SHADOW ECONOMY OVER THE BUSINESS CYCLE:
HOW DO FORMAL AND INFORMAL CYCLES INTERACT?

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How do Formal and Informal Cycles Interact?

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Thesis Abstract

Serdar Birinci, “Shadow Economy over the Business Cycle: How do Formal and Informal Cycles Interact?”

In this thesis, first, relying on a two-sector dynamic general equilibrium model, I construct quarterly estimates of shadow economy size for 15 advanced economies for a time period from 1960 to 2010. This gives me the largest quarterly shadow economy size data in the literature. Next, using this novel data, I provide a comprehensive empirical characterization of the linkages between the formal and the shadow economies around the business cycles. The results indicate that the shadow economy size as a percentage of official GDP is generally countercyclical and a larger shadow economy is associated with a larger amplitude and longer duration of formal expansions and larger amplitude of formal recessions.

Tez Özeti

Serdar Birinci, “ Kayıt Dışılığın Ekonomik Dalgalanmalar Üzerine Etkisi: Kayıt Dışı Ekonomi ile Kayıt Altındaki Ekonominin Etkileşimi”

Bu tez çalışmasında, öncelikle iki sektörlü genel denge modeli üzerinden 15 gelişmiş ülke ekonomisinin 1960-2010 yılları arasında her bir çeyrek için kayıt dışı ekonomi seviyesi tahmin edilmiştir. Bu sayede, literatürdeki çeyrek dönemler için sunulmuş en geniş kayıt dışı ekonomi seviyesi verisi oluşturulmuştur. Daha sonra, bu veri kullanılarak söz konusu dönemde veri setindeki ülkelerin her biri için kayıt dışı ekonomi ile kayıt altındaki ekonomi arasındaki etkileşim ampirik olarak analiz edilmiştir. Sonuçlara göre kayıt dışı ekonomi seviyesinin, kayıt altındaki ekonomi ile ters yönde hareket ettiği ve daha yüksek kayıt dışı ekonomi seviyesinin, daha büyük ve daha uzun kayıtlı ekonomi büyümeleri ve daha büyük kayıtlı ekonomi küçülmeleri ile ilişkili olduğu saptanmıştır.

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CHAPTER 1

INTRODUCTION

Considering the drastic busts many advanced economies had experienced during the past few years, understanding the nature of economic fluctuations is proven to be important especially in the face of designing economic policies aiming towards reducing the effects of these recessions. This led many economists to develop an intensive discussion about the determinants of business cycles. (See Chari, Kehoe, and McGrattan, 2007; Claessens, Kose, and Terrones, 2011; Altug and Canova, 2012 among many other examples.) In this regard, a cyclical analysis of any macroeconomic variable is important because such an analysis would provide empirical evidence for the impact of that specific variable to the cyclical fluctuations. For example, Claessens, Kose and Terrones (2011) investigate the variation in the nature of business cycles across different phases of financial cycles and they conclude that the interaction between business and financial cycles contributes significantly to various specific features of recessions and recoveries. Moreover, in another recent paper Altug and Canova (2012) examine the role of institutions and culture on economic fluctuations of a set of developed, developing and emerging market economies. They found that institutional and cultural indicators have significant impacts on the duration and the amplitude of the business cycles.

To broaden our understanding about the dynamics of the business cycles, more factors should be incorporated into the business cycle analysis. Presence of a shadow economy is definitely one of these factors that have not been studied before within a business cycle framework. Shadow economy, sometimes also titled informal, hidden, black, second or underground economy is defined by Tanzi (1999),

as the production and distribution of goods and services that are unaccounted for in the official National Income Accounts of a country. A similar definition is provided by Hart (2008) as a set of economic activities that takes place outside the framework of bureaucratic public and private sector establishments. Generally, the shadow economy is viewed as a highly labor-intensive sector operating on small scale, avoiding most (if not all) of the taxes and government regulations and also not utilizing public capital as much as the formal economy. (See Ihrig and Moe, 2004 and Elgin, 2010.) However, in this regard, it serves as a substitute (albeit an imperfect one) to the formal economy both for firms and households. Being outside of government scrutiny, it does not comply with government regulations (including social security requirements), standards and usually avoid most of the (if not all) taxes. With these characteristics, the informal economy provides room for a significant amount of labor and produces a substantial value-added which, as argued above, is largely absent in official GDP statistics. Notably, among many other complications, this leads to a certain amount of underestimation of total value-added within an economy. Considering that firms and households in either sector (formal and informal) can reallocate from one sector to another omitting the interaction between formal and informal cycles maybe misleading for policy makers.

One can see from the above-mentioned definitions of the shadow economy that the cyclical behavior of the shadow economy as well as its effects on formal cycles are not immediately clear. To address this and fill in the gap in the literature, in this paper relying on a two-sector dynamic general equilibrium model, I first construct quarterly estimates of shadow economy size for 15 advanced economies for a time period from 1960:1 to 2010:4. This gives me the largest quarterly shadow

economy size data in the literature. Moreover, here I find that even though the size of the shadow economy follows a decreasing trend over time, it also exhibits cyclical fluctuations. This observation strengthens my hypothesis that there might be strong linkages between formal and informal cycles. Next, using this novel data, I provide a comprehensive empirical characterization of the linkages between the formal and the shadow economies around the business cycles for these countries over the given period. Specifically, I focus on the duration, time in event, amplitude, cumulative loss or gain and the slope of the phases and cycles to determine their dynamics. At the cycle level, I end up with 82 formal cycles and 126 informal cycles for 15 advanced economies over the specified period. Here, I observe that formal cycles are longer than informal cycles. Then, when I go to deeper to the phase (recessions and expansions) level, I identify 172 phases of formal cycles and 263 phases of informal cycles. Here I observe that there are more recessions and expansions in informal cycles than formal cycles. Thus, informal cycles are more volatile than formal cycles. Moreover, duration, amplitude, cumulative gain, and pace are higher in the formal expansions than in their informal counterparts. Finally, I employ a more formal analysis to examine how the duration of business cycles and the duration and amplitude of their phases are associated with the size of the shadow economy. Here, I find that a larger shadow economy size is associated with a higher duration of formal cycles. Moreover, at the phase level, a rise in the size of the informal economy is associated with larger and longer formal expansions and deeper but not necessarily longer formal recessions. With all these characterization at hand, using the concordance index, I also find evidence towards the procyclicality of the

aggregate shadow economy output level and the countercyclicality of the size of the shadow economy (as % of GDP) in most countries.

