The Implications of Changes in Hours Fluctuations on Welfare Costs of Business Cycles*†

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Abstract

Hours volatility has changed non-monotonically across skill groups since the mid-1980s. This study researches the implications of such changes on the welfare costs of business cycles. Using a partial equilibrium model in which hours fluctuations are the only source of uncertainty, we find that (1) the welfare cost of business cycles of mid-skilled workers is comparable to that of high-skilled workers after the mid-1980s, (2) the relative welfare cost of low-skilled to high-skilled workers declined substantially but remains very high, and (3) treating mid- and low-skilled workers as one group provides incorrect information about the changes in welfare costs.

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1 Introduction

This study analyzes the implications of changes in hours fluctuations on the welfare costs of business cycles. We first show that there have been non-monotonic changes in hours fluctuations since the mid-1980s across different skill groups. Our empirical finding is relevant in an economy in which (1) the uncertainty is mainly from hours fluctuations and (2) the asset market is incomplete. In order to show this quantitatively, we develop a simple partial equilibrium model in which consumption of different skill groups is endogenously generated. We then compute the welfare costs of business cycles of workers with different skill levels following Lucas (1987). In addition, we compare the conventional approach of considering only two groups ("skilled" and "unskilled" workers) with a three-group approach ("high-skilled", "mid-skilled", and "low-skilled" workers) in analyzing welfare costs. We find that the conventional approach of treating mid-skilled and low-skilled workers as one group might provide incorrect information about the changes in welfare costs. This study is important because it clearly identifies the skill groups that government policy should target for reducing the negative welfare consequences of economic fluctuations.

2 Data

We use the National Bureau of Economic Research (NBER) extracts of the Current Population Survey (CPS) Merged Outgoing Rotation Groups (MORG) from January 1979 to December 2010.[1] We restrict the sample to individuals aged 16–64 years and exclude farmers and members of the armed forces.[2] In addition, we exclude individuals from the sample if their earnings or hours worked are coded as zero or have a missing value.

Workers are divided into three groups. First, low-skilled workers are those who have not completed high school. Second, mid-skilled workers are those with a high school diploma or some level of college study. Last, high-skilled workers are those with a college degree or higher.

[1]Data were extracted from the NBER website: http://www.nber.org/data/morg.html.

[2]The results in Section 3 are robust when we restrict our sample to prime-age workers (aged 24–54 years).

We then construct monthly series for total hours worked for each group and seasonally adjust by X-12 ARIMA. Each series are then detrended by the Baxter-King filter (Baxter and King (1999)), by setting $\kappa = 12$, where κ is the number of leads/lags used in the approximation. The lowest frequency is 6 quarters and the highest frequency is 32 quarters.

3 Empirical Finding

Table 3.1 presents our main empirical findings on the standard deviations of the detrended total hours series.[3] Following Castro and Coen-Pirani (2008), Galí and Gambetti (2009), and Champagne and Kurmann (2013), we divide the sample into two periods: 1979–1983 and 1984–2010. The volatilities of the total hours worked for high-skilled workers have increased slightly by 12 percent from the first to the second subperiods. However, the volatilities of the total hours for mid-skilled workers and low-skilled workers have declined by 38 percent and 21 percent from the first to the second subperiods. In the last column, we report volatilities for the group that combines mid-skilled and low-skilled workers, denoted as "Combined". The volatilities of the total hours worked for the combined group have declined by 45 percent.

Table 3.1: Standard Deviations of Total Hours

	High	Mid	Low	Combined
(1) 1979–1983	0.36	0.81	1.41	0.92
(2) 1984–2010	0.40	0.50	1.11	0.50
Ratio ((2)/(1))	1.12	0.62	0.79	0.54

4 Welfare Cost of Business Cycles

As Castro and Coen-Pirani (2008) point out, hours fluctuations, with acyclical skill premia and incomplete asset markets, have direct effects on welfare costs of business cycles. The natural

[3] We perform the same exercise with the March CPS, whose first subperiod is longer than that of the MORG data; it covers the period from 1975 to 1983. Qualitatively, the observations are almost identical between the two data sets, and hence, the following discussions are based on the statistics reported in Table 3.1. See Shim and Yang (2014) for more detailed results.

way to estimate the welfare costs of business cycles of different skill groups would be to use actual consumption data. Since actual consumption data are affected by many other factors than hours fluctuations, we instead construct artificial consumption series of workers from a partial equilibrium model.[4] Let c_t^f be the steady state consumption and let c_t^v fluctuate around c_t^f and $\mathbb{E}[c_t^v] = c_t^f$. Then, the Lucas formula to compute the welfare cost is given by

$$\lambda = \frac{1}{2}\sigma^2\rho \tag{4.1}$$

where σ is the standard deviation of the log of the uncertain component of c_t^v and ρ is the CRRA parameter of the utility function. λ is the compensation variation in terms of consumption good that equates lifetime utility from the volatile consumption schedule to utility from the certain consumption schedule.

