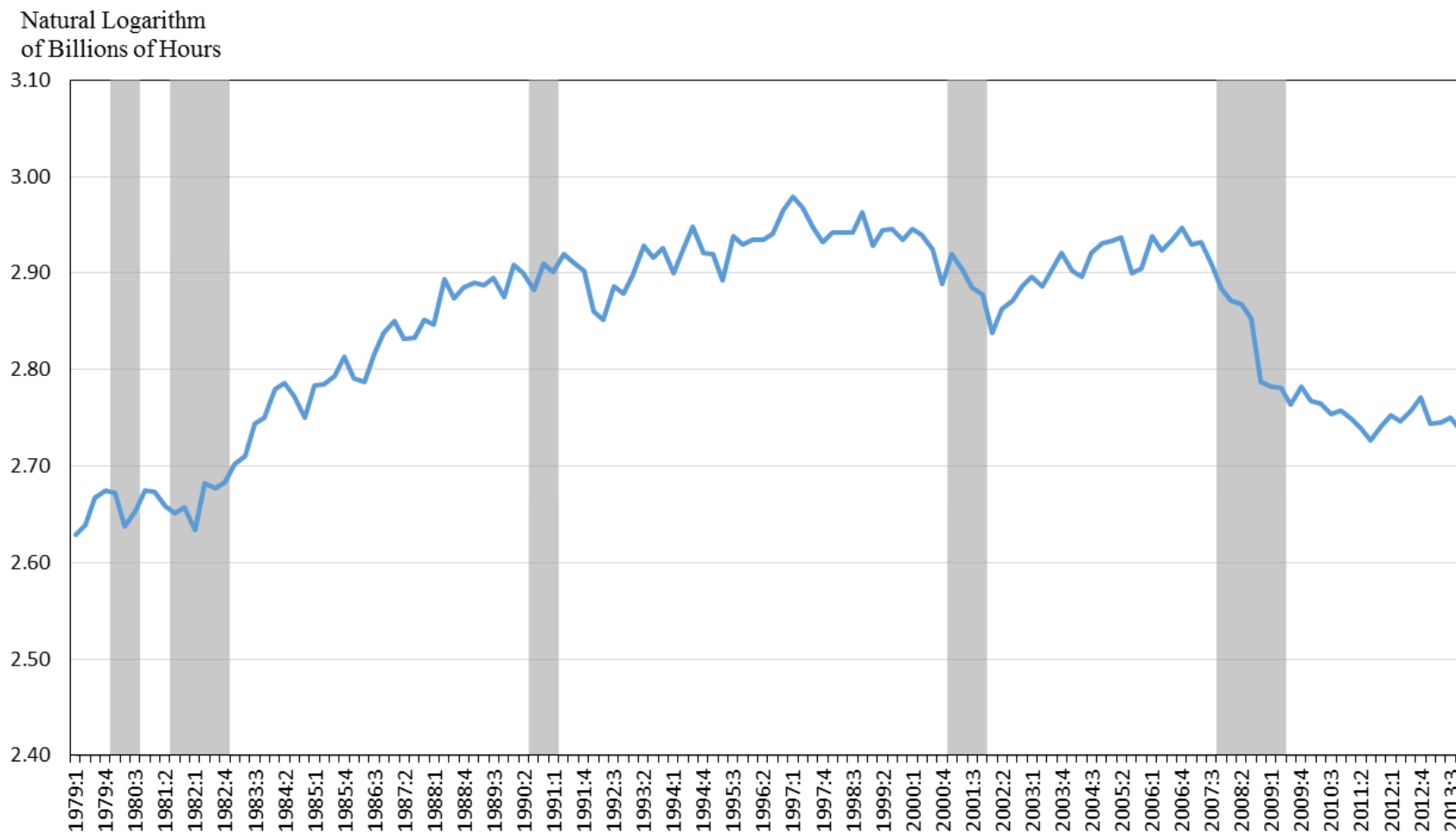
Notes: N = 140. Robust standard errors are in parentheses. *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level.