This thesis is particularly important as there is no paper in the literature that examines the behavior of the shadow economy over the business cycles. The lack of such studies is due to a simple reason: Absence of significantly large time-series data of shadow economy size. Although, there are several approaches in the informality literature to measure the size of the shadow economy, they are all based on different econometric estimation methods (See Elgin and Oztunali, 2012 for a detailed discussion about these estimation methods) relying on various identifying assumptions. These assumptions require collection of data of various additional variables that are even harder to find. Second, even though Elgin and Oztunali (2012) provides model based annual estimates for the size of the shadow economy of 161 countries over the period 1950 and 2009, yearly data is not always preferred in the business cycle analysis. In the current paper however, by borrowing the model based estimation methodology of Elgin and Oztunali (2012), I construct a quarterly dataset of the shadow economy size for 15 advanced economies over the period 1960:1 and 2010:4. This allows me to investigate the shadow economy over the business cycles for 15 advanced countries in a quarterly dataset with a significantly large time-series dimension. In that sense, the empirical investigation made in this paper sheds light on the relationship between informal sector size and business cycles.

In summary, I believe that the current paper has three main contributions to the literature: First, I provide the first quarterly dataset of the size of the shadow economy for 15 advanced economies over the period 1960 and 2010. Second, I study the shadow economy over the business cycles which could not have been studied

before due to the lack of datasets with a significantly large time-series dimension suitable for business cycle analysis. And third, I investigate the interactions between different phases of formal and informal cycles for 15 advanced countries over a long period of time. To address these contributions, I raise two main questions in this paper: Does the level of the shadow economy size affect the main characteristics of formal cycles (i. e. number of cycles, duration, time in event, amplitude, cumulative loss or gain, and slope) in both cycle and phase level? And how do formal and informal cycles interact with each other?

The rest of the paper is organized as follows: In the next section, I present the model I use to construct our quarterly shadow economy dataset as well as the methodology I employ to study business cycles. Next in section three I discuss our basic findings related to the behavior of the shadow economy over the business cycles and phases. Then, in the next section I use a more formal analysis to investigate the relationship between shadow economy size and business cycles. Finally, in the last section I provide some concluding remarks and discussion.

CHAPTER 2

METHODOLOGY

Measuring the Size of the Shadow Economy

I will use a simple two sector dynamic general equilibrium model which is mostly adapted from Elgin and Oztunali (2012), Ihrig and Moe (2004), Roca, Moreno and Sanchez (2001), and Busato and Chiarini (2004). In the environment of this model, infinitely-lived representative household is endowed with K_0 units of productive capital and a total of $T > 0$ units of time and she has access to two productive technologies, denoted formal and shadow. The representative household solves the following problem to maximize its lifetime utility:

$$\max_{\{C_t, X_t, N_{St}, N_{Ft}\}} \sum_{t=0}^{\infty} \beta^t U(C_t)$$

st

$$C_t + X_t = (1 - \tau_t)\theta_{Ft} K_t^{\alpha} N_{Ft}^{1-\alpha} + \theta_{St} N_{St}^{\gamma} \quad (1)$$

$$K_{t+1} = X_t + (1 - \delta)K_t \quad (2)$$

$$N_{St} + N_{Ft} = T \quad (3)$$

The standard assumptions on the utility function are valid in this problem and $\beta < 1$ is the discount factor. Moreover, Equation (1) is the feasibility constraint and it shows that the amount of consumption C_t and investment X_t should equal the amount produced using the formal and informal technologies. Here, the informal technology, where θ_{St} is the level of productivity exclusive to the informal technology and N_{St} is the amount of time that the household devotes to the informal technology, is labor intensive, i.e. the informal firm cannot access to the capital market easily. However,

the government cannot enforce payment of taxes on informal output and the household can hide the income received from the informal technology. On the other hand, the output of the formal technology, which follows a standard Cobb-Douglas specification with θ_{Ft} is the level of productivity exclusive to the formal sector, K_t is the household's capital stock, and N_{Ft} is the amount of hours the household devotes to the formal technology, gets taxed at a rate, τ, ε [0, 1].

The rest of the household's problem is standard: Equation (2) is the household's law of motion for capital, where δ, ε [0, 1] is a depreciation rate. Equation (3) is the household's time constraint. Also note that the tax rate τ is exogenously determined and the tax revenue is used to finance an exogenous stream of government spending G_t. Then, we can define an equilibrium as follows:

Definition: Given the government policy variable tax burden $\{\tau\}$, a competitive equilibrium of the two-sector model is a set of sequences $\{C_t, X_t, K_{t+1}, N_{St}, N_{Ft}, G_t\}$ such that

1. The household's problem is solved by $\{C_t, X_t, K_{t+1}, N_{St}, N_{Ft}\}$

2. $G_t = \tau_t \theta_{Ft} K_t^{\alpha} N_{Ft}^{1-\alpha}$

Assuming a logarithmic utility, The household's maximization problem can be characterized by taking first order conditions with respect to C_t, C_{t+1}, K_{t+1}, and N_{St}:

$$\frac{C_{t+1}}{C_t} = \beta \left[(1-\tau_t)\alpha \frac{Y_{Ft+1}}{K_{t+1}} + 1 - \delta\right] \quad (4)$$

where $Y_{Ft} = \theta_{Ft} K_t^{\alpha} N_{Ft}^{1-\alpha}$ and

$$\theta_{St}\, \gamma\, N_{St}^{\gamma-1} = (1-\tau_t)\theta_{Ft} K_t^{\alpha} N_{Ft}^{-\alpha} \quad (5)$$

We can obtain K_t in terms of N_{Ft} using Equation (4):

$$K_t = N_{Ft}\left[\frac{(1-\tau_t)\theta_{Ft}\alpha}{\frac{1+g_c}{\beta}-1+\delta}\right]^{1/(1-\alpha)} \tag{6}$$

where g_c is the growth rate of consumption in period t, i.e $1 + g_c = \frac{C_t}{C_{t-1}}$. Then, informal labor can be obtained by using Equation (5):

$$N_{St} = \left\{\frac{\gamma\theta_{St}}{(1-\tau_t)\theta_{Ft}(1-\alpha)}\left[\frac{\frac{1+g_c}{\beta}-1+\delta}{(1-\tau_t)\theta_{Ft}\alpha}\right]^{\alpha/(1-\alpha)}\right\}^{1/(1-\gamma)} \tag{7}$$

Remember that in this section, my ultimate goal is to back out time-varying estimates of the size of the shadow economy as the percentage of the official GDP in every country for any year t. In this model, that is given by $\frac{\theta_{St}N_{St}^{\gamma}}{\theta_{Ft}K_t^{\alpha}N_{Ft}^{1-\alpha}}$. To find these estimates, first I assume that $\alpha = 0.36$, $\delta = 0.08$ as standard in the real business cycle literature, and take $\gamma = 0.425$ following Ihrig and Moe (2004). Then, I construct the capital stock K_t series relying on the widely used perpetual inventory method:

$$K_{t+1} = (1-\delta)K_t + I_t \tag{8}$$

$$\frac{K_{1950}}{Y_{1950}} = \frac{\sum_{i=1950}^{2009}\frac{I_i}{Y_i}}{\delta + g_Y} \tag{9}$$

Next, I have quarterly data for C_t, τ_t and N_{Ft} from Ohanian and Raffo (2011). Then, one can calibrate β for every country using the Euler Equation (4). Using the specified values for α and δ the calibrated value of β and year specific τ_t, N_{Ft}, and K_t, I use the Equation (6) to back out θ_{Ft} for any year t.

