Andolfatto Meets Tallarini: Risk-Sensitive Unemployment Volatility*

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Abstract

This paper studies the business cycle, asset pricing, and their concomitant welfare effects when risk aversion is disentangled from intertemporal substitution and endogenous unemployment risk is present.

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*The usual disclaimer applies.

1 Introduction

Lucas (1987) argues that the upper bound estimate of welfare gains from eliminating business cycles is extremely small in an endowment economy. Assuming a representative agent with the standard CRRA preferences, his estimates of welfare costs of aggregate consumption fluctuations are no more than 0.00008 percent of lifetime aggregate consumption. In the same vein, Cho and Cooley (2005) further demonstrates that in a standard RBC production economy with logarithmic preferences, business cycle fluctuations are God's blessings, rather than misfortune: eliminating business cycles in this production economy results in welfare losses, not welfare gains.

[TO BE ADDED]

This paper studies the business cycle, asset pricing, and their concomitant welfare effects when risk aversion is disentangled from intertemporal substitution *and* endogenous unemployment risk is present. We argue that a RBC model would generate plausible welfare costs with both endogenous unemployment risk and the separation between risk averson and intertemporal substitution (EIS), but not with either taken separately.

One general diagnosis of the counter-intuitive welfare gains derived from the standard RBC model is that purposeful agents can take advantage of the business cycle uncertainty by working hard and investing more, enhancing the mean values of equilibrium output and consumption[1]. In response to this diagnosis, one plausible prescription is to consider agent heterogeniety, endogenously created by unemployment risk, whose impacts unequivocally differentiate between the social costs of business cycles and the costs to individuals. In other words, employed agents can effectively exploit shocks by working more, while unemployed agents cannot. Furthermore, we choose RBC models with endogenous capital accumulations and labour search as the benchmark model of endogenous unemployment risk. RBC models with labour search have the advantage of being parsimonious and tractable: in most cases, the models have one representative household (family) whose members are endogenously distributed according to unemployment risk. However, we find that without the separation between risk aversion and EIS, this class of models with endogenous unemployment risk fails to correct the observed welfare biases quantitatively. This quantitative failure reveals one unexpected but important link with the labour market volatility: without the observed high volatility of unemployment, the welfare costs of the models with endogenous unemployment risk should be small or even of opposite signs. In other words, as long as the models are biased by the unemployment volatility puzzle (the Shimer puzzle), their welfare implications are biased, too.

[TO BE ADDED]

[1] Cho and Cooley (2005) coined the term "the mean effect of the business cycle uncertainty" to denote these welfare-enhancing effects. This mean effect contrasts sharply with the "flucutation effect" of the business cycle uncertainty; the latter is always detrimental to welfare but the mean effect dominates the fluctuation effect in the production economy with common technology shocks, which is appropriately calibrated on the macro side.

The relevance of the separation between risk aversion and EIS in our context can be easily justified. As demonstrated in Kaltenbrunner and Lochstoer (2010), a standard production economy model where the representative agent has Epstein-Zin preferences can generate long-run consumption risk endogenously, even if common technology shocks are stationary. This additional long-run risk helps enhance the asset pricing performances of the production economy model and thus the significant amount of non-diversifiable risk in the economy can have substantial effects on the welfare estimates of the economy. In other words, once financial risk is taken into account, the welfare costs of business cycles can be large. In fact, this strategy has been regarded as a promising avenue for welfare estimates (Tallarini (2000)).[2] However, Caldara et al. (2009) find that for a reasonable range of the parameterization of risk aversion and EIS, the RBC models with Epstein-Zin preferences and endogenous labour supply fail to correct the observed welfare biases quantitatively.

[TO BE ADDED]

Based on two detailed observations, we entertain the hypothesis that both endogenous unemployment risk and the separation between risk aversion and EIS could correct the welfare biases. First, *given the separation between risk aversion and EIS*, the relevance of labour market frictions for the price of aggregate risk also seems to be easily justified. Without labour market frictions, any equilibrium business cycle models will have greater difficulty in generating the realistic persistence of output dynamics. In fact, Cogley and Nason (1995) demonstrate that the standard production economy generates virtually zero autocorrelations for the output growth; on the contrary, the US data reveals that the output growth is persistent within two quarters. This lack of persistence has the consequence of dramatically reducing the persistence of capital income dynamics and generating a quantitatively insignificant amount of non-diversifiable aggregate risk. In contrast, incorporating labour market frictions and the large flows in and out of employment into the standard business cycle model can generate realistic persistence in the output growth as shown in Andolfatto (1996). Second, *given endogenous unemployment risk*, the standard production economy model with Epstein-Zin preferences may recover the endogenous channel of long-run consumption risk.

