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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

The dynamics of the economic cycle with duration dependence: Further evidence from Jordan

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Received: 17 March 2018
Accepted: 03 January 2019
First Published: 08 January 2019

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Reviewing editor:
Jorge Miguel Lopo Gonçalves Andraz, Universidade do Algarve, Puerto Rico

Additional information is available at the end of the article

Abstract: In this article, we investigate the effectiveness of the credit facilities and foreign trade to combat the cycle duration in the industrial production index. The turning point methodology of Harding and Pagan was adapted to formulate the economic cycle. Using the industrial production index of the Jordanian economy over the months from January 2000 to December 2017, the Logit model was used to test for duration dependence, with the credit facilities and net export included as controls. We find that industrial production index expansions and contractions have positive duration dependence, since their exit probabilities increase with duration. These results first help policy-makers to predict the length of economic cycles and to use these factors to reduce the consequences of the contraction. Second, the fact that duration is significant for the expansion phase could become a useful indicator in predicting the length of an economic cycle. The asymmetric nature of our duration dependence findings is striking.

Subjects: Economics; Industrial Economics; Econometrics

Keywords: duration dependence; economic cycles asymmetry; logit model; turning points methodology

1. Introduction

The cyclical behavior of macroeconomic variables has long been of interest to policy-makers and economists alike. More attention has also been paid to the dynamics of these cycled, in which, according to the literature, the reduction in volatility is widespread (Carvalho & Harvey, 2005; Stock

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This work is a part of a project that investigated the economic cycle issue in both developed and developing countries.

PUBLIC INTEREST STATEMENT

In this paper, we tend to advocate the literature on combating the economic cycle duration by concentrating on new econometric methodology. Further, to assess the role of credit facilities and net export on the duration dependences on economic cycle represented by a time series of the Industrial production index.

It is striking that our duration dependence findings are found to be asymmetric in nature. Despite its exploratory nature, this study offers some insight into examining whether the economic cycle responds asymmetrically to the other factors (such as FDI, Productivity and Openness); and, second, to show to what extent the macro variables outperforms the micro one in affecting the economic cycle.

& Watson, 2003), and little tendency has been shown to increase the international synchronization of cyclical fluctuations (Heathcote & Perri, 2002; Kose, Prasad, & Terrones, 2003). Hitherto, however, one widely held view has been that the older the phase, the greater the likelihood that it will end, i.e., that the lengths of cycle phases tend to cluster (see among others; Mills, 2001; Sichel, 1991).

In the history of business cycles, real GDP or industrial production has been viewed as a key factor in the construction of a business cycle indicator and test for duration dependence. Moreover, a number of studies have highlighted that control variables can also be added to the duration model to assess their influence on phase age. Seminal work in this area (see among others, Lam, 2004; Layton & Smith, 2007) provides evidence of positive duration dependence in contractions, with negative duration dependence in expansion phases.

Despite this effort, most of the above studies argue that the business cycle is symmetrical and responds symmetrically to any change in the fundamentals. Moreover, the assessment of factors that reduce economic fluctuation can be a puzzling task when the noisy data give mixed signals about the overall state of the economy. Therefore, much interest has been shown in a model that takes asymmetric properties into account, in which we can distinguish between different phases and which is sufficiently flexible to allow different relationships to apply over them.

Our work bridges the gap in this literature by extending the use of duration dependence to test for the asymmetrical response of turning points in the industrial production index. Put differently, the aim here is to answer the following questions: first, what are the main characteristics of the business cycle? Second, do business cycles exhibit duration dependence? That is, are expansions (contractions) more likely (less likely) to end as they grow older? Finally, does this cycle's response vary as to the fundamentals across phases?