Table 4. ATUS-CPS Main Job Average Weekly Hours Comparisons for the Unincorporated Self-Employed in the Nonfarm Business Sector

	N	ATUS	CPS	Difference	P-value
<i>All years pooled</i>					
Average weekly hours (2003–2011)	1,442	35.60	36.21	-0.60	0.42
<i>Pre- and post-recession years pooled</i>					
Average weekly hours (2003–2007)	809	36.02	37.42	-1.40	0.21
Average weekly hours (2008–2013)	633	35.11	34.77	0.33	0.73
<i>By year</i>					
Year = 2003	227	37.06	37.11	-0.05	0.98
Year = 2004	153	36.02	38.01	-1.98	0.37
Year = 2005	165	34.19	37.40	-3.20	0.18
Year = 2006	138	33.15	34.80	-1.65	0.56
Year = 2007	126	40.11	39.49	0.62	0.81
Year = 2008	124	39.31	38.32	0.99	0.63
Year = 2009	117	32.19	34.04	-1.85	0.44
Year = 2010	104	34.06	32.47	1.59	0.49
Year = 2011	99	36.64	33.32	3.32	0.29
Year = 2012	103	37.89	35.33	2.56	0.26
Year = 2013	86	28.68	34.33	-5.66	0.01

Notes: ATUS final weights used were re-weighted for equal day of the week representation. This analysis is conducted for respondents whose usual hours reports in the two surveys were within 5 hours (exclusive) of each other and whose diary day was not on a holiday in the ATUS.

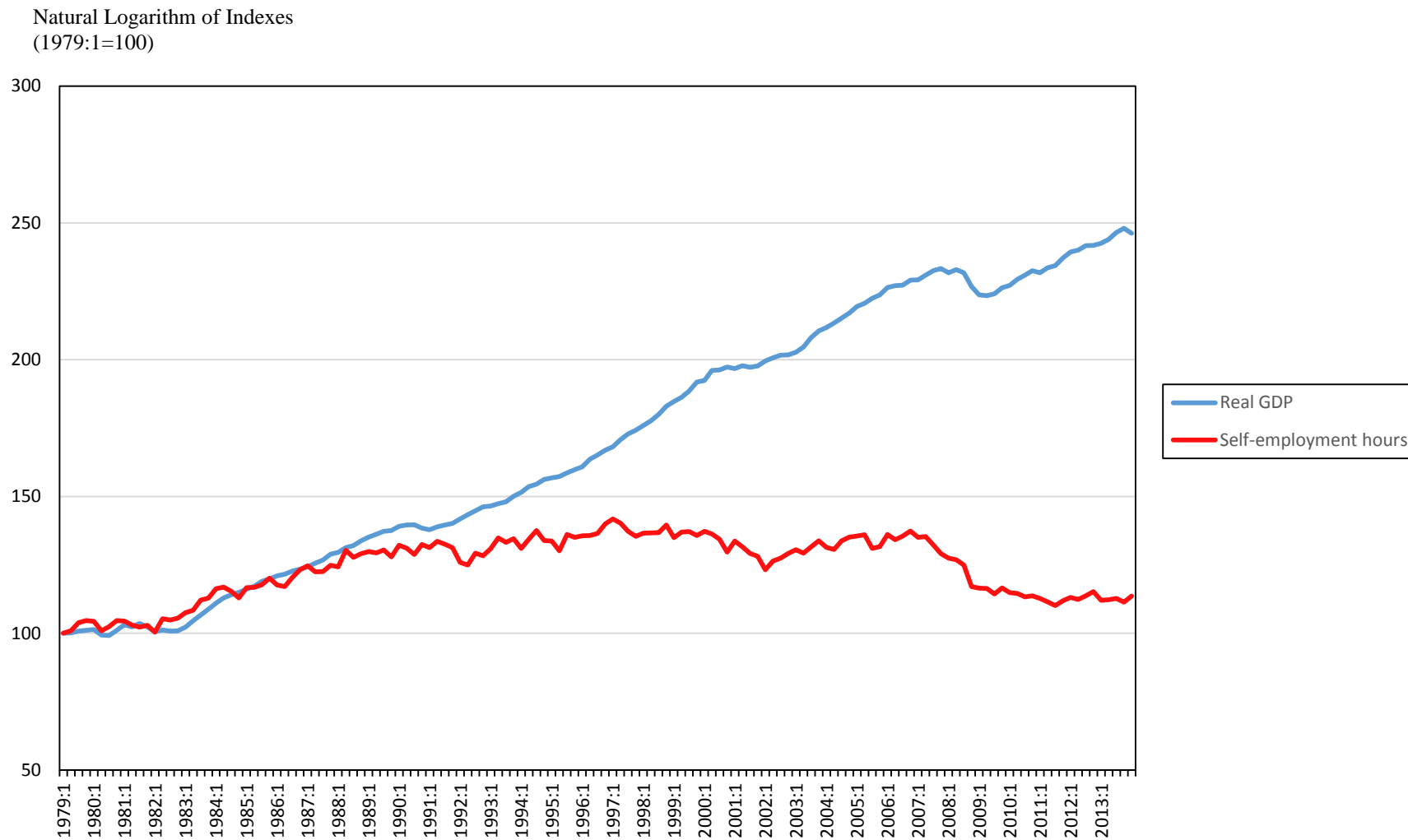
Figure 1. Natural Log Hours of the Nonfarm Unincorporated Self-Employed (1979-2013)



