Trading Business−Cycle Depth for Duration using an economy−specific characteristic

Ossama Mikhail
Dept. of Economics − College of Business Administration − University of Central Florida

Abstract

Regarding the trade−off between the depth and the duration of recessions, there exists a mounting empirical evidence of the idiosyncratic and non−synchronized behavior of the business cycle over time within and across countries. To account for the trade−off, a model is presented wherein an economy−specific parameter does control the magnitude, severity and persistence of the business cycle without the need to add an asymmetric functional form [that captures the propagation mechanism] to the model. The model results show that as much as half of a percentage point of GDP in depth and a relative difference of three years duration can be attributed to this parameter. The model implies a two−dimensional depth−duration space wherein we place the [average] depth−duration expansion and contraction for the U.S.

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Trading Business-Cycle Depth for Duration Using an Economy-Specific Characteristic.

Ossama Mikhail *

Department of Economics, University of Central Florida

Abstract

Regarding the trade-off between the depth and the duration of recessions, there exists a mounting empirical evidence of the idiosyncratic and non-synchronized behavior of the business cycle over time within and across countries. To account for the trade-off, a model is presented wherein an economy-specific parameter does control the magnitude, severity and persistence of the business cycle without the need to add an asymmetric functional form [that captures the propagation mechanism] to the model. The model results show that as much as half of a percentage point of GDP in depth and a relative difference of three years duration can be attributed to this parameter. The model implies a two-dimensional depth-duration space wherein we place the [average] depth-duration expansion and contraction for the U.S.

Keywords: Business Cycles Depth; Business Cycles Duration; Real Business Cycle; U.S. Business Cycle Asymmetry.

JEL classification: B41; E32; P16

* Phone: (407) 823-4258; Fax: (407) 823-3269. I am thankful to the Associate Editor for helpful comments and to John Chitty for editorial assistance.

Email address: omikhail@bus.ucf.edu (Ossama Mikhail).

1 Introduction

Ever since the seminal paper by Ragnar Frisch (1933), the 'rocking-horse theory' of the business cycle[1] (also referred to as the Cassel paper, after the volume in which it appeared) became the base and the antecedent of most macroeconomists dynamic pursuit to understand and explain business cycles. Build on Wicksell's original idea, Frisch outlined a distinctive separation and a clear dichotomy between the impulse problem and the propagation problem of random shocks that impinge on the economy.

> "There need not be any synchronism between the initiating force or forces and the movement of the swinging system. This fact has frequently been overlooked in economic cycle analysis. If a cyclical variation is analysed from the point of view of a free oscillation, we have to distinguish between two fundamental problems: first, the **propagation** problem; second, the **impulse** problem." Frisch (1933, p. 171)

Explaining the shape of the business cycle has been (and still is) a concern for researchers. Based on the premise of a 'rigid' impulse problem, - that is once specified at the outset, will not change its characteristics, - and following Frisch dichotomy, most studies propose different propagation mechanisms by which the shock get translated and amplified into a fully developed business cycle.

In this paper, we propose a formulation, wherein the standard benchmark model conforms to Frisch' theory: the impulse is the technology shocks and the propagation is carried through a 'time to build' as outlined by Kydland and Prescott (1982). The suggested formulation allows for an economy-specific parameter that does control the severity [magnitude] and the persistence of the business cycle - at the same time. By knitting the propagation and the impulse problems into a single parameter, the model proposed here is able to generate different

[1] 'If you hit a wooden rocking-horse with a club, the movement of the horse will be very different to that of the club.' Frisch (1933, p. 198). For a complete review, refer to Morgan (1995, pp. 92-93).

depth-duration trade-offs based solely on the behavior of this economy-specific parameter. The parameter serves two functions: it is an integral part of the economy productive capacity [structure], and it controls the degree of persistence of the shock [impulse], therefore this formulation puts into question the merits of the dichotomy.