Now, I assume that θ_{St} grows at a rate which is the average of the growth rate of K_t and θ_{Ft}. Then, I choose θ_S in 2007:4 to match the shadow economy size in 2007 of the series reported in Schneider et al. (2010) and construct the rest of the θ_{St} series using the calculated growth rates. This at the end gives me a θ_{St} series over time.

Finally, I calculate N_{St} using Equation (7). Once N_{St} is obtained, the size of the shadow economy in a specific year can easily be computed using $\frac{\theta_{St}N_{St}^{\gamma}}{\theta_{Ft}K_t^{\alpha}N_{Ft}^{1-\alpha}}$ for every year.

Business Cycle Analysis

I use "classical" definition of a business cycle to extract the main features of cyclical fluctuations in 15 advanced countries. I identify turning points based on the classical definition and measure the main characteristics using the resulting turning point classification. Note that classical methodology considers the changes in levels of a variable although there is an alternative methodology in which deviations from trend is used to define growth cycles. I have two reasons to prefer classical definition. First, it provides a simple but effective procedure to detect the cyclical turning points. Second, it defines the guiding principle of the National Bureau of Economic Research (NBER) in defining the turning points of US business cycles.

The methodology that I employ to determine the turning points in the log-level of a series is developed by Harding and Pagan (2002a), which is the quarterly version of BB algorithm developed by Bry and Boschan (1971). In fact, this algorithm first defines the peaks and troughs by searching for maxima and minima for a specific period of time interval. Then, it selects pairs of adjacent, locally absolute maxima and minima that meet minimal duration which requires that the

minimum duration of a cycle should be at least five quarters and the minimum duration of a phase should be at least two quarters. A typical complete cycle goes from one peak (trough) to the next peak (trough) with its two phases, the recession phase (from peak to trough) and the expansion phase (from trough to peak). In particular, a peak is determined in a quarterly series y_t at time t if:

$$y_t - y_{t-2} > 0,\ y_t - y_{t-1} > 0 \text{ and } y_{t+2} - y_t < 0,\ y_{t+1} - y_t < 0.$$

Similarly, a trough is determined at time t if:

$$y_t - y_{t-2} < 0,\ y_t - y_{t-1} < 0 \text{ and } y_{t+2} - y_t > 0,\ y_{t+1} - y_t > 0.$$

I use this algorithm to identify formal an informal cycles. My main variable for formal cycles is logarithm of aggregate GDP while our main variable for informal cycles is logarithm of the aggregate informal output. The main characteristics of cyclical fluctuations are duration, amplitude, cumulative loss or gain, and slope. The duration of a cycle or a phase (recession or expansion), D^c is the number of quarters, k, between a peak and the next trough. The amplitude of a cycle or a phase, A^c, measures the change in y_t from a peak (trough) (y_0) to the next trough (peak) (y_k) Thus, $A^c = y_k - y_0$. The slope of a cycle or a phase is the ratio of its amplitude to its duration. Hence, the slope measures the violence of a recession or the pace of an expansion of a given cyclical phase. Cumulative loss or gain combines information about the duration and amplitude to measure the overall cost or gain of a cycle or a phase. Then, the cumulative loss or gain, F^c, during a cycle or a phase, with duration k is defined as the following:

$$F^c = \sum_{i=1}^{k} (y_i - y_0) - \frac{A^c}{2}$$

To analyze the degree of synchronization between formal and informal cycles, I use the concordance index developed by Harding and Pagan (2002b). The concordance index, CI_{xy}, for variables x and y is calculated as follows:

$$CI_{xy} = \frac{1}{T}\sum_{t=1}^{T}[C_t^x C_t^y + (1 - C_t^x)(1 - C_t^y)]$$

where C_t^x and C_t^y are binary variables that are equal to 1 (0) if they are in the expansion (recession) phase at time t.

Observe that concordance index is calculated by using two binary variables C_t^x and C_t^y whose values change depending on the phase of the cycle. Also, note that T = min (T_x, T_y) and T denotes the number of quarters in the sample. Moreover, it takes its maximum value of one when $C_t^x = C_t^y$ and minimum value of zero when $C_t^x = 1 - C_t^y$. Thus, the concordance index gives a measure of the fraction of time in which the two series are in the same phase of their cycles. Hence, the algorithm concludes that the series are perfectly procyclical (countercyclical), if the concordance index is equal to one (zero).

CHAPTER 3

FORMAL AND INFORMAL CYCLES: BASIC FEATURES

Informal Sector Size Series

Using the calibration process that we present in section 2.1, I obtain the size of the shadow economy as the percentage of the official GDP for each country over the period 1960 and 2010. This procedure gives me an unbalanced panel dataset with 2870 observations. I report the descriptive statistics and present an illustrative figure in this section and the dataset is available upon request.

Table 1: Informal Sector Size Summary Statistics

	Mean	Std. Dev.	Minimum	Maximum	Data Range
Australia	15.66	1.33	13.15	18.65	1964-2010
Austria	10.77	1.19	9.35	13.60	1960-2010
Canada	17.56	1.58	14.96	21.30	1961-2010
Finland	19.56	2.28	16.50	25.53	1960-2010
France	17.02	2.08	14.38	22.42	1960-2010
Germany	16.47	1.45	14.95	20.75	1960-2010
Ireland	22.07	4.32	15.12	30.48	1960-2010
Italy	30.05	3.30	26.62	39.77	1960-2010
Japan	12.00	2.23	10.711	17.92	1960-2010
South Korea	30.53	4.95	24.781	40.84	1982-2010
Norway	20.09	2.15	17.41	25.97	1960-2010
Spain	25.16	1.85	21.62	27.61	1980-2010
Sweden	20.15	1.61	17.46	25.06	1960-2010
UK	14.00	1.33	12.07	16.85	1960-2010
US	9.91	0.98	9.83	11.95	1960-2010

In Table 1, I present the descriptive statistics of the informal economy size for 15 advanced countries over the given period. For US, for example, the average size of the informal economy between 1960 and 2010 is 9.91 percent of the country's official GDP and this is the lowest average size of the informal economy while Italy has the highest average size of the informal economy among these countries.