Investigating the dynamics of growth in the industrial sector depends on institutional features and macroeconomic conditions; most notably the impact of the financial sector (represented by the credit facilities) on the industrial production index (as economic growth indicator) merits special attention since industrialization is often essential for economic growth, and for long-run poverty reduction. In his seminal work, Schumpeter (1934) highlighted that easing credit facilities to the industrial sector could stimulate technological innovation and economic growth by funding productive investments. In the same way, writers (among others, Goldsmith, 1969; Gurley & Shaw, 1967; Robinson, 1952; Spellman, 1982; Zang & Kim, 2007) have advanced the thinking to contend that financial development could enhance industrial development and hence economic growth by increasing saving, improving the efficient allocation of funds, and promoting capital accumulation.

Much of the current literature on the role of credit facilities on economic growth pays particular attention to the growth of the Small and Medium Scale industrial Enterprise sector due to its immense contribution to gross domestic product (GDP) and, hence, economic growth (see among others; Mensah, Tribe, & Weiss, 2007). In this vein, Kasekende and Opondo (2003) suggest that the ease of credit facilities to those industrial Enterprise sector would indirectly affect economic growth because of the strategic role of such industrial Enterprises play a crucial in economic growth and development through their contribution in the creation of wealth, employment and income generation. Okpara (2011) demonstrated that the credit facilities to industrial Enterprise sector have been a widely spread in Sub-Saharan Africa due to the continuous recognition as the catalyst of growth and macro-economic variables booster.

The response of economic growth to foreign trade has also received attention (e.g. Becker & Knudsen, 2002). For instance, on the one hand, net exports are likely to bring foreign investment into the country. This is often vital, especially in an economy's early stages of development (see e.g. King & Levine, 1993 and the references therein). On the other, it is also likely to increase productivity, because it brings external competition to domestic companies (see e.g. Levine, 1997; Zang & Kim, 2007).

Numerous studies have attempted to explain this relation between the export and the economic growth. An influential work of Furuoka (2007) highlight that, in the long run, there is a mutually reinforcing relationship between Malaysia's GDP and exports (or virtuous cycle). Furthermore, the author found only a unidirectional short-run causality from GDP to exports. The overall conclusion is that the output expansions in Malaysia's export resulted in an increase in export. Similarly, Furuoka and Munir (2010) examine the relation between export dependency and the economic growth in Singapore. Using the causality test developed by Toda and Yamamoto (1995), they highlight a negative long-run relationship between export dependency and economic growth. However, Singapore's economic growth seems not to be affected by such negative relation since the increase in export dependency was an effect, and not a cause, of the country's output expansion.

The approach taken in the present study is that of a mixed methodology, in which we first define economic cycles and explore any evidence of asymmetry based on the turning point methodology, as highlighted in the influential paper of Harding and Pagan (2002). Next, we use the binary random variables from this technique, applying the logit model, to assess whether and how the credit facilities and net export affect the duration of the cycle.

The analysis of this issue merits special attention in case of Jordanian economy because of the highly swings in terms of the size and length in the variables of interest (see e.g. Alqaralleh, Al-Saraireh, & Alamro, 2018). Such highly volatile data produce an interesting finding that account more for robustness of the impact of the considered variables on the duration and size of the Jordanian economic cycle. As shown, Figures 1 and 2 present the variables behavior with turning point indices identified by the shaded areas over the study period. Unsurprisingly, net export and credit facilities variables (as stressed in Figures 1 and 2) shows a high volatility in the economic cycle and the major fluctuations in this cycle is associated with the turning point indices agreed by the shaded area.

The paper is structured as follows: Section 2 describes the method of deriving a cycle chronology and summarizes the characteristics of such a cycle. Section 3 introduces the logit model which is used for the analysis. Section 4 concludes.

Figure 1.