2 Review of the literature

The motivation of the paper builds on a paramount [empirical] business cycles studies that reported evidence of idiosyncratic and non-synchronous behavior regarding the magnitude and the persistence of the cycle. The empirical fact of changes in the severity and persistence of business cycles is well documented and concede at a varying rate to the evidence suggesting that business cycles are no longer similar, nor linked, over time within or across countries. For the U.S., a moderation in output fluctuations is observed. McConnell and Perez-Quiros (2000), Blanchard and Simon (2001), and Stock and Watson (2002, 2003) reported evidence of changes in the character of the U.S. business cycle. In international data, output volatility and the non-synchronous behavior are documented in Artis and Zhang (1999), Mills and Wang (2002), van Dijk, Osborn, and Sensier (2002), Del Negro and Otrok (2003) and Ambler, Cardia and Zimmermann (2004). Regarding the trade-off between depth and duration, cycles in emerging countries tend to have shorter duration and larger [amplitude] volatility than in developing countries (Edwards, Biscarri and de Gracia 2003).

[Insert Table 1, Figures 1 and 2 here]

Table 1 and Figures 1 and 2 show the asymmetric nature of peace-time U.S. business cycles. Contractions and expansions do not share the same [average] amplitude, or duration. An asymmetry is well present, in the sense that contractions [expansions] are of lower [higher] amplitude and persist less [more]. At first, the model presented here is an attempt to structurally model the within-cycle asymmetry, wherein we assume 'amplitude symmetry' and focus on the trade-off between the amplitude and the duration of the cycle.[2] This exercise is useful for cross-country comparisons. Later, Table 2 will provide a mapping from the model parameters to the apparent asymmetry in Figures 1 and 2 and to the empirical facts presented in Table 1. Here, the economy-specific parameter holds the key to the shape of the business cycle.[3]

3 Model and results

The economy is characterized by a large number of identical consumers. The single consumer is assumed to be representative of the society as a whole. Representative agents' preferences are represented by a utility function which is time separable in consumption and leisure, and it is state independent. The household solves the following problem.

$$\max_{\{c_t,n_t,k_{t+1}\}_{t=0}^{\infty}} E_t \left\{ \sum_{t=0}^{\infty} \beta^t (\log c_t - \gamma n_t) \right\} \tag{1}$$

subject to,

$$y_t = \frac{1}{\mu} A_t k_t^{\alpha} n_t^{1-\alpha} \tag{2}$$

$$k_{t+1} = (1-\delta_k)k_t + i_t \tag{3}$$

$$\log A_{t+1} = (1-\psi\mu)\log \overline{A} + \psi\mu \log A_t + \epsilon_{t+1} \tag{4}$$

$$c_t + i_t \leq y_t \tag{5}$$

$$l_t + n_t \leq 1 \tag{6}$$

[2] Here, the calibrated model represents one line in Figure 4.

[3] For example, the Canadian and the U.S. economies exhibit different business cycle characteristics to the extent that few have argued that it must have been different shocks that impinged on both. With similar technological trends in Canada and the U.S., it is unlikely that technological change can lead to a relatively more persistent business cycle in Canada when it does not have that effect in the U.S. (Sharpe (1999, p. 31)). However, and while it is accepted that both countries tend to face similar technological trends, the Canadian economy is characterized by relatively different institutional structures and public programs. In terms of industry' existence and functioning, there are gaps that impinge on the speed of recovery during a recession. Faced with a technology shock similar to that in the U.S., the Canadian economy will experience higher persistence in terms of output deviations. This relative higher persistence of the business cycle can be captured by the proposed parameter.

c_t, n_t, l_t, k_t and y_t refer to consumption, labor, leisure, capital and output, respectively. E_t refers to the expectation operator. A_t denotes the technology shock. The subjective time discount factor β is constrained to $0 < \beta < 1$ and is defined as $\beta \equiv 1/(1 + \rho)$, where ρ is the rate of time preference. α and δ_k refers to the capital share in income and the capital depreciation rate, respectively. There is one final good in this economy, and it is produced according to a constant returns to scale production function given by Equation (2). Equation (3) is the capital law of motion, i.e., 'time to build' for capital. Equation (4) describes the evolution of the technology shock, and ϵ_t denotes a white noise process. Equations (5) and (6) are the resources and time constraints, respectively.