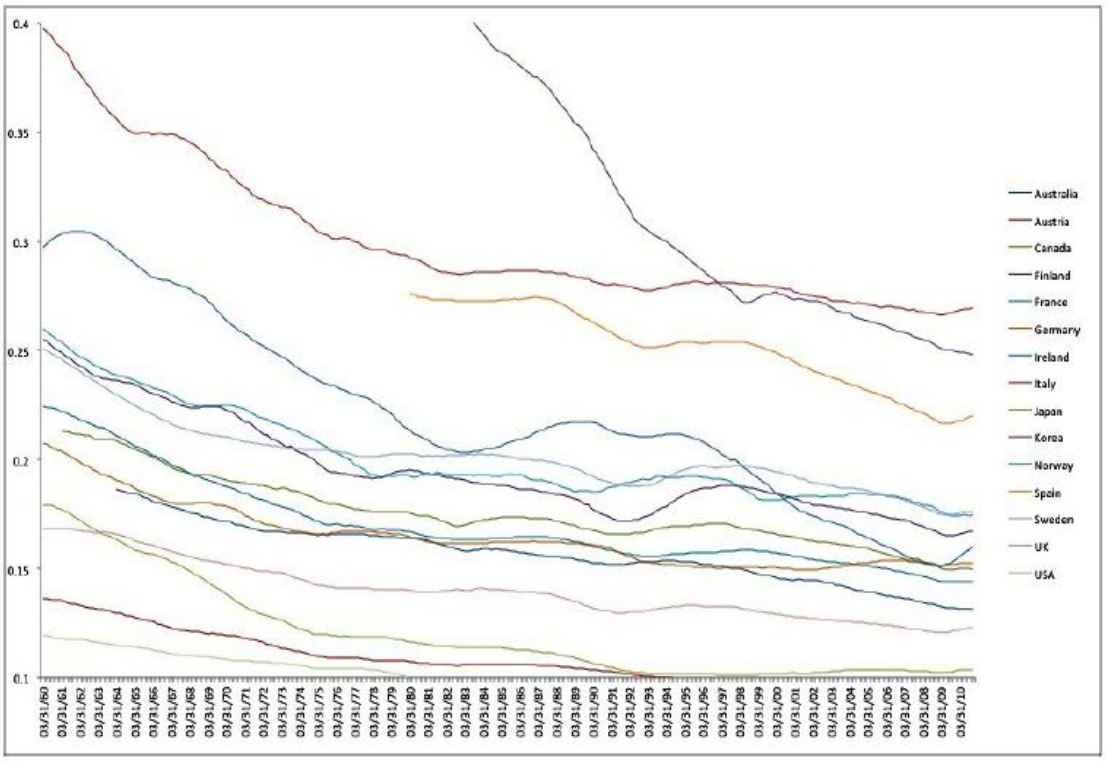

Figure 1: Shadow economies: 1960-2010

Moreover, Figure 1 presents the evolution of size of the informal economy for all countries over the given period. Observe that there is a decreasing trend in the size of the informal economy for 15 countries over that period. Moreover, one of the most important observations from this figure is that there are cyclical fluctuations in the informal economy size. Hence, this observation strengthens my previous claim that there are strong linkages between output level and the shadow economy size around the cycles for these countries over the given period.

Features of Formal and Informal Cycles

To have a basic understanding about formal and informal cycles of 15 advanced countries, I first look at the number of cycles and average duration of these cycles for each country. I identify 82 formal cycles and 126 informal cycles for 15 advanced economies over the period 1960 and 2010. When I examine Table 2, I see that all economies except Spain have more informal cycles than formal cycles.

According to Table 2, a typical formal cycle lasts almost in 26 quarters, while a typical informal cycle lasts about 18.5 quarters, in average. From Table 2 again, I also find that formal cycles are longer than informal cycles in all economies except for Spain.

Table 2: Formal and Informal Cycles

	Formal Cycles		Informal Cycles	
Country	Number	Duration	Number	Duration
Australia	5	23.80	8	21.62
		[13.00]		[17.50]
Austria	7	24.85	10	18.90
		[30.00]		[15.50]
Canada	3	37.00	8	20.75
		[35.00]		[17.50]
Finland	6	25.50	10	18.40
		[13.50]		[15.00]
France	3	44.66	5	26.80
		[48.00]		[28.00]
Germany	10	16.70	12	14.00
		[17.50]		[17.00]
Ireland	4	34.25	11	15.36
		[19.50]		[14.00]
Italy	10	17.40	14	12.21
		[15.50]		[9.50]
Japan	5	27.40	8	18.75
		[16.00]		[16.00]
Korea	2	47.00	3	21.66
		[47.00]		[22.00]
Norway	6	20.00	11	16.72
		[22.00]		[16.00]
Spain	4	33.25	1	74.00
		[18.00]		[74.00]
Sweden	6	24.66	7	24.00
		[22.50]		[22.00]
UK	6	31.16	11	17.00
		[19.00]		[9.00]
US	5	30.60	7	21.85
		[25.00]		[17.00]
Whole Cycles	82	26.10	126	18.53
		[19.00]		[16.00]

Before I look deeply at the interaction between formal and informal cycles, in this section, I present the main features of both formal and informal phases. In particular, I focus on the duration, time in event, amplitude, cumulative loss or gain and the slope of the phases to determine their dynamics.

Table 3: Formal Cycles: Recessions

Country	Number	Time in event	Duration	Amplitude	Cumulative Loss	Slope
Australia	6	0.17	3.50	-1.86	-2.61	-0.52
		[0.15]	[3.00]	[-2.09]	[-3.98]	[-0.64]
Austria	8	0.21	2.75	-1.28	-1.82	-0.53
		[0.06]	[2.50]	[-1.79]	[-2.84]	[-0.62]
Canada	4	0.23	4.50	-3.42	-5.43	-0.70
		[0.17]	[5.00]	[-3.02]	[-6.27]	[-0.59]
Finland	6	0.26	4.16	-2.77	-3.93	-1.01
		[0.16]	[2.50]	[-5.31]	[-20.94]	[-1.17]
France	4	0.08	3.75	-1.97	-3.58	-0.55
		[0.06]	[3.50]	[-2.16]	[-4.62]	[-0.56]
Germany	9	0.17	3.55	-1.88	-2.13	-0.47
		[0.15]	[3.00]	[-2.13]	[-2.84]	[-0.64]
Ireland	3	0.30	5.66	-1.28	-2.05	-0.42
		[0.14]	[3.00]	[-5.39]	[-21.85]	[-0.67]
Italy	10	0.20	3.50	-1.08	-1.31	-0.31
		[0.15]	[3.00]	[-1.88]	[-4.05]	[-0.49]
Japan	4	0.18	3.50	-2.67	-5.39	-0.69
		[0.10]	[3.50]	[-4.27]	[-6.51]	[-0.11]
Korea	2	0.11	4.50	-6.51	-14.54	-1.80
		[0.11]	[4.50]	[-6.51]	[-14.54]	[-1.80]
Norway	4	0.20	4.00	-2.80	-4.50	-0.58
		[0.18]	[4.00]	[-2.53]	[-5.33]	[-0.79]
Spain	5	0.14	3.80	-0.67	-0.90	-0.33
		[0.11]	[3.00]	[-1.91]	[-5.86]	[-0.41]
Sweden	5	0.15	5.20	-2.05	-5.32	-0.41
		[0.08]	[5.00]	[-3.17]	[-7.28]	[-0.55]
UK	6	0.27	4.50	-3.09	-7.20	-0.77
		[0.28]	[4.50]	[-3.70]	[-10.28]	[-0.78]
US	6	0.18	3.83	-2.58	-2.95	-0.67
		[0.20]	[4.00]	[-2.43]	[-4.31]	[-0.75]
Whole Recessions	82	0.20	3.89	-2.04	-3.10	-0.56
		[0.13]	[3.00]	[-2.88]	[-7.04]	[-0.71]