We consider a simple partial equilibrium model with three types of workers: high-, mid-, and low-skilled workers. They are given a fixed interest rate, r[5], and a fixed wage rate, w^i, where $i = h, m, l$. The wage rates are fixed because wage rates and skill premia are almost acyclical. The uncertainty faced by workers in this economy derives from the uncertain hours worked, which are decided in the market and vary across agents, and the asset market is incomplete as in Hugget (1993) and Aiyagari (1994). This is in line with the previous literature, including Lucas (1987), Krusell, Mukoyama, Şahin, and Smith (2009), and Mukoyama and Şahin (2006), that assumes exogenous labor supply. Two general equilibrium effects can be important as discussed in Mukoyama and Şahin (2006); the precautionary motive for saving declines as the business cycle is eliminated, and hence, less capital is accumulated. This increases the interest rate and decreases the wage rate under the usual assumption on production function. Given that the skill premium is acyclical, the general equilibrium effect on the wage rate is limited. The general equilibrium effect on the interest rate, on the other hand, is beneficial for skilled workers because the asset holding increases with skill level as introduced in Section 4.2. As a result, the relative welfare costs of business cycles for different skill groups computed from the partial equilibrium

[4]See Heathcote, Storesletten, and Violante (2013) for a similar argument.

[5]In other words, asset supply is infinite at a certain level of interest rate, r, from the perspective of infinitesimal agents.

model can be interpreted as the lower bound.

Finally, in order to emphasize the importance of considering appropriate degrees of heterogeneity across workers, we compute the welfare costs of business cycles when there are only two skill groups, skilled and combined workers (denoted as un), where combined workers include both mid- and low-skilled workers.

4.1 Model

Each agent i solves the following maximization problem:

$$\max_{\{c_t^i, a_{t+1}^i\}_{t=0}^{\infty}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{(c_t^i)^{1-\rho}}{1-\rho} \right] \tag{4.2}$$

subject to

$$(1)\ c_t^i + a_{t+1}^i = w^i h_t^i + (1+r) a_t^i$$

$$(2)\ a_0^i = a^i \textit{ is given}$$

where a_t^i is the asset holding of worker $i \in \{l, m, h, un\}$, a^i is the steady state wealth level of the worker i, and h_t^i represents the hours worked of worker i.

We need to compute the standard deviation of $\hat{c}_t^i$, the percentage deviation from the steady state. Suppose $c_t^v = c^f z_t$, where $\ln z_t \sim \mathbb{N}(-\frac{\sigma^2}{2}, \sigma^2)$ so that $\mathbb{E}[c_t^v] = c_t^f = c^f$. Then $\hat{c}_t \equiv \ln\left(\frac{c_t^v}{c_f}\right) = \ln z_t$. Therefore, it is sufficient to compute the standard deviation of $\hat{c}_t$ in order to estimate the welfare costs of business cycles. In so doing, we log-linearize the model around the steady state and generate the simulated (detrended) consumption path.[6]

4.2 Calibration

We calibrate the key parameter values used in the model. First, the interest rate is chosen to be 4 percent and hence $\beta = 1/(1+r) = 0.96154$. The steady state hours h is assumed to be the same across workers as 1/3. We then calibrate the steady state wealth of each skill group in 1997 following Díaz-Giménez, Glover, and Ríos-Rull (2011). We use the fact that

[6]See Appendix for the derivation of linearized solution.

the (approximated) relative size of wealth is 1:2.5:6.7 (low:mid:high) and 2:6.7 (combined:skilled)[7] when mid- and low-skilled workers are combined as one group. Because the wealth of the low-skilled group is about five times its earnings, we normalize a^L as 5. The choice of normalization does not affect the results in the next section because the wealth level determines the level of consumption, not the relative degree of fluctuation.

For the wage, we normalize w^L as 1. We fix the wage rates over the period because the hourly wage rates change little at the business cycle frequency.[8] The ratio of the wage rates is obtained from our data on hourly wage rates: we take the time average of the hourly wage, and then, compute the ratio of the jth group over the low group. In calibrating h_t^i, we divide the sample into two periods: 1979–1983 and 1984–2010 and then estimate with a simple regression.[9] Table 4.1 summarizes the calibrated parameters. It can easily be observed that σ^M is similar to σ^{un} but σ^L is relatively higher than σ^{un}, which is in line with the observations in Section 3.

Table 4.1: Calibration

Parameter	$1979-1983$	$1984-2010$
w^M	1.3	
w^{un}	1.15	
w^H	2.2	
ρ_h^L	0.9817	0.9460
ρ_h^M	0.9651	0.9777
ρ_h^{un}	0.9724	0.9825
ρ_h^H	0.8925	0.9165
σ^L	0.0033	0.0036
σ^M	0.0020	0.0013
σ^{un}	0.0022	0.0012
σ^H	0.0018	0.0016

We set the CRRA parameter, ρ, as 2 and do not vary it in the simulations because we focus on the relative welfare cost across different groups, which is not affected by the choice of ρ.

[7] 2 is the relative size of the wealth of combined workers to that of low skilled workers.