An exogenous economy-specific parameter is integrated into a standard real business cycle model to investigate the merit of the 'trade-off between depth and duration' statement. The parameter μ is a rate and it is constrained to the interval $0 < \mu \leq 1$ in equations (2) and (4). μ refers to the economy-specific parameter that controls the shape of the business cycle. Think of μ as an absorption rate parameter. A higher value for this parameter is equivalent to a higher absorption rate of the technological shock. In other words, the higher μ is, the lower is the amplitude of the business cycle swing and the more persistent is the business cycle. Assume that μ is exogenous and could be identified and estimated using both: the economic freedom index and the Solow' residuals, for example. Here, we abstract from the endogeneity, identification and estimation of this parameter.

Note that if $\mu = 1$ (no absorption), then the proposed model reduces to a standard real business cycle model, wherein $0 < \psi < 1$ is the sole parameter that controls the persistence of the shock. Subjected to a stochastic technology shock A_t, the structure of the economy absorbs part of this shock ($1/\mu$). Also, the structure of the economy controls how persistent the shock is (μ in Equation (4)).

The model is solved, log-linearized and simulated with sensitivity to the structure using numerical rational expectations - following Uhlig (2001, p. 38). The calibrated parameters are chosen to ensure that the capital to output steady state value matches the U.S. sample data. The quarterly calibrated parameters used to generate the impulse responses are: $\beta = 0.99$, $\alpha = 0.36$, $\delta_k = 0.025$ and $\psi = 0.95$. β is set to imply a steady-state real interest rate of 1 percent per quarter. α is set to match the average fraction of total income going to capital in the U.S. economy. The depreciation rate (δ_k) is set to imply a steady-state ratio of capital to output of approximately 10 and a ratio of investment to output of 0.26. ψ and the standard deviation $\sigma_\epsilon = 0.007$ are set equal to the same value used by Prescott (1986). γ is computed from the steady-state and equals 2.5.

There is no single point estimate for the parameter μ, therefore we address this issue by calibrating the model with different set of points for this parameter ($\mu \in \{0.01, 0.5, 0.99\}$).

[Insert Figure 3 here]

Figure 3 presents the impulse response for output following a shock to technology under three different rates $\mu \in \{0.01, 0.5, 0.99\}$. At $\mu = 0.01$, the effects of the shock ends after one year, whereas at $\mu = 0.99$, the effects last for (at least) four years. A relative difference of three years persistence in the business cycle is attributed to this parameter. The relative difference in the depth stands at a half percentage point of GDP. The Figure illustrates how can an economy-specific parameter be responsible for the depth-duration trade off. The higher μ is, the higher is the absorption rate and the lower is the amplitude of the business cycle.

An immediate extension of the model, is to replace the parameter μ by μ_i $(i = 1, 2)$, where 1 and 2 refer to the degree of shallowness and persistence of the business cycle, respectively. μ_1 and μ_2 should replace μ in Equations (2) and (4), respectively. This parametrization implies that the parameter is different in value for the amplitude relative to persistence, but still influenced and determined by the structure of the economy.[4] Also, this model could be adapted to map within-economy asymmetries like the one observed in the U.S. Table 2 and Figure 4 propose a range of values whereby the model parameters can explain the asymmetries in the U.S. business cycle. Note that the U.S. expansion fits on the line of region IV, and the contraction fits in Region II of Figure 4.

