The Implication of Subsistence Consumption for Economic Welfare*

Myungkyu Shim[†] Yongheng Wen[‡]

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Abstract

This paper assesses the implications of subsistence consumption for the welfare cost of business cycles. Using a subsistence consumption-augmented real business cycle model that can generate several stylized facts for less-developed economies, it is shown that business cycles are more costly in economies with high subsistence consumption–output ratios. Our findings hence suggest that stabilization policies can play a more important role in less-developed countries. We argue that this finding can be attributed to a positive relationship between consumption volatility and the level of subsistence consumption.

JEL classification: E20, E32, I31

Keywords: Subsistence consumption-augmented RBC model, Business cycles in less-developed countries, Economic welfare

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†Corresponding Author. Sogang University. Email: mkshim@sogang.ac.kr

‡Shanghai University of Finance and Economics. Email: yonghengwen@126.com

1 Introduction

Subsistence consumption, which refers to a minimum level of consumption required to sustain life, is usually determined by the poverty line. In particular, lower and upper international poverty lines employed by the World Bank are $694 and $1,132 (in 2011 PPP prices)[1], implying that the poverty line over GNI per capita ranges from 2% for high income economies to 44% for low income economies, as reported in Table 1.1.

Table 1.1: Poverty Line over Per Capita Income

Group of countries[a] (number of countries)	GNI per capita[b]	Ratio I[c]	Ratio II[d]
Low income economies (31)	1,571	0.44	0.72
Lower middle income economies (51)	6,002	0.12	0.19
Upper middle income economies (53)	14,225	0.05	0.08
High income economies: OECD (32)	43,588	0.02	0.03

Note: Data are taken from the Word Bank.
[a]Country grouping according to the World Bank.
[b]In 2014 dollars.
[c]Ratio between the lower poverty line ($694) and GNI per capita.
[d]Ratio between the upper poverty line ($1,132) and GNI per capita.

Hence, incorporation of subsistence consumption into macroeconomic models is definitively more important for less-developed countries. While effects of subsistence consumption on growth have been extensively studied in the growth/development literature[2], attempts to analyze implications of subsistence consumption for business cycles are rare. They include Ravn, Schmitt-Grohe, and Uribe (2008), who studied the implications for business cycle properties, and Achury, Hubar, and Koulovatianos (2012), who analyzed the implications on saving rate and portfolio choice. Our paper adds to the literature by studying the effects of subsistence consumption on the welfare cost of business cycles.

In doing so, we utilize a standard real business cycle (RBC, henceforth) model that incorporates subsistence consumption considerations as part of the Stone-Geary preferences and compute the welfare cost à-la Lucas (1987). Our main finding is that the welfare cost of business cycles is increasing in terms of the subsistence consumption–output ratio, which is robust to a wide range of parameter values. We also demonstrate that previous findings with the standard RBC model, indicating that consumers may prefer a more volatile economy (Cho, Cooley, and Kim (2015)), do not hold in an economy where the level

[1]This corresponds to $1.90 and $3.1 a day, respectively.
[2]See Steger (2000) for instance. See also Herrendorf, Rogerson, and Valentinyi (2014) for an extensive review.

of subsistence consumption is substantially high. We further argue that this finding can be explained by the fact that the model's implied consumption volatility increases alongside subsistence consumption, which is consistent with the well-known fact that consumption volatility is greater in developing countries (Aguiar and Gopinath (2007)). Our findings hence suggest that eliminating business cycles can be more beneficial in the less-developed economies in which the subsistence consumption–output ratio is high (Table 1.1).

2 The Model

The standard RBC model is extended in the simplest way to make our analysis comparable with those in the existing literature.

2.1 Setup

The economy consists of a representative household and a firm.

Household. Preference of the representative household takes the Stone-Geary form[3] as follows.