Table 4: Formal Cycles: Expansions

Country	Number	Time in event	Duration	Amplitude	Cumulative Gain	Slope
Australia	7	0.80	14.42	7.91	28.37	1.16
		[0.80]	[8.00]	[17.70]	[200.52]	[1.19]
Austria	8	0.74	19.25	15.42	100.35	1.10
		[0.90]	[18.50]	[16.97]	[200.23]	[0.99]
Canada	3	0.79	33.00	29.43	400.95	1.01
		[0.82]	[29.00]	[27.89]	[700.19]	[1.08]
Finland	7	0.69	18.14	15.45	76.32	0.92
		[0.83]	[13.00]	[18.10]	[300.13]	[1.03]
France	3	0.91	41.33	26.50	500.53	0.58
		[0.93]	[45.00]	[25.53]	[500.68]	[0.68]
Germany	12	0.78	11.25	9.22	74.69	0.71
		[0.82]	[13.50]	[9.76]	[72.65]	[0.86]
Ireland	3	0.89	39.33	27.91	400.41	1.07
		[0.96]	[26.00]	[55.59]	[1600.50]	[1.18]
Italy	10	0.79	14.50	10.57	60.28	0.69
		[0.84]	[12.00]	[12.61]	[100.40]	[0.80]
Japan	5	0.78	25.00	8.31	48.37	0.57
		[0.88]	[14.00]	[20.38]	[600.31]	[0.59]
Korea	2	0.88	42.50	89.21	2800.12	1.91
		[0.88]	[42.50]	[89.21]	[2800.12]	[1.91]
Norway	7	0.78	14.71	11.33	75.01	0.75
		[0.81]	[15.00]	[12.34]	[100.24]	[0.81]
Spain	5	0.85	24.20	11.26	83.10	0.67
		[0.88]	[20.00]	[18.95]	[300.81]	[0.67]
Sweden	6	0.82	20.83	15.35	100.46	0.73
		[0.91]	[19.00]	[15.43]	[100.76]	[0.75]
UK	7	0.72	23.71	13.59	90.40	0.83
		[0.71]	[15.00]	[18.73]	[300.82]	[0.88]
US	5	0.81	27.20	20.87	200.28	1.04
		[0.80]	[20.00]	[24.83]	[500.51]	[1.02]
Whole Expansions	90	0.79	20.71	13.06	92.05	0.85
		[0.86]	[15.00]	[19.62]	[300.87]	[0.91]

I identify 172 phases of formal cycles and 263 phases of informal cycles. While there are 82 recession and 90 expansion phases in the formal cycles, there are 125 recession and 138 expansion phases in the informal cycles (Table 3 to Table 6). By analyzing Table 3 and Table 5 together, I can conclude that all of the advanced countries except Spain have more informal recessions than formal recessions.

Similarly, from Table 4 and Table 6, one can easily recognize that all of the advanced countries except Spain have more informal expansions than formal expansions. From these two results, I conclude that the informal cycles are more volatile than the formal cycles in all of the economies except for Spain.

One mechanism behind this results might be due to the fact that the informal sector has a highly labor intensive production technology. This leads to a very low degree (if any) of complementability of capital in the informal sector. This combined with the fact that the insurance mechanisms do not work efficiently due to the restricted access to both capital and financial markets and absence of the enforcement of labor market regulations in the informal sector makes this sector more sensitive to exogenous shocks. As a result of these, it is not surprising that the informal sector is more volatile than the formal one.

Table 5: Informal Cycles: Recessions

Country	Number	Time in event	Duration	Amplitude	Cumulative Loss	Slope
Australia	7	0.14	3.14	-1.90	-2.42	-0.61
		[0.14]	[2.00]	[-2.42]	[-5.15]	[-0.75]
Austria	9	0.21	3.22	-1.88	-2.19	-0.55
		[0.14]	[2.00]	[-2.30]	[-4.43]	[-0.69]
Canada	8	0.19	4.00	-1.08	-1.36	-0.40
		[0.18]	[3.00]	[-2.75]	[-6.09]	[-0.56]
Finland	10	0.18	3.60	-1.90	-2.16	-0.95
		[0.13]	[2.00]	[-4.50]	[-14.09]	[-1.03]
France	6	0.23	4.33	-1.54	-2.57	-0.46
		[0.18]	[3.50]	[-2.53]	[-5.72]	[-0.60]
Germany	12	0.28	3.75	-2.15	-4.50	-0.44
		[0.28]	[3.50]	[-0.87]	[-4.80]	[-0.09]
Ireland	10	0.25	4.20	-1.35	-2.60	-0.41
		[0.26]	[3.50]	[-2.77]	[-10.62]	[-0.53]
Italy	14	0.30	3.64	-1.35	-2.19	-0.47
		[0.28]	[3.00]	[-2.36]	[-4.52]	[-0.67]
Japan	7	0.22	4.71	-2.27	-3.73	-0.68
		[0.11]	[4.00]	[-3.65]	[-7.61]	[-0.89]
Korea	4	0.13	2.50	-3.72	-5.35	-1.36
		[0.09]	[2.50]	[-4.72]	[-6.67]	[-1.67]
Norway	11	0.22	3.18	-0.86	-1.00	-0.43
		[0.20]	[2.00]	[-1.99]	[-4.35]	[-0.58]
Spain	2	0.05	5.00	-5.33	-14.93	-1.04
		[0.05]	[5.00]	[-5.33]	[-14.93]	[-1.04]
Sweden	6	0.16	5.66	-4.73	-2.02	-0.46
		[0.10]	[4.50]	[-11.94]	[-3.93]	[-0.68]
UK	11	0.27	3.36	-1.32	-1.70	-0.66
		[0.22]	[2.00]	[-3.03]	[-7.04]	[-0.76]
US	8	0.26	4.50	-2.60	-4.91	-0.64
		[0.25]	[4.50]	[-2.86]	[-6.50]	[-0.61]
Whole Recessions	125	0.23	3.82	-1.70	-2.42	-0.57
		[0.20]	[3.00]	[-2.78]	[-7.09]	[-0.66]