[8] This assumption is valid when skill premia are acyclical, which is the case in our data.

[9] One problem is that the first subperiod is much shorter than the second subperiod. However, the March CPS cannot be used instead, because we have only 36 observations owing to the fact that the data are low frequency (yearly data). Hence, the calibration of the first subperiod is the best we can do, given the data limitation.

4.3 Welfare Costs For the simulation, we set the time period $T = 1,000$ and the number of simulations $I = 500$. We obtain σ_c^i (the standard deviation of the volatile consumption schedules for group i) from each simulation and then take their averages. Equation (4.1) is then applied to compute the welfare costs of business cycles for each skill group and we normalize the welfare cost for high-skilled workers as one. Table 4.2 summarizes the results.[10]

Table 4.2: Relative Welfare Costs of Business Cycles

	Mid/High	Low/High	Combined/High
(1) 1979–1983	8.5614	66.5105	13.0263
(2) 1984–2010	3.8368	24.6036	4.7068
Ratio ((2)/(1))	0.4482	0.3699	0.3613

First, the welfare cost of the mid-skilled group is 8.5 times higher than that of the high-skilled group during the first subperiod, while it is 4 times higher than that of the high-skilled group during the second subperiod. This decline in the relative welfare cost comes from the fact that hours fluctuations of each group become similar during the second period, as in Table 3.1. Second, the relative welfare cost of low-skilled to high-skilled workers is 66.5 times higher during the first subperiod but is 24.6 times higher during the second subperiod. While the decline is dramatic, the welfare cost of low-skilled workers is still much higher than that of high-skilled workers.

Lastly, we compare our approach of considering mid- and low-skilled workers as separate groups (three-group approach) with the conventional approach of considering the two workers as one group (two-group approach).[11] If mid- and low-skilled workers are grouped together as combined workers, the relative welfare cost of the combined group to that of high-skilled workers changes from 13 to 4.7. This implies that: (1) the welfare cost of business cycles of mid-skilled workers would be overestimated by about 50% during the first subperiod if they were combined with low-skilled workers; and (2) the welfare cost of low-skilled workers would

[10] Original values for welfare costs are not reported because the numbers themselves are not our primary interest. The values are small, which is consistent with Lucas (1987).

[11] Examples of studies that follow the two-group approach are Krusell, Ohanian, Rios-Rull, and Violante (2000), Lindquist (2004), and Castro and Coen-Pirani (2008).

be underestimated if they were grouped with mid-skilled workers, regardless of the period. In particular, the computed welfare cost of low-skilled workers is only about 1/5 when we follow the two-group approach.

5 Conclusion

This study shows that the welfare cost of mid-skilled workers has become similar to that of high-skilled workers since the mid-1980s. In addition, the welfare cost of low-skilled workers can be underestimated when they are grouped together with mid-skilled workers. Our findings imply that the three-group approach provides more precise and detailed information on heterogeneity in welfare costs across different skill groups, and thus, may help to design more efficient labor market policies.

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A Model Solution

We have two equilibrium conditions for each worker i:

$$(c_t^i)^{-\rho} = \beta(1+r)\mathbb{E}_t\left[(c_{t+1}^i)^{-\rho}\right] \tag{A.1}$$

$$c_t^i + a_{t+1}^i = w^i h_t^i + (1+r)a_t^i \tag{A.2}$$

We log-linearize the model around the steady state[12] to obtain the following system of equations.

$$\hat{c}_t^i = \mathbb{E}_t \hat{c}_{t+1}^i \tag{A.3}$$

$$c^i \hat{c}_t^i + a^i \hat{a}_{t+1}^i = w^i h \hat{h}_t^i + (1+r)a^i \hat{a}_t^i \tag{A.4}$$

where $\hat{x}_t = \ln(x_t/x)$, with x being the steady state value. We assume that $\hat{h}_t^i$ follows an AR(1) process: $\hat{h}_{t+1}^i = \rho_h^i \hat{h}_t^i + \varepsilon_{t+1}^i$ where $\varepsilon^i \sim N(0, (\sigma^i)^2)$.

Then, we guess the solutions $\hat{c}_t^i = \phi_0^i \hat{h}_t^i + \phi_1^i \hat{a}_t^i$ and $\hat{a}_{t+1}^i = \phi_2^i \hat{h}_t^i + \phi_3^i \hat{a}_t^i$ so that the choice variables are the functions of the state variables. Using the method of the undetermined coefficients, we obtain the expressions for the coefficients of the guess as follows.

[12] We assume that the steady state hours worked are the same across workers.

$$\phi_0^i = \frac{rw^i h}{c^i(r + 1 - \rho_h^i)},\ \phi_1^i = \frac{ra^i}{c^i},\ \phi_2^i = \frac{w^i h}{\left(\frac{r}{1-\rho_h^i} + 1\right) a^i},\ \phi_3^i = 1 \tag{A.5}$$

Hence, we can generate the simulated (detrended) consumption path, given the parameter values and the steady state values.