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \hat{\beta}^t N_t \left[\ln (c_t - \overline{c}) - \psi \frac{h_t^{1+\phi}}{1+\phi} \right], \tag{2.1}$$

where $\hat{\beta} \in (0,1)$ is the discount factor, c_t is period t consumption, $\overline{c} \geq 0$ denotes subsistence consumption, h_t represents hours worked at period t, and all variables are measured at the individual level. N_t is the population size that grows at a net rate $g_N \geq 0$ and $N_0 \equiv 1$. In addition, $\phi > 0$ is the inverse Frisch labor elasticity and $\psi > 0$ is the preference parameter.[4]

We recast the problem:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\ln (c_t - \overline{c}) - \psi \frac{h_t^{1+\phi}}{1+\phi} \right], \tag{2.2}$$

where $\beta = \hat{\beta}(1+g_N)$.[5]

Firm. Aggregate production function takes the usual Cobb-Douglass form:

$$Y_t = Z_t K_t^{1-\alpha} (h_t N_t)^{\alpha}, \tag{2.3}$$

[3] Stone-Geary form is in the class of Gorman polar form so that aggregation is available as in the standard models. See Acemoglu (2009) for related discussions.

[4] We consider log utility in order for the model to exhibit balanced growth property (King, Plosser, and Rebelo (2002)). In Supplementary Online Appendix, we also show that our finding is robust to a general CRRA utility function.

[5] The condition $\hat{\beta} \in (0,1)$ is sufficient for existence of the equilibrium (see Appendix A).

where $\alpha \in (0,1)$, Y_t is an aggregate output, K_t denotes an aggregate capital stock, and Z_t denotes a total factor productivity of the economy, which follows AR (1) process:

$$\ln Z_t = g_z + \rho \ln Z_{t-1} + \varepsilon_t, \tag{2.4}$$

where $\rho \in (0,1)$, $\varepsilon_t \sim N(-\frac{\sigma_z^2}{2}, \sigma_z^2)$, and $g_z \geq 0$ drives trends of the productivity.[6]

Feasibility condition of the transformed economy is

$$c_t + (1+g_N)k_{t+1} = Z_t k_t^{1-\alpha} h_t^{\alpha} + (1-\delta)k_t, \tag{2.5}$$

where $\delta \in (0,1)$ is the rate of depreciation, $k_t = K_t/N_t$, and $c_t = C_t/N_t$.

Social Planner Problem. As there is no distortion in this economy, we proceed with the social planner's problem:

$$V(Z_t, k_t) = \max_{\tilde{c}_t, h_t, k_{t+1}} \left\{ \ln \tilde{c}_t - \psi \frac{h_t^{1+\phi}}{1+\phi} + \beta \mathbb{E}_t V(Z_{t+1}, k_{t+1}) \right\} \tag{2.6}$$

subject to

$$\tilde{c}_t + (1+g_N)k_{t+1} = Z_t k_t^{1-\alpha} h_t^{\alpha} + (1-\delta)k_t - \overline{c}, \tag{2.7}$$

where $\tilde{c}_t \equiv c_t - \overline{c}$.

2.2 Computation of Welfare Cost

The welfare cost can be computed by comparing the value of life-time utility drawn from non-fluctuating variables at the steady-state with that drawn from fluctuating variables around the steady-state.

We first define the value of the non-fluctuating economy as V^{NF}:

$$V^{NF} = \sum_{t=0}^{\infty} \beta^t U(c - \overline{c}, h), \tag{2.8}$$

where variables without subscript are evaluated at the steady-state and U denotes a utility function in a general form.

Similarly the value of the fluctuating economy, V^F, is given by

[6] Analyzing how g_z affects the welfare cost is interesting but it turns out that the welfare cost does not alter with respect to g_z under the current specification; see Supplementary Online Appendix for details.

$$V^F = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(c_t - \overline{c}, h_t) \tag{2.9}$$

and

$$V^{F,\lambda} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U((1+\lambda)(c_t - \overline{c}), h_t), \tag{2.10}$$

where λ is the compensating variation of consumption, which measures the fraction of consumption a consumer would be willing to pay to live in a stable economy, that solves the following equation:

$$V^{NF} = V^{F,\lambda}. \tag{2.11}$$

We can solve for λ using the utility specification in equation (2.2) and obtain[7]

$$\lambda = \exp\big((1-\beta)(V^{NF} - V^F)\big) - 1 \tag{2.12}$$

We compute the conditional welfare cost of business cycles, where initial steady-state is $x_0 = x$ and the scaling parameter, σ_z, is set to be 0, following Schmitt-Grohé and Uribe (2006) and Lester, Pries, and Sims (2014).