Table 6: Informal Cycles: Expansions

Country	Number	Time in event	Duration	Amplitude	Cumulative Gain	Slope
Australia	11	0.77	12.72	8.21	33.44	0.91
		[0.85]	[10.00]	[11.87]	[100.11]	[0.97]
Austria	11	0.74	14.27	11.66	59.51	0.65
		[0.85]	[10.00]	[10.91]	[98.46]	[0.83]
Canada	8	0.79	17.37	11.11	98.07	0.80
		[0.81]	[15.50]	[14.98]	[200.03]	[0.82]
Finland	10	0.80	15.30	12.37	98.42	0.80
		[0.86]	[13.50]	[14.25]	[100.51]	[0.90]
France	5	0.76	22.60	15.68	100.56	0.56
		[0.81]	[25.00]	[12.90]	[100.74]	[0.51]
Germany	16	0.68	8.68	5.59	20.69	0.73
		[0.68]	[7.00]	[6.32]	[47.10]	[0.26]
Ireland	11	0.74	12.45	10.34	58.80	1.29
		[0.73]	[10.00]	[14.79]	[100.53]	[1.27]
Italy	13	0.67	9.61	6.40	25.09	0.72
		[0.71]	[7.00]	[8.62]	[63.65]	[0.87]
Japan	8	0.78	13.50	10.37	53.23	0.73
		[0.80]	[12.50]	[10.93]	[95.68]	[0.76]
Korea	4	0.86	14.50	20.50	100.49	1.17
		[0.90]	[14.50]	[19.18]	[100.52]	[1.45]
Norway	11	0.77	14.09	12.01	68.36	0.91
		[0.79]	[13.00]	[12.87]	[100.32]	[0.99]
Spain	2	0.94	35.00	20.48	600.46	0.46
		[0.94]	[35.00]	[20.48]	[600.46]	[0.46]
Sweden	7	0.81	19.57	14.76	100.20	0.72
		[0.89]	[19.00]	[13.84]	[100.37]	[0.76]
UK	14	0.70	10.92	4.37	8.48	0.82
		[0.66]	[4.00]	[7.96]	[100.31]	[0.89]
US	7	0.71	17.42	12.85	65.92	0.95
		[0.66]	[10.00]	[15.05]	[100.07]	[0.97]
Whole Expansions	138	0.74	13.81	10.21	53.79	0.86
		[0.79]	[11.00]	[11.69]	[100.29]	[0.84]

Moreover, time in event is a useful statistic to examine the relative frequency of recessions and expansions for both formal and informal cycles. When I analyze Table 4 (6) and Table 3 (5), I find that in average, formal (informal) cycles of the advanced economies are in the expansion phase for about 79 (74) percent of the time, while they are in the recession phase for about 20 (23) percent of the time.

Next, I examine the main characteristics of cyclical phases. Note that while I prefer to use mean values for both duration and time in event, I use the median values for amplitude, cumulative loss or gain, and slope since they are less affected by the presence of outliers. I obtain from Table 3 (5) that a typical formal (informal) recession lasts in 3.89 (3.82) quarters, and from Table 4 (6) that a typical formal (informal) expansions lasts in 20.71 (13.81) quarters. Moreover, from Table 4 and Table 6, I find that all of the advanced economies except Spain have experienced longer expansions in the formal sector than in the informal sector. On the other hand, from Table 3 and Table 5, I find that while recessions are longer in the informal sector for 8 countries (Austria, France, Germany, Italy, Japan, Spain, Sweden, and US), the other 7 advanced economies have experienced longer formal recessions. From these findings, I can conclude that in general, expansions are longer in the formal sector than in the informal sector, but I do not have a significant difference for the the duration of formal and informal recessions.

Amplitude is the other characteristic feature of a business cycle. I obtain from Table 3 (5) that the amplitude of a typical formal (informal) recession is -2.04 (-1.70) percent, and from Table 4 (6) that the amplitude of a typical formal (informal) expansion is 13.06 (10.21) percent. Furthermore, from Table 4 and Table 6, I find that all of the advanced economies except Australia, Japan, Norway, and Spain have experienced larger expansions in the formal sector than informal sector. However, when I analyze Table 3 and Table 5 together, I find that while 8 advanced economies (Australia, Austria, Germany, Ireland, Italy, Spain, Sweden, and US) have experienced deeper recessions in the informal sector, the other 7 advanced economies have experienced deeper formal recessions. From these findings, I can

conclude that the expansions are mainly larger in formal cycles than in informal cycles, but there is no such conclusion about the amplitude of formal and informal recessions.

The information about both the duration and the amplitude is combined in the cumulative loss (gain) statistic to measure the overall loss (gain) of a recession (expansion) phase. I obtain from Table 3 (5) that the cumulative loss of a typical formal (informal) recession is -3.10 (-2.42) percent, and from Table 4 (6) that the cumulative gain of a typical formal (informal) expansion is 92.05 (53.79) percent. The difference between the gain of expansion and the loss of recession can stem from our earlier findings that the amplitude of a typical formal (13.06) or informal (10.21) expansion is higher in absolute terms than a typical formal (-2.04) or informal (-1.70) recession and that the duration of a typical formal (20.71) or informal (13.81) expansion is longer than a typical formal (3.89) or informal (3.82) recession. Moreover, when I analyze Table 3 and Table 5 together, I find that while there is no clear distinction between the cumulative loss of formal and informal recessions (i.e. for 6 countries cumulative loss is higher in absolute terms in informal cycles and for 9 countries the cumulative loss is higher in absolute terms in formal cycles), from Table 4 and Table 6, I find that the cumulative gain of expansion is higher in formal cycles than in informal cycles for all of the advanced economies except Australia, Finland, Japan, and Spain. From these findings, I can conclude that the gain of the expansions are mainly higher in the formal cycles than in the informal cycles but the loss of the recessions in formal and informal cycles are not very different from each other.

Finally, the slope of a(n) recession (expansion) reflects the violence (pace) of the recession (expansion). I obtain from Table 3 (5) that the slope of a typical formal (informal) recession is -0.56 (-0.57), and from Table 4 (6) that the slope of a typical formal (informal) expansion is 0.85 (0.86). At the country level, when I analyze Table 3 and Table 5 together, I find that the violence of informal recessions are higher than formal recessions in all of the countries except Canada, Italy, Spain, and Sweden. However, from Table 4 and Table 6, I find that while the slope of the expansions in 5 advanced economies (Germany, Italy, Ireland, Japan, and Norway) is higher in informal cycles, but in the other 10 advanced economies, the slope of the expansions is higher in formal cycles than in informal cycles. From these findings, I can conclude that the pace of the expansion is slightly higher in the formal cycles than in the informal cycles but the violence of informal recessions are higher than formal recessions.