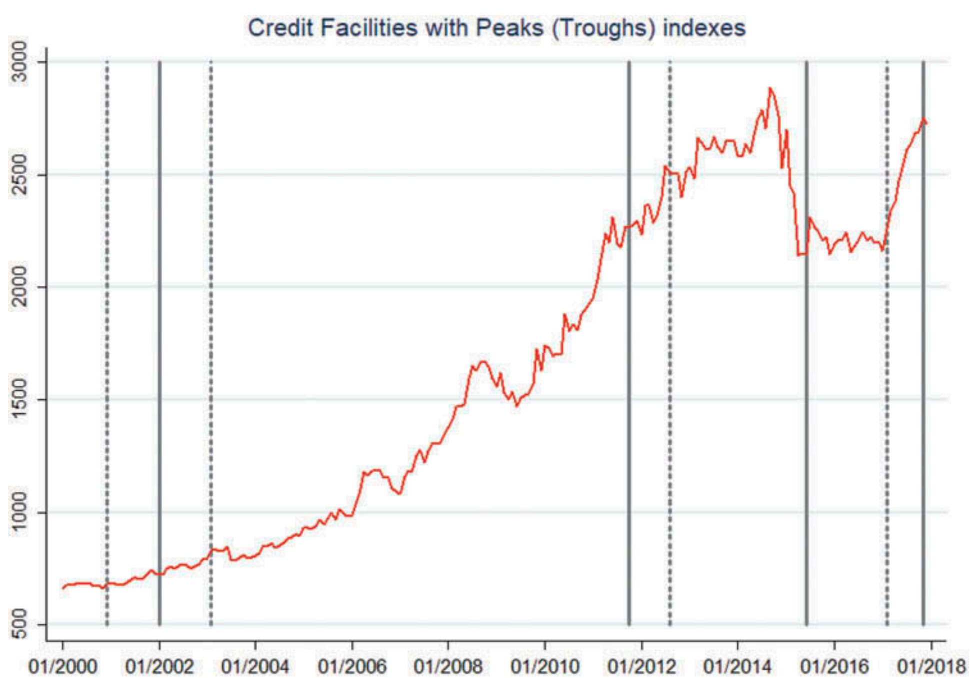
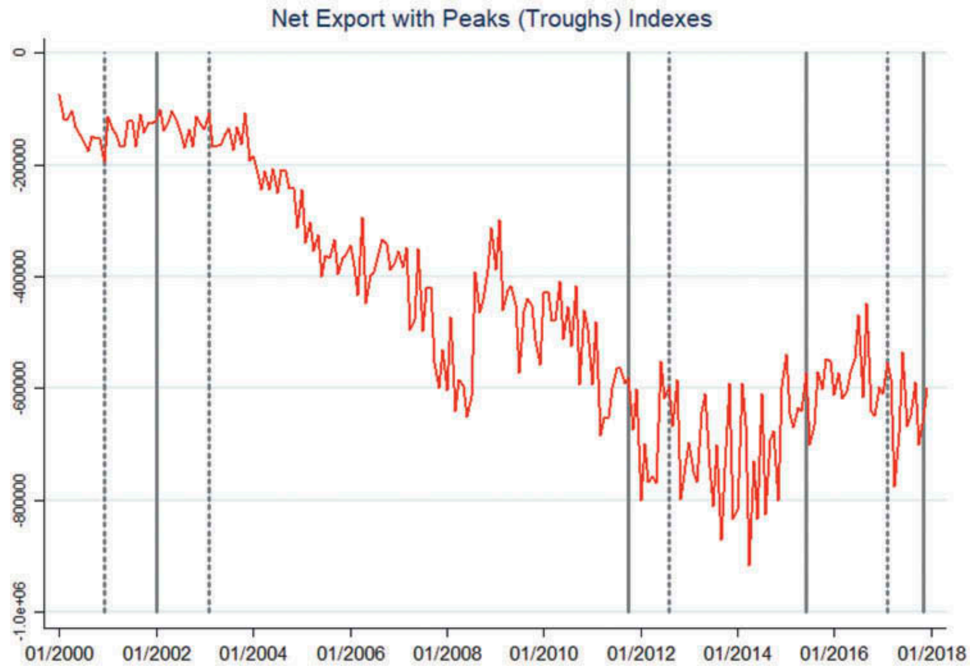


Figure 2.