2.3 Parameterization We calibrate the parameters to match long-run moments of the U.S. economy: $\hat{\beta}$ is set as 0.995 to match an annualized real risk-free rate of return of 2%. α is 0.67 in line with the labor income share in the post-war U.S. data and δ is 0.02 to match the investment–capital ratio observed in the data. We further set $\rho = 0.95$ and $\sigma_z = 0.01$. While we calibrate parameters to be consistent with the U.S. data, the results are robust to different parameter values as will be shown later.

One can interpret the economy with $\overline{c} = 0$ corresponding to a developed economy since the subsistence consumption–income ratio is very small in the data in such an economy (Table 1.1) and the scaling parameter, ψ, is set to ensure that hours worked in the developed economy are one third at the steady-state for given values of ϕ.

[7] See Appendix B for the derivation.

3 Implications for Economic Welfare

3.1 Key Observations As a benchmark we set $\phi = 1$. In this exercise, we consider the following values for subsistence consumption: $\overline{c} = (0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7)$, implying the subsistence consumption–output ratio as $\frac{\overline{c}}{y} = (0\%, 10\%, 19\%, 27\%, 33\%, 38\%, 43\%, 46\%)$, respectively, where y is the per capita output at the steady-state.

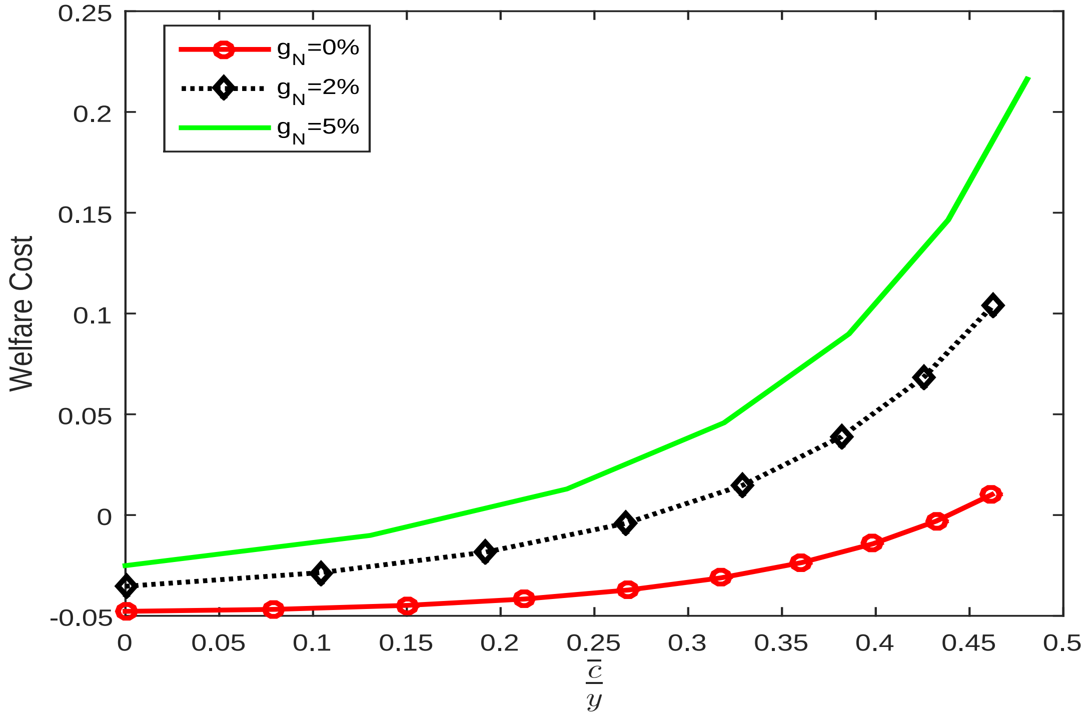

Figure 3.1: Welfare Cost of Business Cycles (%): Benchmark Economy

Figure 3.1 plots the welfare cost of business cycles in the benchmark economy; we compute the welfare costs for different $\overline{c}/y$ while keeping other parameters fixed. We note that positive (resp. negative) values for the welfare cost means that a consumer prefers to live in a less (resp. more) volatile economy. One can observe that for low $\overline{c}$, the welfare cost is actually negative, which is consistent with Lester, Pries, and Sims (2014) and Cho, Cooley, and Kim (2015).[8] That is, agents prefer a volatile economy to a stable one. However, as the level of subsistence consumption increases, the welfare cost becomes greater and positive, hence, implies that the previous finding is not robust to the introduction of subsistence consumption. This fact further implies that if we compare two economies whose only difference is