My main finding from this section is as follows: Duration, amplitude, and cumulative gain are higher in the formal expansions than informal expansions, but there is no conclusive evidence for the difference between the recessions of formal and informal cycles. This result suggests that expansions are longer and larger in the formal sector than in the informal sector. To understand the mechanism behind this result, suppose that the economy enters an expansion period. Then, it will be easier for informal workers to find a secure job in the formal sector because firms in the formal sector will want to hire experienced workers rather than inexperienced unemployed people to increase their production capacity during the expansion period. On the other hand, informal firms may want to hire unemployed people to benefit from the growth of the overall economy since their production is labor

intensive. Therefore, both the formal and the informal sectors will grow, but the growth of the formal sector is going to be larger due to a higher increase in production efficiency as a result of the employment of experienced workers. Moreover, during the expansion period, increase in investment and capital utilization create a higher return in the formal sector than in the informal sector due to the easy access to these markets in the formal economy.

On the other hand, there is no such a conclusion about the duration and amplitude of the formal and informal recessions. This means that each economy shrinks almost at the same level during a recession period. What could be the mechanism behind this result? One can think as in the case of an expansion that the production loss in the formal sector will be more severe than in the informal sector due to the lack of investment and a higher reduction in capital utilization. However, the cost of reducing the production capacity is higher in the formal economy. Therefore, firms in the formal economy might reduce their capacity less than they would decrease if they had unrecorded workers and fixed amount of capital as in the informal economy. As a result, each sector decreases almost at the same level and thus the size of the informal economy as a percentage of official GDP stays more or less constant.

Implications of Coincidence of Formal and Informal Cycles

In this section, I analyze the degree of synchronization between formal and informal cycles using the concordance index developed by Harding and Pagan (2002b). I compute concordance both for 5 different decades and for the whole period of each country.

Table 7: Synchronization of Formal and Informal Cycles

Country	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	Whole Period
Australia	0.48	0.83	0.93	-	-	0.45
Austria	0.55	0.80	0.93	0.98	0.85	0.80
Canada	-	-	0.90	1.00	0.73	0.53
Finland	-	0.90	0.93	0.95	0.73	0.69
France	-	0.60	0.93	0.90	0.78	0.63
Germany	0.43	0.68	0.98	0.90	0.75	0.73
Ireland	-	0.33	0.90	0.95	0.70	0.56
Italy	0.60	0.83	0.85	0.83	0.78	0.76
Japan	-	0.53	0.95	0.75	0.83	0.60
Korea	-	-	-	0.83	0.20	0.20
Norway	-	-	0.88	0.90	0.75	0.51
Spain	-	-	-	0.98	0.88	0.39
Sweden	-	0.98	0.90	0.95	0.78	0.71
UK	0.78	0.90	0.95	1.00	0.85	0.88
US	-	0.83	0.95	0.95	0.78	0.71

Table 7 shows that aggregate informal output level is generally procyclical since most of the concordance index values are closer to unity. Hence, a typical informal cycle is generally in the same phase with a typical formal cycle.

When I analyze the whole period (last column of Table 7), I see that the synchronization between formal and informal cycles is highest in UK, 0.88, and lowest in Korea, 0.20. That is to say, cycles in formal and informal output are typically in the same phase about 88 (20) percent of the time in UK (Korea). Thus, I conclude that even though informal cycles are countercyclical in Korea and Spain, they are mainly procyclical across advanced economies.

However, I would like to know the cyclicality of the size of the informal economy as a percentage of official GDP rather than the cyclicality of aggregate informal output level. To analyze the cyclicality of the size of the informal economy, remember that I have also found before that the amplitude of formal cycles (and expansions) are higher than the informal cycles (and expansions). This means that in

the case of a(n) expansion (recession) aggregate GDP level increases (decreases) more than aggregate informal output level. When I combine this finding with the procyclicality of aggregate informal economy level, I find that the size of the informal economy, which is calculated as the rate of informal output to formal output, decreases (increases) in expansions (recessions). Therefore, I find evidence towards the countercyclicality of the size of the informal economy as percentage of GDP.

CHAPTER 4

INTERACTION BETWEEN FORMAL AND INFORMAL CYCLES: A FORMAL ANALYSIS

The tables I have presented above suggest that size of the informal economy plays a key role in shaping both the recessions and expansions of the official GDP. However, these findings do not analyze the impact of other external factors on the formal cycles. Factors such as openness, financial development, government expenditure, and current account could all have significant effects on the evolution of formal cycles. Therefore, in this section, using different econometric specifications, I will analyze the impact of such factors on the duration and amplitude of the formal fluctuations at both the cycle and the phase level.

Before moving on to our analysis, I will introduce my main variables and their sources. Openness of a country is the share of the trade in its official GDP level and calculated by the ratio of the sum of exports and imports to the official GDP. Similarly, government expenditure is the share of government spending in the official GDP. Moreover, current account is the difference between exports and imports divided by official GDP. These three variables is constructed from PWT. Furthermore, domestic bank credits over official GDP is used as a proxy for financial development and the series for financial development is obtained from World Development Indicator.

Table 8 presents the summary statistics of variables that I use in my cyclical analysis.

Table 8: Summary Statistics for Cyclical Analysis

	Mean	Std. Dev.	Minimum	Maximum
Duration (quarters)	26.11	21.90	5.00	96.00
Amplitude (Abs. Value)	0.20	0.25	0.00	1.41
Openness (% of GDP)	43.82	24.80	9.96	156.27
Informal Sector (% of GDP)	18.85	6.75	9.20	38.27
Gov. exp. (% of GDP)	9.85	1.53	5.93	13.29
Current Account (% of GDP)	1.55	4.96	-7.28	21.43
GDP per-capita (thousand USD)	24.22	7.56	10.22	50.42
Fin. Dev. (% of GDP)	94.60	54.42	36.18	304.41

Now, I examine the effect of the level of the size of the shadow economy and other external factors on the duration of formal cycles. From Table 9, I find that the size of the shadow economy is significantly associated with the longer formal cycles. This is due to the fact that informal sector acts as an additional insurance mechanism for the formal sector. The peaks and troughs of the formal sector are made smoother thanks to the informal sector's presence. In a sense, some of the shocks hitting the economy are absorbed by the informal sector. Therefore, there are a lower number formal cycles for a given period. Moreover, the duration of the previous cycle is positively related and consistently significant with the duration of formal cycles. On the other hand, there are strong and consistently significant negative relationships between both openness and duration, and GDP per capita level and duration.