2. Test for duration dependences on industrial production index

Duration analysis is a suitable way of studying the duration of contractions and expansions since the duration variable is defined as the number of months that an economy is in a state of contraction or expansion, depending on which phase is being analyzed. To test for the dependence on duration and evaluate the factors during the contraction and expansion phases in the economic cycle, two possible outcomes over any two consecutive periods are considered; first, that the economic cycle experiences a turning point whereby it switches from a period of expansion to a period of contraction; and second, that it experiences a turning point when it switches from shrinkage to a period of expansion.

A few techniques have been developed to examine duration dependence in the context of the business cycle (see for details Diebold & Rudebusch, 1999; Kim & Nelson, 1998; Lam, 2004). Logit models are also of interest for identifying such dependences (see Cole & White, 2012; Kolari, Glennon, Shin, & Caputo, 2002). A key insight from this type of analysis is that the probability of an event at any point in time can be inferred from the distribution of the actual series. The latter has advantages in investigating the length of the current phase of a cycle. Moreover, the findings provide useful guidance for policy-makers interested in finding the most likely factors affecting this duration.

Following the literature of duration dependency, this paper investigates the existence of duration dependences by using the logit model with time-varying covariates. To this end, the logit function is assessed for both expansion and contraction phases.

Denote by a Y_i as a realization of a random binary (expansion = 1; contraction = 0) time series variable for an industrial production index created using a classical business cycle chronology (discussed above). One model concerns the systematic structure of the data that estimate the probabilities of such an event P_i depending on a vector of observed covariates (X_i), including credit facilities to the industrial sector and the trade (proxied by net export) given as a linear function of the covariates by

$$P_i = \beta X_i \tag{1}$$

where β is a $k \times 1$ vector of coefficients to be estimated.

The likelihood of such event, say the exit to expansion phase given that the current state is contraction, can be viewed as logit form (which has the effect of removing the floor restriction) for the ratio of an event's (E_i) happening (with a probability of P_i) to its not happening (with probability $\overline{P_i} = 1 - P_i$), that is the likelihood ratio as follows:

$$\log(E_i) = \log\left(\frac{P_i}{\overline{P_i}}\right) \tag{2}$$

It is necessary here to clarify the exact impact of changing the predictor by one unit while holding all the other variables constant. Thus, we can define a multiplicative model for the odds as

$$\left(\frac{P_i}{\overline{P_i}}\right) = e^{(\beta X_i)} \tag{3}$$

It is worth noting that the Y_i under consideration defines the exit indicator as a binary variable. Therefore, the dependent variable in this context is a dummy variable with N observations representing the possible phase changes between any two consecutive periods, namely,

$$S^E = \left\{\begin{array}{ll} 1; & S_t = 2 \text{ and } S_{t-1} = 1 \\ 0; & \text{otherwise} \end{array}\right\}, \tag{4}$$

$$S^C = \left\{\begin{array}{ll} 1; & S_t = 1 \text{ and } S_{t-1} = 2 \\ 0; & \text{otherwise} \end{array}\right\}. \tag{5}$$

where S^E and S^C refer to the current state of expansion and contraction, respectively. In addition, the duration (d) of the current phase up to time $t-1$ can be defined as

$$d = \left\{\begin{array}{ll} d_{t-1} + 1; & S_t = S_{t-1} \\ 1; & S_t \neq S_{t-1} \end{array}\right\}. \tag{6}$$

We should bear in mind that the logistic regression model just developed is a generalized linear model with binomial errors and link logit. Therefore, we can rely on the general theory of maximum likelihood to obtain estimates of the parameters and to test hypotheses.

3. The industrial production index classical cycle

This paper used monthly data for the Jordanian economy over the sample period from January 2000 to December 2017 to assess the role of the credit facilities and net export on the duration dependence on the economic cycle represented by a time series of the Industrial production index. The time series are seasonally adjusted, deflated by the consumer price index and the logarithms were taken to remove (potentially) exponential growth patterns and to linearize the series approximately.

For the purpose of analysis, this section uses the turning point procedure so far proposed in the literature: assessing the peaks and troughs. One reason behind limiting the data to this interval is to concentrate on the troubled period in which the global financial crisis and the Arab spring took place, rather than on stable periods.