[8]This is a natural consequence since their models are special cases of our model when $\overline{c} = 0$.

the level of subsistence consumption, the welfare cost is greater in the economy with high subsistence consumption, implying the greater welfare consequence of economic fluctuations on consumers in the less-developed economy. Therefore, stabilization policies may be more crucial for such an economy.

We can also observe that the welfare cost increases in g_N, the rate of population growth. On average, population growth is greater in the less-developed economies[9] so that considering population growth enhances our argument that stabilizing economic fluctuations are more important for such countries.

Robustness Checks. In order to check the robustness of our findings, we vary Frisch labor elasticity, as this is one of the key parameters in determining the welfare cost. In particular, we consider $\phi = (0, 1, 10)$ while g_N is kept as 2% in Figure 3.2, which confirms the robustness of our main finding.

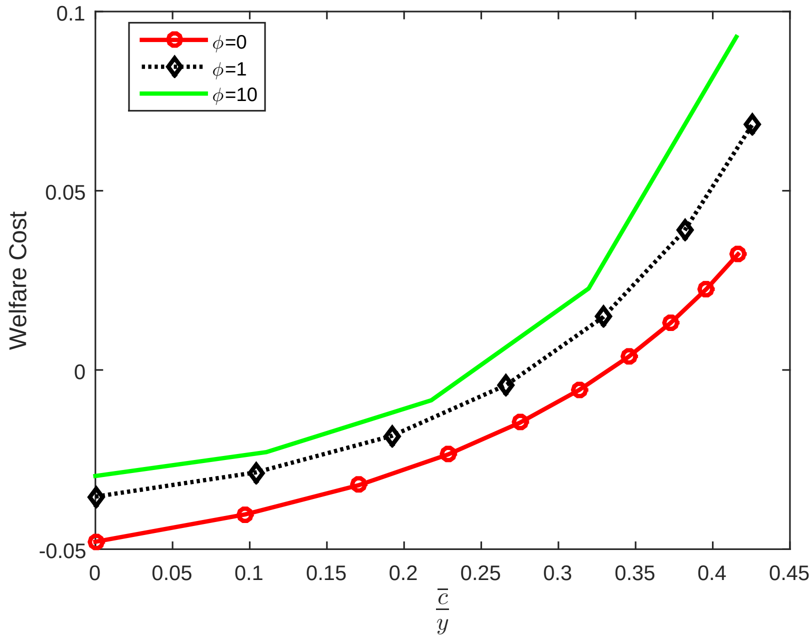

Figure 3.2: Welfare Cost of Business Cycles (%): varying ϕ

3.2 Economic Intuition

This section discusses why $\bar{c}$ and the welfare cost are positively related. As the welfare cost is a function of consumption volatility and hours volatility, the key to understand our finding is to study behavior of variability of consumption (and labor) alongside subsistence consumption. Figure 3.3 plots the standard deviation of detrended consumption relative to that of labor $(\sigma(c)/\sigma(h))$, indicating that it is increasing in subsistence consumption. In other words, consumption volatility

[9] Annualized population growth rate is above 2% for most poor countries and is around zero for developed countries (http://data.worldbank.org/indicator/SP.POP.GROW).

increases in subsistence consumption and so does the welfare cost of business cycles.