[Insert Table 2 and Figure 4 here]

4 Conclusion

In this paper, we presented a formulation wherein an economy-specific parameter - (e.g., the financial institutional framework and regulations) does control the magnitude, severity and persistence of the business cycle. Conditioned on the calibrated parameters, the results suggest that an economy-specific parameter is suspect for the depth-duration trade off that is observed over time within and across countries. As much as half of a percentage point of GDP in depth and a relative difference of three years duration can be attributed to this parameter.

[4] As for the Canadian and the U.S. business cycles comparison, the empirical facts reported in Section 2 suggest that $\mu_1^{CAD} \simeq \mu_1^{U.S.}$, and $\mu_2^{CAD} > \mu_2^{U.S.}$, i.e., both economies share the same amplitude, but the Canadian business cycle will persist more relative to the U.S.

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5 Tables

Table 1: Average Duration in Months of Business Cycles in the U.S. 1854-2001

	Number of	Contraction		Expansion		Cycle (T to T)	
Period in years	Cycles	Mean	StDev	Mean	StDev	Mean	StDev
1854-1897	10	24	17	27	9	51	24
1897-1933	10	20	10	23	10	43	10
1933-1982	10	11	3	49	27	60	26
1933-1982 excl. wars	7	11	4	37	15	48	14
1854-2001	32	17	12	38	27	55	26
1854-1919	16	22	14	27	10	48	19
1919-1945	6	18	13	35	26	53	22
1945-2001	10	10	3	57	37	67	35
Peace-Time cycles							
1854-2001	27	18	13	33	24	51	24
1854-1919	14	22	14	24	7	46	19
1919-1945	6	19	12	28	14	47	15
1945-2001	7	10	4	54	39	65	37

The ‘Business Cycle Dates’ data are from the National Bureau of Economic Research (NBER).

Table 2: Mapping the Model Parameters to the U.S. business Cycle Asymmetry

	μ	$\mu\psi$
ϵ^+ : Positive Shock [Expansion]	$\mu \leq 0.5$: High Amplitude	$\mu\psi \geq 0.5$: High Duration
ϵ^- : Negative Shock [Contraction]	$\mu > 0.5$: Low Amplitude	$\mu\psi < 0.5$: Low Duration
U.S. Expansion falls in Region IV	Figure 4	
U.S. Contraction falls in Region II	Figure 4	