Note: Shaded areas indicate recessions. Quarterly hours are seasonally-adjusted.

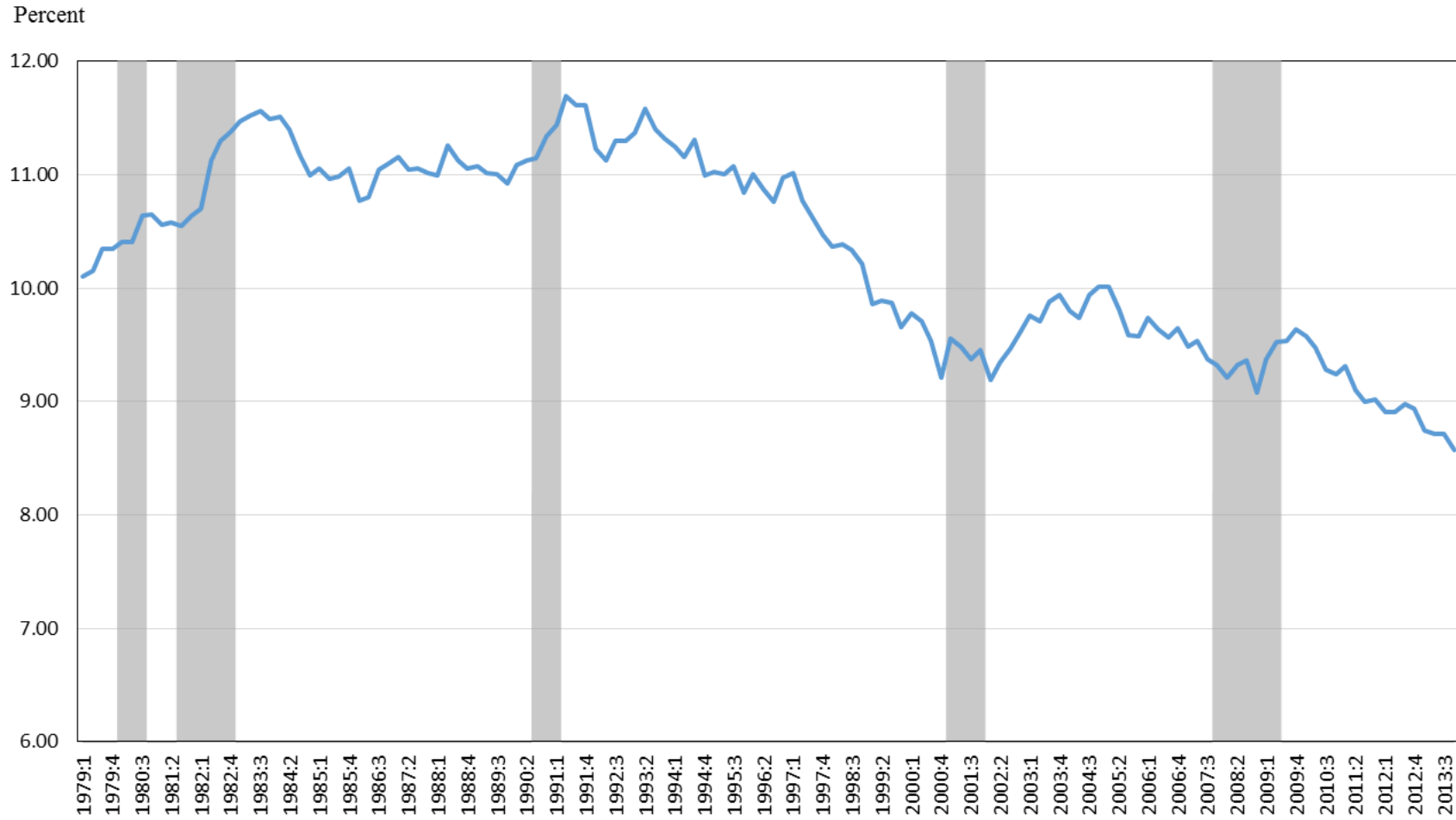
Sources: U.S. Bureau of Labor Statistics