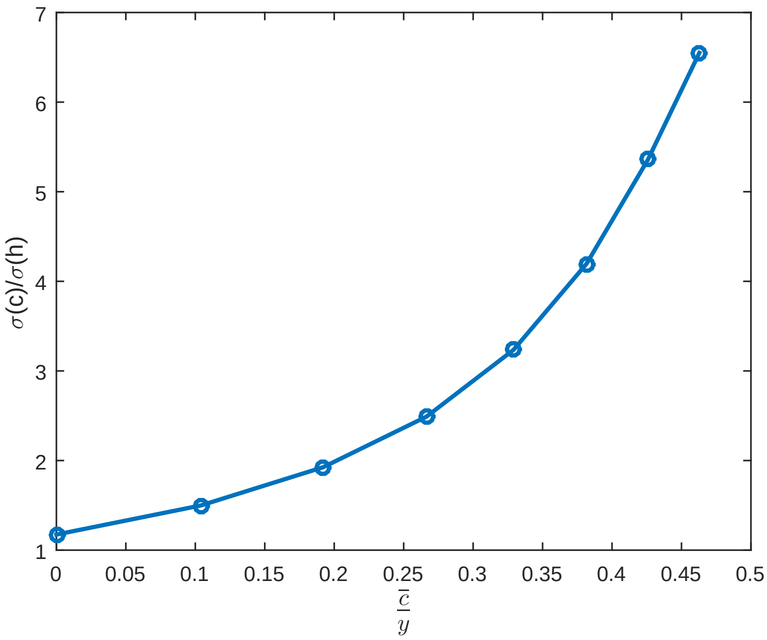

Figure 3.3: Consumption Volatility Relative to Hours Worked Volatility

We can explain this observation by understanding Figure 3.4: when there is a positive technology shock, both consumption and labor increase. However, consumption responds more while labor responds less as the level of subsistence consumption (–output ratio) becomes higher. The response of labor to an exogenous shock becomes lower by the following reasons: Given a positive shock, the consumers in economies with high subsistence consumption will be reluctant to supply a great deal of labor because of the already high marginal disutility from working as the steady-state hours worked are already high in such an economy (see Figure 3.5). On the flipside, given a negative shock, the consumer cannot substantially lower hours worked because of the subsistence consumption. As a labor supply equation equates the marginal rate of substitution between consumption and labor (MRS) and wage, MRS should change as the wage level changes: Restricted changes in labor due to high subsistence consumption require consumption to respond more.[10]

[10] Positive relationship between the rate of population growth and the welfare cost can be explained by the same logic hence analysis is omitted.