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In sum, both factors can generate the realistic amount of endogenous non-diversifiable risk and its ripple effects on welfare costs of cycles could be large.

[2] Tallarini (2000) shows that holding intertemporal substitution constant, the welfare effects of increased risk aversion could be large in a standard RBC model with common random walk shocks. However, his model can generate a modest risk premium of 0.44% and his parameterization of risk aversion is a counterfactually high number of 100. Thus we consider Tallarini (2000) as an extreme case.

2 The Model

2.1 Representative Household

The model incorporates generalized recursive preferences (i.e. Epstein-Zin preferences) into an otherwise RBC framework with endogenous capital accumulation and labour search. In other words, the model economy shares the same features as Andolfatto (1996) except its preference specifications. In the model economy, there are households distributed uniformly on the unit interval and they face the standard consumption-saving problem. Due to labour market fricitions, however, households face altoghether unemployment risk; in each period households either have a job opportunity or not. Conditional on its employment status, each household has generalized recursive preferences represented by a utility function of the following form:

$$V_t^z = \left((1-\beta)\left(u(c_t^z, l_t^z)\right)^{1-\rho} + \beta\left(\Re_t^z\right)^{1-\rho}\right)^{\frac{1}{1-\rho}} \qquad (z = e, n)$$

where c_t^z and l_t^z represent its consumption and leisure, respectively, and the risk aggregator $\Re_t^z$, depending upon its employment status, is defined by

$$\Re_t^z = \left[E_t\left(V_{t+1}^z\right)^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \quad (z = e, n).$$

It is natural to impose the condition that $\rho \neq 1$ and $\gamma \neq 1$.

Introducing labour search in an RBC environment inevitably creates agent heterogeniety, conditional on unemployment risk, whose equilibrium characterizations are undoubtedly found intractable. Therefore, it would be extremely convenient to have one representative household (family) whose members perfectly insure each other againist variations in labour income due to unemployment risk. In other words, we seek to formulate the following maximization problem of a representative household:

$$J(k_t, n_t, z_t) = \max_{\{c_t^e, c_t^n, i_t, k_{t+1}, b_{t+1}^n\}} n_t W(u(c_t^e, 1-h_t), \Re_t) + (1-n_t) W(u(c_t^n, 1-e), \Re_t) \tag{1}$$

s.t.

$$n_t c_t^e + (1-n_t) c_t^n + i_t + \kappa \nu_t \leq y_t \tag{2}$$

$$y_t = z_t\left(k_t\right)^{\alpha}\left(n_t h_t\right)^{1-\alpha}$$

$$k_{t+1} = (1-\delta)k_t + i_t$$

$$n_{t+1} = (1-\psi)\,n_t + m_t \tag{3}$$

$$m_t = m(\nu_t, 1-n_t)$$

$$W(u(c_t^e, 1-h_t), \Re_t) = \left((1-\beta)\left(u(c_t^e, 1-h_t)\right)^{1-\rho} + \beta\left(\Re_t\right)^{1-\rho}\right)^{\frac{1}{1-\rho}}$$

$$W(u(c_t^n, 1-h_t), \Re_t) = \left((1-\beta)\left(u(c_t^n, 1-e)\right)^{1-\rho} + \beta\left(\Re_t\right)^{1-\rho}\right)^{\frac{1}{1-\rho}}$$

$$\Re_t = \left[E_t\left(J(k_{t+1}, n_{t+1}, z_{t+1})\right)^{1-\gamma}\right]^{\frac{1}{1-\gamma}}$$

This representative household (family), by construction, implies perfect risk sharing between its employed members and its unemployed members, but the real question is whether such representative household (family) does exist or not. It is not so obvious as in the case of the standard expected utility preferences. As a matter of fact, under the standard expected utility preferences, the very existence of the representative household can be warranted in the following manner.

Theorem 1 *Suppose that in the model economy with endogenous capital accumulations and labour search, conditional on its employment status, each household has the standard expected utility preferences represented by a utility function, not necessarily separable between consumption and leisure, of the following form:*

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_t^z, l_t^z) \quad (z = e, n).$$

Then, the standard expected utility preference specifications allow for a representative household (family) whose members (workers) perfectly insure each other agaimist variations in labour income due to unemployment risk. In other words, its employed workers and its unemployed workers allocate risk efficiently.