Table 9: Duration of Cycles and Informality

Duration								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	GMM
IS	5.12**	3.48***	3.45**	3.41**	3.34**	3.47**	3.40**	2.90**
	(2.75)	(1.92)	(1.98)	(1.99)	(2.14)	(2.23)	(2.32)	(2.12)
Openness		-1.41*	-1.37*	-1.42**	-1.32*	-1.35*	-1.40*	-1.74*
		(5.07)	(5.26)	(2.51)	(3.42)	(3.25)	(3.20)	(3.33)
Gov. exp.			1.70	1.75	1.69	1.75	1.83	1.62
			(0.37)	(0.38)	(0.34)	(0.42)	(0.41)	(0.51)
Curr. Acc.				0.25	-1.17	-1.28	-1.07	-1.47
				(0.15)	(0.84)	(0.81)	(0.85)	(0.74)
GDP per-ca					-3.52*	-3.03*	-2.92*	-2.99*
					(3.15)	(3.14)	(3.34)	(4.02)
Financial Dev.						-1.19***	-1.41	-1.13
						(1.79)	(0.93)	(0.85)
Prev. Cyc.							0.39*	0.33*
							(4.31)	(4.08)
Adj. R^2	0.75	0.88	0.88	0.88	0.90	0.91	0.93	
Obs.	82	82	82	82	82	82	67	52
Time F-Test	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
J-Test								0.28

Then, I construct a similar analysis at the phase level. In Table 10, I analyze the impact of the level of the size of the shadow economy and other external factors on the amplitude and time in event statistics of formal expansions and recessions. Moreover, in this table, I eliminate the effect of unobserved time-invariant factor by constructing fixed effect regression.

Table 10: Amplitude and Duration of Recessions and Expansions

	Expansions				Recessions			
	Amplitude		Time in Event		Amplitude		Time in Event	
	FE	GMM	FE	GMM	FE	GMM	FE	GMM
IS	7.82*	5.93**	2.42**	3.16***	1.60**	1.77*	0.69	0.78
	(2.80)	(3.04)	(2.06)	(1.84)	(2.32)	(3.35)	(1.34)	(0.98)
Openness	0.01	0.04	-0.03	-0.05	-0.03**	-0.04**	0.03	0.02
	(1.56)	(0.99)	(0.78)	(0.64)	(2.03)	(2.14)	(1.00)	(0.83)
Gov. exp.	0.05	0.10***	-0.04	-0.06**	0.07	0.11	0.19	0.14
	(0.56)	(1.79)	(1.31)	(2.21)	(0.67)	(0.84)	(0.43)	(0.54)
Curr. Acc.	-0.01	0.14	0.01	-0.05	0.02	0.03	0.05	0.09
	(0.42)	(0.39)	(0.75)	(0.42)	(0.83)	(0.79)	(0.76)	(0.88)
Fin. Dep.	0.14***	0.22	0.20	0.07	-0.11	-0.07	-0.08	-0.13
	(1.71)	(1.23)	(0.69)	(0.90)	(0.83)	(0.61)	(0.61)	(0.90)
GDP per-cap	-0.002	-0.003	0.002	0.004	-0.004*	-0.006**	0.003	0.005
	(0.19)	(0.34)	(0.64)	(0.76)	(3.52)	(2.31)	(0.98)	(1.06)
Prev. Phase		0.78*		0.79*		1.02**		0.92**
		(4.03)		(4.15)		(2.30)		(2.19)
Constant	-6.04*	1.05**	-0.36**	-0.54**	-0.15**	-0.10***	1.56**	1.32**
	(4.24)	(2.01)	(2.13)	(2.04)	(2.02)	(1.75)	(2.10)	(2.19)
Adj. R^2	0.53		0.14		0.39		0.21	
Obs.	90	60	79	49	82	52	70	40
Time-F-Test	0.00		0.00		0.00		0.00	
J-Test		0.27		0.33		0.30		0.22

According to this table, increased level of informal economy size creates larger and longer formal expansions, and larger but not necessarily longer formal recessions. What is the mechanism behind this finding? Suppose that the economy enters a recession period. In the case of such period, it is expected that some of the workers will lose their jobs in the formal sector. Then, these workers may be hired by the informal firms because they will provide efficiency in the informal production due to the fact that formal workers are more skillful than the informal workers. Hence, informal sector creates a room for the firms in the formal sector to shift their labor. This means that if there was no informal sector in the economy, the amplitude of a recession would be smaller. Informal sector creates a room for a shift in production that might not occur if informal sector was not present. Altug and Canova (2012)

finds that better governance, which could be interpreted as an indicator of lower informal economy, is associated with shorter and less severe recessions and milder expansions. This finding confirms my result that a higher size of the informal economy increases the duration and amplitude of expansions.

Similarly, a rise in the amplitude and the frequency of the previous phase increases the amplitude and frequency of both the current expansion and recession. Finally, both openness and GDP per capita reduce both the frequency and the amplitude of formal recessions but these impacts are smaller, and the other external factors do not significantly affect the shape of the formal phases.

CHAPTER 5

CONCLUSION

Even though there are many studies that investigate the evolution of different variables over the business cycles, more factors should be incorporated into the analysis by using a different perspective to extend our knowledge about the determinants of cyclical fluctuations. One of these factors is the size of the informal economy since the informal economy generally acts as a substitute for the formal economy. However, due to the lack of large and robust quarterly datasets of the size of the informal economy, shadow economy over the business cycles and the interaction between the formal and informal sector analysis could not be investigated before in detail.

This thesis addresses these important gaps in the literature. First, relying on a two-sector dynamic general equilibrium model, I use the model based estimation methodology to construct quarterly estimates of shadow economy size for 15 developed economies from 1960 to 2010, which is the largest quarterly data of shadow economy size in the literature. Second, I examine the shadow economy over the business cycle analysis using our novel panel dataset. And finally, I investigate the interactions between different phases of formal and informal cycles for 15 advanced countries over a long period of time.

I find that although the size of the shadow economy follows a decreasing trend over time, there are cyclical fluctuations for the size of the shadow economy. This observation strengthens my previous claim that there might be strong linkages between formal and informal cycles. After detecting the formal and informal cycles

using the turning point algorithm, at the cycle level, I find 82 formal cycles and 126 informal cycles for 15 advanced economies over the period 1960 and 2010 and conclude that informal cycles are more volatile than formal cycles. At the phase level, I identify 249 phases of formal cycles and 324 phases of informal cycles. Then, I find that duration, amplitude, and cumulative gain are higher in the formal expansions than informal expansions, but there is no such a conclusion between the recessions of formal and informal cycles.

Next, using the concordance index calculation to find out the degree of synchronization between formal and informal cycles, I find that aggregate informal output level is generally procyclical, while the size of the informal economy as a percentage of official GDP is countercyclical. Finally, I employ a more formal analysis to argue the extend of the role the size of the shadow economy on formal business cycles and to account for other factors that could influence the shape of cyclical fluctuations of official GDP by constructing various regression models. I find that a larger shadow economy size is associated with a higher duration formal cycles. Moreover, at the phase level, a larger informal economy size is associated with larger and longer formal expansions, and larger but not necessarily longer formal recessions.

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