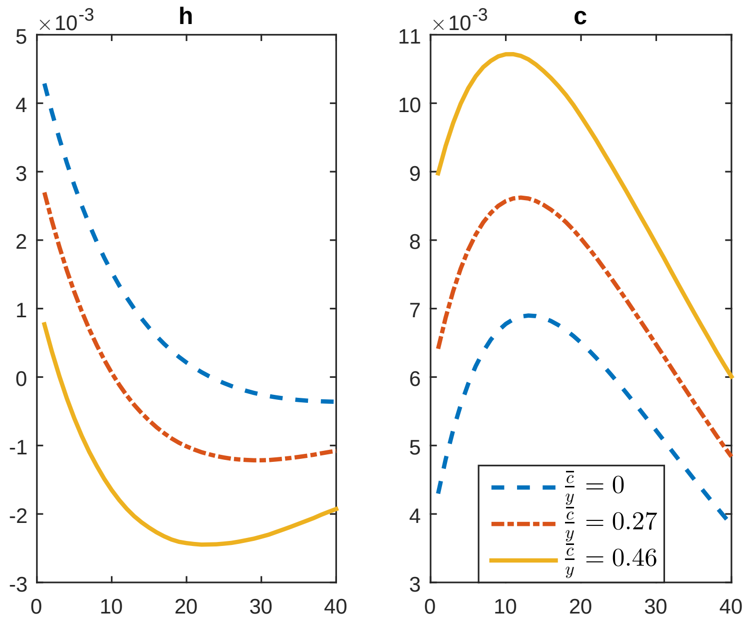

Figure 3.4: Impulse Response of Labor and Consumption

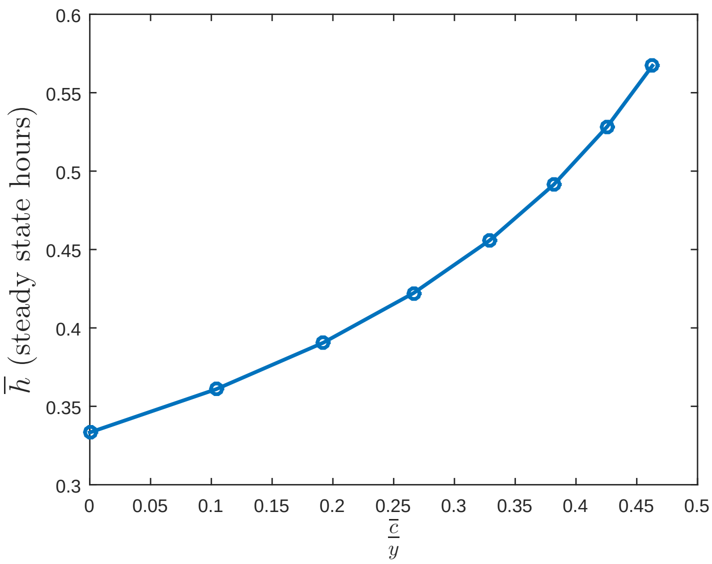

Figure 3.5: Steady-State Labor

4 Conclusion

We study the implications of subsistence consumption for the welfare cost of business cycles, which has not been studied in the previous literature. In doing so, considerations regarding subsistence consumption are introduced into the standard RBC model. We find that the welfare cost is increasing in the level of subsistence consumption–output ratio, which can be explained by the fact that consumption volatility is also increasing in the subsistence consumption–output ratio. Given that our model can match several key properties of less-developed countries such as high hours worked and high consumption volatility, our findings justify more active stabilization policies for those countries.

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A Appendix A. Optimality Conditions

There are three optimality conditions:

$$\tilde{c}_t^{-1} = \mathbb{E}_t \hat{\beta} \tilde{c}_{t+1}^{-1}((1-\alpha)Z_{t+1}k_{t+1}^{-\alpha}h_{t+1}^{\alpha} + 1 - \delta) \tag{A.1}$$

$$\tilde{c}_t \psi h_t^{\phi} = \alpha Z_t k_t^{1-\alpha} h_t^{\alpha-1} \tag{A.2}$$

$$\tilde{c}_t + (1+g_N)k_{t+1} = Z_t k_t^{1-\alpha} h_t^{\alpha} + (1-\delta)k_t - \overline{c} \tag{A.3}$$

B Appendix B. Derivation of λ

The value of the fluctuating economy is

$$V^{F,\lambda} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U((1+\lambda)(c_t - \overline{c}), h_t) \tag{B.1}$$

and

$$V^F = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\log(c_t - \overline{c}) - \psi \frac{h_t^{1+\phi}}{1+\phi} \right) = V^{FC} + V^{FN}, \tag{B.2}$$

where

$$V^{FC} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \log\left(c_t - \overline{c}\right) \tag{B.3}$$

$$V^{FN} = -\psi \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{h_t^{1+\phi}}{1+\phi} \tag{B.4}$$

$$V^{NF} = V^{F,\lambda} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\log((1+\lambda)(c_t - \overline{c})) - \psi \frac{h_t^{1+\phi}}{1+\phi} \right). \tag{B.5}$$