Lemma 1 *(Andolfatto (1996)) Suppose that in the model economy with endogenous capital accumulations and labour search, conditional on its employment status, each household has the standard CRRA separable preferences represented by a utility function of the following form:*

$$E_0 \sum_{t=0}^{\infty} \beta^t [u(c_t^z) + \phi(z) H(l_t^z)] \quad (z = e, n),$$

where the value of the parameter $\phi(z) > 0$ depends on a household's employment status. Then, the standard CRRA separable preference specifications allow for a representative household (family) whose members (workers) perfectly insure each other agaimist variations in labour income due to unemployment risk. Its perfect risk-sharing condition reads as

$$u'(c_t^e) = u'(c_t^n).$$

In other words, the model economy acheives an equilibirum with classical perfect risk-sharing such that

$$c_t^e = c_t^n.$$

Lemma 2 *(Cheron and Longot (2003)) Suppose that in the model economy with endogenous capital accumulations and labour search, conditional on its employment status, each household has the Rogerson-Wright expected utility preferences represented by a utility function, nonseparable between consumption and leisure, of the following form:*

$$E_0 \sum_{t=0}^{\infty} \beta^t [u(c_t^z + \phi(z) H(l_t^z)) + a c_t^z] \quad (z = e, n),$$

where the value of the parameter $\phi(z) > 0$ depends on a household's employment status and $a \geq 0$. Then, the Rogerson-Wright expected utility preference specifications allow for a representative household (family) whose members (workers) perfectly insure each other againist variations in labour income due to unemployment risk. Its perfect risk-sharing condition reads as

$$u'(c_t^e + \phi(e) H(l_t^e)) = u'(c_t^n + \phi(n) H(l_t^n)).$$

In other words, the model economy acheives an equilibirum with Rogerson-Wright perfect risk-sharing where the utility of unemployed workers cannot exceed the utility of employed workers and

$$c_t^e > c_t^n.$$

Theorem 2 *Suppose that in the model economy with endogenous capital accumulations and labour search, conditional on its employment status, each household has generalized recursive preferences (i.e. Epstein-Zin preferences) represented by a utility function of the following form:*

$$V_t^z = \left((1-\beta) \left(u(c_t^z, l_t^z) \right)^{1-\rho} + \beta \left(\Re_t^z \right)^{1-\rho} \right)^{\frac{1}{1-\rho}} \qquad (z = e, n)$$

where the risk aggregator $\Re_t^z$, depending upon its employment status, is defined by

$$\Re_t^z = \left[E_t \left(V_{t+1}^z \right)^{1-\gamma} \right]^{\frac{1}{1-\gamma}} \quad (z = e, n).$$

It is natural to impose the condition that $\rho \neq 1$ and $\gamma \neq 1$. Then, independently of the EIS parameter $\frac{1}{\rho}$, the Epstein-Zin preference specifications allow for a representative household (family) whose members (workers) perfectly insure each other againist variations in labour income due to unemployment risk if and only if the felicity function $u(c_t^z, l_t^z)$ $(z = e, n)$ is given by

$$u(c_t^z, l_t^z) = c_t^z + \phi(z) H(l_t^z).$$

Its perfect risk-sharing condition reads as

$$u'(c_t^e + \phi(e) H(l_t^e)) = u'(c_t^n + \phi(n) H(l_t^n)).$$

In other words, the model economy acheives an equilibirum with Rogerson-Wright perfect risk-sharing where the utility of unemployed workers equals the utility of employed workers and

$$c_t^e > c_t^n.$$

Lemma 3 *Suppose that in the model economy with endogenous capital accumulations and labour search, conditional on its employment status, each household has Epstein-Zin preferences represented by a utility function of the following form:*

$$V_t^z = \left((1-\beta)\left(u(c_t^z, l_t^z)\right)^{1-\rho} + \beta\left(\Re_t^z\right)^{1-\rho}\right)^{\frac{1}{1-\rho}} + ac_t^z \qquad (z = e, n)$$

where the risk aggregator $\Re_t^z$, depending upon its employment status, is defined by

$$\Re_t^z = \left[E_t\left(V_{t+1}^z\right)^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \quad (z = e, n).$$