To identify the behavior of a classical cycle, we apply the turning point procedure to date the peaks and troughs in the log-level of aggregate economic activity (Harding & Pagan, 2002; Bry and Boschan, 1971). This procedure defines cyclical behavior as sequences of contractions and expansions and the results deal with the characteristics of the short-term cycle. This position is still widely used and known as the "'classical cycle'" approach (Alqaralleh, 2017; Morley & Piger, 2012; Zarnowitz & Ozyildirim, 2006), in which the turning point of the series $y_t = \Delta \log Y_t$ at time t is defined as

$$\text{Trough at } t = \left\{y_{t-j} > y_t < y_{t+j}\right\}, \tag{7}$$

$$\text{Peak at } t = \left\{y_{t-j} < y_t > y_{t+j}\right\}. \forall j = 1, \ldots, 5. \tag{8}$$

Table 1. Classical cycle in industrial production index

Contraction		Expansion	
Trough	**Duration before trough point is reached**	**Peak**	**Duration before peak point is reached**
Dec. 2000	12	Jan. 2002	13
Feb. 2003	13	Oct. 2011	104
Aug. 2012	10	Jun. 2015	34
Feb. 2017	20	Nov. 2017	9
Panel B: Cycle Characteristics.			
Average duration	13.5	40.25	
Average amplitude	−0.327	0.309	
Average cumulative	−2.55	13.292	

(1) Durations are expressed in months. (2) Duration and amplitude refer to the average of the duration and amplitude of the cyclical component by the city. (3) Amplitude and cumulative are expressed in percent.

We should not forget that the selected turning point is chosen so that they alternate. In other words, a peak (trough) must be higher (lower) than the previous one. Moreover, a complete cycle should last for at least 15 months. In addition, each contraction (expansion) phase has a minimum duration of 6 months (see e.g. Engel et al. (2005)).

To rule out the possibility that the cycle is symmetric, an interesting non-parametric statistical analysis is estimated; that is, the duration of expansions $\left(D^E\right)$ and contractions (D^C) given by

$$D^E = \frac{1}{M}\sum_{i=1}^{M} D_i^E;\ D^C = \frac{1}{M}\sum_{i=1}^{M} D_i^C. \tag{9}$$

where *M* refers to the number of contractions (expansions) in the period.

The results in Table 1 report the date at which the peaks (troughs) of the economic cycle occurred. The most obvious finding to emerge from Panel A of Table 1 is that the time to reach the turning point within the phase is quite heterogeneous, which suggests evidence of asymmetry. For instance, the length of the expansion periods before the financial crisis was similar to that of the contractions, the cycle phases lasting slightly less than 13 months. By contrast, industrial production in Jordan experienced a relatively long expansion phase continuing for more than 8 years. In line with expectations, the results indicate that the trough points were quickly reached, and the industrial sector was no longer in contraction.

Another important finding is stated in Panel C of Table 1. These results indicate that the expansion period extended three times longer than the downturn period. The total period of economic gain (measured by the average cumulative amount) during the expansion was also much longer than the period of contraction. According to these data, we can infer that the industrial production cycle provides the same information as a typical business cycle. Moreover, there is significant evidence of asymmetry in such cycles and, hence, the response to a shock in the determinant can vary over each phase.

4. Estimation results

To compare and contrast the role of the considered factors in the duration of the cycle phase, it is necessary to impose separately the duration dependences during boom and bust. Hence, we analyze the impact of the duration of the phase, holding other factors unchanged. Next, we replicate the studies after including the above factors to determine whether any major discrepancies in the age of the phase exist.

Table 2. Duration dependences results during the expansion period

	Odd ratio	Coef. *	Probability of continuation
Model A: Duration dependence			
Expansion duration	1.065	0.063	0.51
		(0.010)	
Model B: Duration dependence after considered the regressors			
Credit facilities	0.808	−0.213	0.45
		(0.097)	
Net export	1.213	0.193	0.55
		(0.047)	
Expansion duration	1.646	0.498	0.62
		(0.025)	
Panel C; Goodness of fit			
	Andrews statistic		**H-L Statistic**
Model A	6.789		4.028
Model B	3.212		7.21

Accordingly, each table presents the estimated hazard ratio of the parameters of the logit model obtained for the industrial production index during contraction (expansion) periods, along with robust standard errors, and the p-value of the corresponding z-statistic.