Using the definitions above and simplification yields:

$$V^{NF} = \frac{\log(1+\lambda)}{1-\beta} + V^{FC} + V^{FN} \tag{B.6}$$

Now

$$\lambda = \exp\big((1-\beta)(V^{NF} - V^{FN} - V^{FC})\big) - 1 \tag{B.7}$$

We define three new variables and compute λ:

$$V_t = \log(c_t - \overline{c}) - \psi \frac{h_t^{1+\phi}}{1+\phi} + \beta \mathbb{E}_t V_{t+1} \tag{B.8}$$

$$V_t^C = \log(c_t - \overline{c}) + \beta \mathbb{E}_t V_{t+1}^C \tag{B.9}$$

$$V_t^N = -\psi \frac{h_t^{1+\phi}}{1+\phi} + \beta \mathbb{E}_t V_{t+1}^N \tag{B.10}$$

C Supplementary Online Appendix (Not for Publication)

C.1 Effects of g_z on Welfare Cost In the main text, the shock process was specified as follows:

$$\ln Z_t = g_z + \rho \ln Z_{t-1} + \varepsilon_t \tag{C.1}$$

Here, g_z can be interpreted as a growth prospect of a specific country since it determines the trend of the total factor productivity. As different economies might have different potentials for economic growth, analyzing how growth prospects of an economy affects the welfare cost of business cycle can be an interesting research question.[11] In this section, we particularly analyze the extent to which different combinations of g_z and σ_z affect the welfare cost of business cycles. Results are reported from Table C.1 to C.3:

Table C.1: Welfare Cost of Business Cycles: $\bar{c}/y = 0\%$

g_z / σ_z	0.01	0.02	0.03	0.04	0.05
0.00	−0.0353	−0.1413	−0.3177	−0.5640	−0.8799
0.01	−0.0353	−0.1413	−0.3177	−0.5640	−0.8799
0.02	−0.0353	−0.1413	−0.3177	−0.5640	−0.8799
0.03	−0.0353	−0.1413	−0.3177	−0.5640	−0.8799

Table C.2: Welfare Cost of Business Cycles: $\bar{c}/y = 15\%$

g_z / σ_z	0.01	0.02	0.03	0.04	0.05
0.00	−0.0239	−0.0957	−0.2152	−0.3822	−0.5966
0.01	−0.0239	−0.0957	−0.2152	−0.3822	−0.5966
0.02	−0.0239	−0.0957	−0.2152	−0.3822	−0.5966
0.03	−0.0239	−0.0957	−0.2152	−0.3822	−0.5966

It is easy to observe that different g_z cannot affect the welfare cost of business cycles in our model. This comes from the specification of the shock in equation (C.1); when g_z changes, it only affects the steady-state level of Z but cannot change the dynamics of the model.

[11] We are grateful for the referee's suggestion.

Table C.3: Welfare Cost of Business Cycles: $\bar{c}/y = 40\%$

g_z / σ_z	0.01	0.02	0.03	0.04	0.05
0.00	0.0503	0.2014	0.4536	0.8079	1.2652
0.01	0.0503	0.2014	0.4536	0.8079	1.2652
0.02	0.0503	0.2014	0.4536	0.8079	1.2652
0.03	0.0503	0.2014	0.4536	0.8079	1.2652

C.1.1 Alternative Specification of Exogenous Growth In this section, we examine if an alternative way to introduce exogenous growth meaningfully affects our analysis. In particular, we will show that the model is exactly equivalent to the model discussed in the main text so that our main finding that the welfare cost of business cycles increases in subsistence consumption relative to output is preserved.

We now consider the following aggregate production function:

$$Y_t = Z_t K_t^{1-\alpha} \left(h_t X_t\right)^{\alpha}, \tag{C.2}$$

where X_t is the labor-augmenting technology progress with a net growth rate $g_X \geq 0$. Here we abstract from the population growth and normalize N_t as one.