It is natural to impose the condition that $a > 0$, $\rho \neq 1$ and $\gamma \neq 1$. Then, independently of the EIS parameter $\frac{1}{\rho}$, the above Epstein-Zin preference specifications allow for a representative household (family) whose members (workers) perfectly insure each other againist variations in labour income due to unemployment risk if and only if the felicity function $u(c_t^z, l_t^z)$ $(z = e, n)$ is given by

$$u(c_t^z, l_t^z) = c_t^z + \phi(z)H(l_t^z).$$

Its perfect risk-sharing condition reads as

$$u'(c_t^e + \phi(e)H(l_t^e)) = u'(c_t^n + \phi(n)H(l_t^n)).$$

In addition, the model economy acheives an equilibirum with Rogerson-Wright perfect risk-sharing where the utility of employed workers exceeds the utility of unemployed workers and

$$c_t^e > c_t^n.$$

Lemma 4 *Suppose that in the model economy with endogenous capital accumulations and labour search, conditional on its employment status, each household has Epstein-Zin preferences represented by a utility function of the following form:*

$$V_t^z = \log(c_t^z) + \phi(z)\log(h_t^z) + \beta\left(\frac{2}{\theta}\right)\log\left(E_t[\exp(\left(\frac{\theta}{2}\right)V_{t+1}^z)]\right) \qquad (z = e, n)$$

where the value of the parameter $\phi(z) > 0$ depends on a household's employment status and $\theta = (1 - \beta)(1 - \chi)$. χ represents coefficients of relative risk aversion. Then, the above Epstein-Zin preference specifications allow for a representative household (family) whose members (workers) perfectly insure each other againist variations in labour income due to unemployment risk. Its perfect risk-sharing condition implies an equilibirum with classical perfect risk-sharing such that

$$c_t^e = c_t^n.$$

2.2 Welfare Costs

To estimate the impacts of high unemployment volatility on welfare costs of business cycles, it is illustrative to note that, under differentiability assumptions, the second-order Taylor approximation around the deterministic steady state $(\bar{k}, \bar{n}, \bar{z}; 0)$ reads as:

$$\begin{aligned} V(k_t, n_t, z_t; \sigma) \simeq \; & V_{1,ss}(k_t - \bar{k}) + V_{2,ss}(n_t - \bar{n}) + V_{3,ss}(z_t - \bar{z}) + V_{4,ss}\sigma \\ & \frac{1}{2}V_{11,ss}(k_t - \bar{k})^2 + \frac{1}{2}V_{12,ss}(k_t - \bar{k})(n_t - \bar{n}) + \frac{1}{2}V_{13,ss}(k_t - \bar{k})(z_t - \bar{z}) + \frac{1}{2}V_{14,ss}(k_t - \bar{k})\sigma \\ & \frac{1}{2}V_{21,ss}(k_t - \bar{k})(n_t - \bar{n}) + \frac{1}{2}V_{22,ss}(n_t - \bar{n})^2 + \frac{1}{2}V_{23,ss}(n_t - \bar{n})(z_t - \bar{z}) + \frac{1}{2}V_{24,ss}(n_t - \bar{n})\sigma \\ & \frac{1}{2}V_{31,ss}(k_t - \bar{k})(z_t - \bar{z}) + \frac{1}{2}V_{32,ss}(n_t - \bar{n})(z_t - \bar{z}) + \frac{1}{2}V_{33,ss}(z_t - \bar{z})^2 + \frac{1}{2}V_{34,ss}(z_t - \bar{z})\sigma \\ & \frac{1}{2}V_{41,ss}(k_t - \bar{k})\sigma + \frac{1}{2}V_{42,ss}(n_t - \bar{n})\sigma + \frac{1}{2}V_{43,ss}(z_t - \bar{z})\sigma + \frac{1}{2}V_{44,ss}\sigma^2 \end{aligned}$$

By certainty equivalence, we have

$$V_{4,ss} = V_{14,ss} = V_{24,ss} = V_{34,ss} = 0$$

[TO BE ADDED]

Economy	Welfare gain (loss)?	Welfare Costs	σ_{th}/σ_y	σ_u/σ_y	$E[R^e - R^f]$
Data				7.05	6.18
RBC (inelastic labour)	gain	+0.19%	0.00	0.00	
Hansen	gain	+0.04%	0.84	0.00	
Andolfatto	gain	+1.126%		0.68	
Cheron-Langot					
Tallarini				0.00	
EZ-RBC	gain			0.00	
EZ-MP-RBC					

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