Figure 2. Comparison of Real GDP and Hours of the Nonfarm Unincorporated Self-Employed (1979-2013)



Sources: U.S. Bureau of Labor Statistics and U.S. Bureau of Economic Analysis

Figure 3. Nonfarm Unincorporated Self-Employment as a Percentage of Nonfarm Employment (1979-2013)



Note: Shaded areas indicate recessions.
Sources: U.S. Bureau of Labor Statistics

Appendix

Table 1A. Regression Estimates for Log Hours Worked by the Unincorporated Self-Employed (1979–2013)

Variables	OLS (1)	OLS (2)	Prais-Winsten (3)	Prais-Winsten (4)
Log (real GDP) _{t-1}	0.827*** (0.069)		0.508*** (0.155)	
Unemployment rate _{t-1}		-0.019*** (0.002)		-0.012*** (0.004)
Time trend	-0.001** (0.001)	0.005*** (0.000)	0.002 (0.001)	0.005*** (0.000)
Time trend (1994–2013)	-4.471*** (0.559)	2.434*** (0.031)	-1.911 (1.259)	2.328*** (0.064)
Constant	0.827*** (0.069)		0.508*** (0.155)	
DW-statistic	0.55	0.46	2.16	2.15
R-squared	0.917	0.906	0.959	0.958

Notes: N = 139. Robust standard errors are in parentheses. *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level.

Table 2A. Regression Estimates for Log Difference in Hours Worked by the Unincorporated Self-Employed (1979–2013)

Variables	OLS (1)	OLS (2)	Prais-Winsten (3)	Prais-Winsten (4)
$\Delta \text{Log (real GDP}_{t-1})$	0.015 (0.244)		0.134 (0.220)	
$\Delta \text{Unemployment rate}_{t-1}$		-0.007 (0.005)		-0.007 (0.005)
Time trend	-0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Time trend (1994–2013)	0.015 (0.244)		0.134 (0.220)	
Constant		-0.007 (0.005)		-0.007 (0.005)
DW-statistic	2.34	2.37	2.03	2.04
R-squared	0.040	0.052	0.059	0.074

Notes: N = 138. Robust standard errors are in parentheses. *** is significant at the 1% level; ** is significant at the 5% level; * is significant at the 10% level.