Consider the same household's problem:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\ln\left(C_t - \overline{C}_t\right) - \psi \frac{h_t^{1+\phi}}{1+\phi} \right] \tag{C.3}$$

where $\overline{C}_t \equiv X_t \bar{c}$ in order for the subsistence consumption to be constant at the individual level. Define $c_t \equiv C_t / X_t$ yields

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\ln\left(c_t - \bar{c}\right) - \psi \frac{h_t^{1+\phi}}{1+\phi} \right] \tag{C.4}$$

where $\log X_t$ can be ignored. Hence, the above problem is exactly equivalent to the setup with the population growth but replacing it with the labor-augmenting technology progress. In other words, our finding is robust to the alternative modelling strategy discussed in this subsection.

C.2 CONCAVITY OF UTILITY ON WELFARE COST As is pointed out by Lester, Pries, and Sims (2014), concavity of a utility function may play an important role in determining the welfare cost of business cycles. In this section, we further check robustness of our findings in this regard. In doing so, we consider the following utility specification:

$$U(c_t - \overline{c}, h_t) = \frac{(c_t - \overline{c})^{1-\gamma} - 1}{1-\gamma} - \psi \frac{h_t^{1+\phi}}{1+\phi} \tag{C.5}$$

where $\gamma \geq 0$ measures relative risk aversion.

As the above utility function does not allow the model to exhibit a balanced growth path, we normalize population size as one. The result is drawn in Figure C.1, which confirms robustness of our finding.

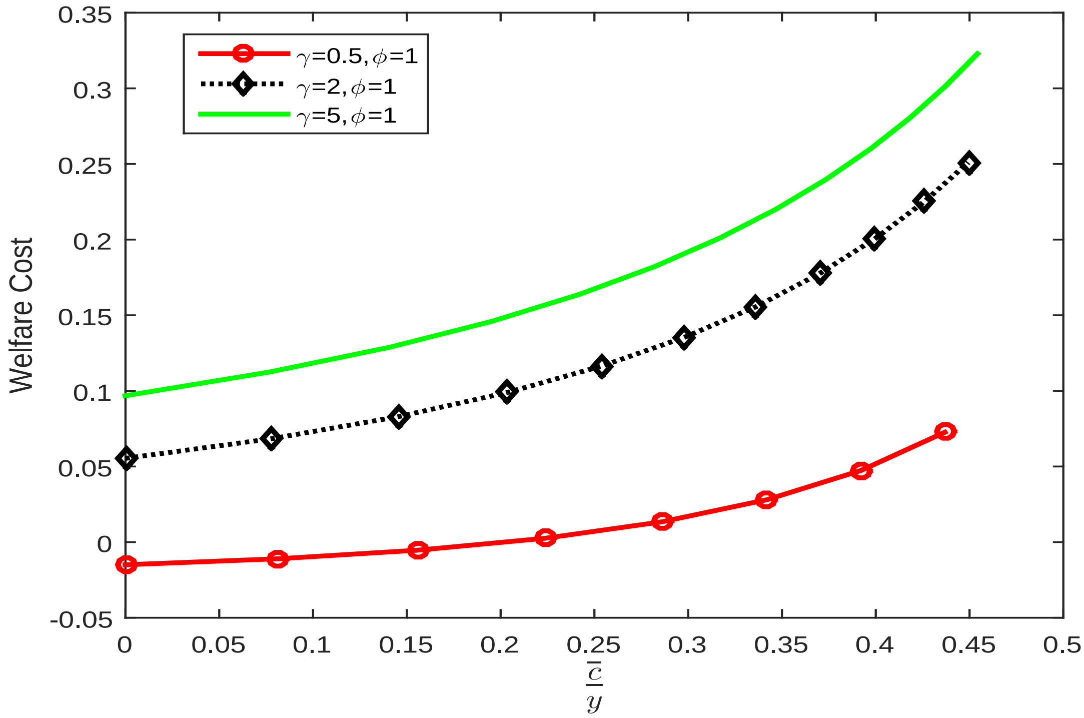

Figure C.1: Welfare Cost of Business Cycles: Effects of Risk Aversion