6 Figures

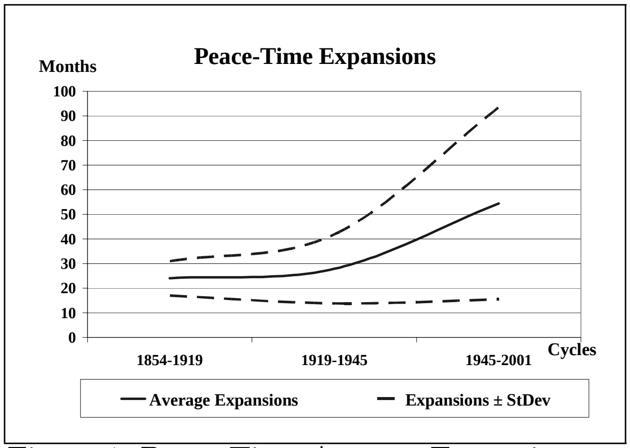

Figure 1: Peace-Time Average Expansions

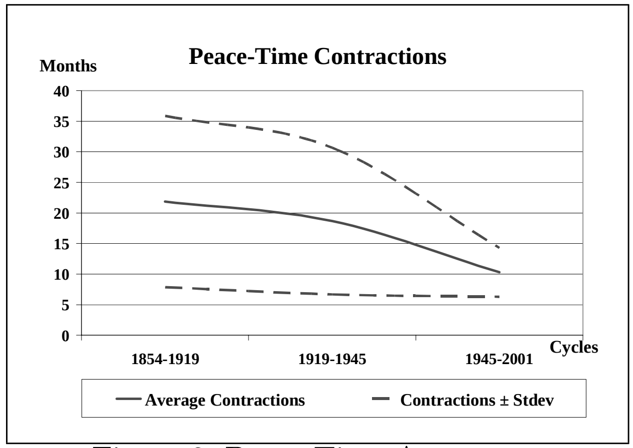

Figure 2: Peace-Time Average Contractions

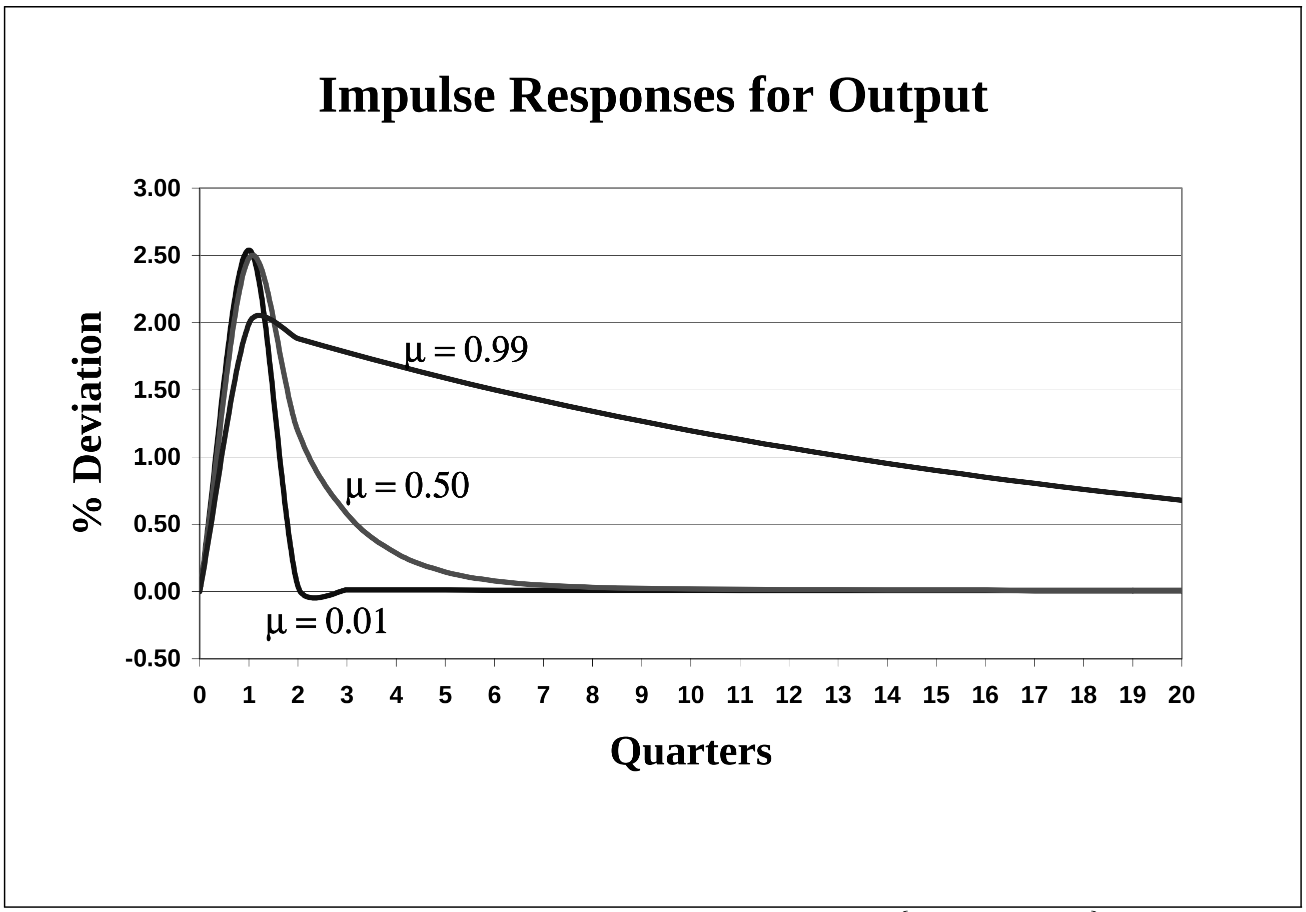