The specifications of benchmark regression reveal that there is evidence of duration dependence in the cycle's expansions and contraction. Specifically, the experimental evidence during expansion periods shows significant dependency between the factors under scrutiny and the likelihood of the expansion's continuing. As can be seen from Table 2, the hazard of the events[1] is 48%, ignoring the change in net export and credit facilities. In other words, the longer the expansion has lasted, the less likely it is to survive. But cooperating these factors leads to the continued existence of the expansion phase and, hence, cuts the hazard of the events to 38% as the phase ages, whereas the credit facilities and net export increase the likelihood of surviving by 43% and 41%, respectively. Consequently, the probability of the events is only 47% and 49%, respectively. This indicates that the expansion is more likely to survive. This finding is consistent with the results of Layton and Smith (2007) and Zuehlke (2003) for business cycle expansions.

The results of the duration dependences model during the contraction period are reported in Table 3. What is attractive in this result is that the probability of surviving declines with time and, here, declines dramatically when we include other factors. More specifically, the likelihood of the contraction to survive without changing the determents is estimated to be around 49%, whereas the likelihood of the event while controlling for the repressors is estimated to be 55%. Moreover, changing net export and credit facilities will increase the probability of the event to around 41% and 43%, respectively. It is apparent from this table, also, that the variables generally have the expected sign.

It should be borne in mind that the duration dependence results are remarkably robust since the p-value of both the Andrews and the H-L Statistic are large enough, which means that the expected and observed event rates in the model are similar (i.e. well calibrated).

5. Implications and conclusions

In this investigation, the aim is to test for duration dependences and to assess the role of credit facilities and net export on the duration dependences on economic cycle represented by a time series of the Industrial production index.

Table 3. Duration dependences results during the contraction period

	Odd ratio	Coef.	Probability of continuation
Model A: Duration dependence			
Contraction duration	0.971	−0.030	0.49
		(0.005)	
Model B: Duration dependence after considering the regressors			
Credit facilities	0.769	−0.262	0.43
		(0.173)	
Net export	0.691	−0.369	0.41
		(0.243)	
Contraction duration	0.808	−0.213	0.45
		(0.036)	
Goodness of fit			
	Andrews statistic		**H-L Statistic**
Model A	8.133		5.220
Model B	7.451		3.205

The findings suggest that control variables, including net export and credit facilities for the industrial sector, can largely be used to reduce the consequences of the contractions in economic cycles. Thus, such contractions will end when the credit facility conditions ease and the net exports increase. Similarly, expansion phases can be explained using these factors.

These results are interesting for policy-makers for several reasons. First, the findings suggest that control factors have a significant impact on the duration of the cycle; hence, these factors can be used to expand the expansion phase and shorten the contraction or at least reduce its consequences. Second, the fact that duration is significant for expansion phases could prove to be a useful indicator in predicting the length of economic cycles. It is striking that our duration dependence findings are found to be asymmetric in nature. Despite its exploratory nature, this study offers some insight into examining whether the economic cycle responds asymmetrically to the other factors (such as FDI, Productivity and Openness); and, second, to show to what extent the macro variables outperforms the micro one in affecting the economic cycle.

Acknowledgements
The authors acknowledge useful comments from an anonymous referee and the editor *Jorge Miguel Lopo Gonçalves Andraz*. All errors, views and conclusions stated in this paper are solely the responsibility of the authors.

Funding
The authors received no direct funding for this research.

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Citation information
Cite this article as: The dynamics of the economic cycle with duration dependence: Further evidence from Jordan, Huthaifa Alqaralleh & Radi Adayleh, *Cogent Economics & Finance* (2019), 7: 1565609.

Note
1. The event here is the exit to contraction and the probability in this case is 1–0.52 = 48%.

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