Figure 3: Model Impulse Responses for Output - $\mu \in \{0.01, 0.5, 0.99\}$

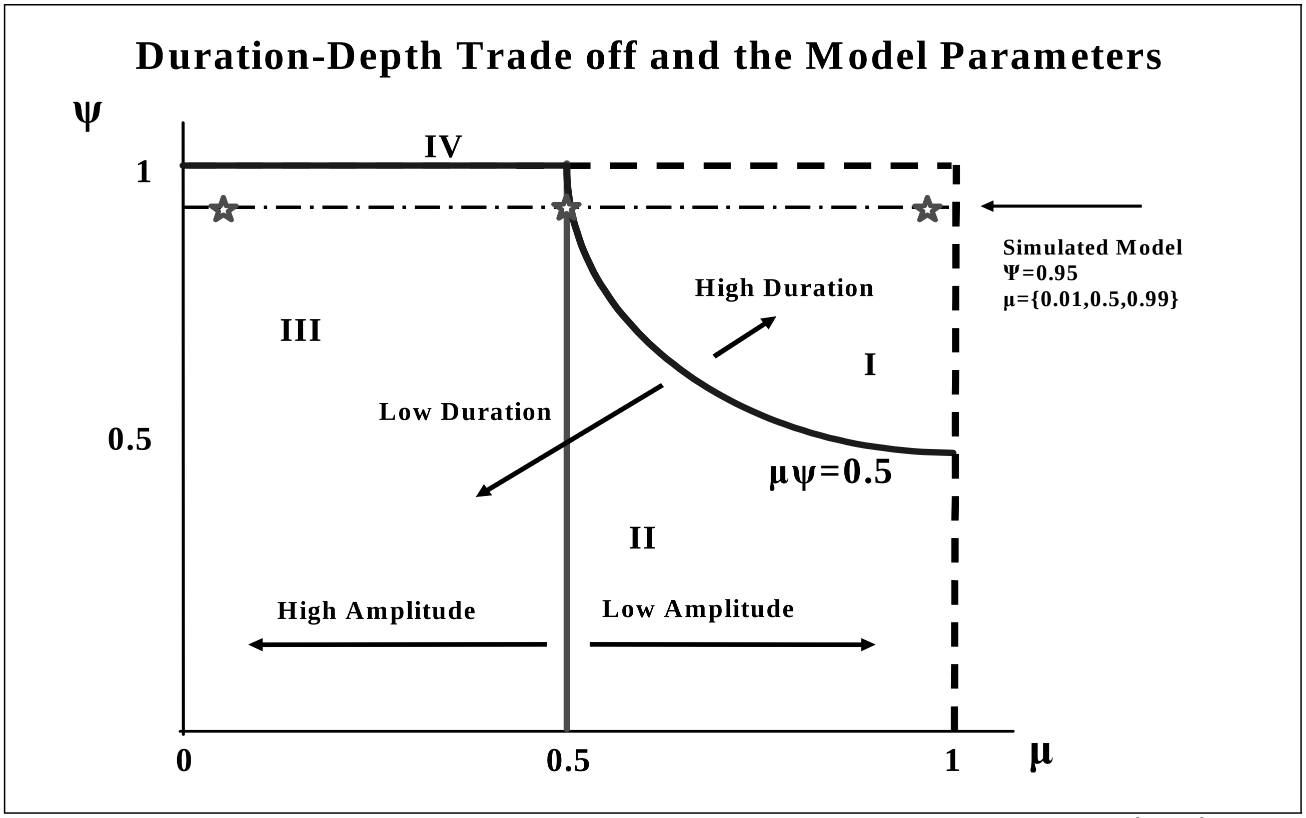

Figure 4: Duration-Depth combinations as a function of the parameters values (μ, ψ).