Samer Matta\*

# New Coincident and Leading Indexes for the Lebanese Economy

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**Abstract:** Weak economic statistics in Lebanon impede economic analysis and decision making. This paper presents a new coincident index and a leading index for the Lebanese economy. A new methodology, based on the National Bureau of Economic Research—Conference Board approach, was used to construct these indexes. The indexes can be used as monthly proxies for the evolution of real gross domestic product with a relatively small time lag (four to five months). Notwithstanding the relatively small sample period, the results reveal promising statistical properties that should make these new indexes valuable coincident and leading (one-year ahead) indexes for analyzing the dynamics of the Lebanese economy. However, given limitations on the length of the gross domestic product time series in Lebanon, the accuracy of these indexes in tracking the business cycle of the Lebanese economy is expected to improve over time as more data points become available.

Keywords: Lebanon, real economy, coincident index, leading index

## 1 Introduction

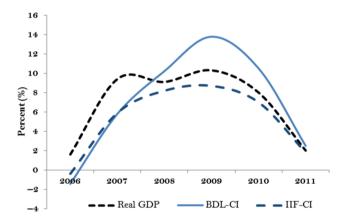
Lebanon's weak economic statistics are impeding timely decision making by businesses, investors and policy makers. Over the years, the quality of economic statistics in Lebanon has been extremely weak in terms of data compilation and frequency, even relative to countries with similar level of development (IMF 2012). Statistical weaknesses include areas such as national accounts, balance of payments, prices and inflation, and labor and social measures. In particular, as of May 2014, Lebanon's latest GDP data are from 2011 and are only available on an annual basis.<sup>1</sup>

<sup>1</sup> In October 2013, the Central Administration of Statistics (CAS) published for the first time revised national accounts from 2004–2011 using (i) new data (VAT returns, imports of services and the latest household budget survey 2011–2012) and (ii) a revised National Accounts framework that is consistent with the latest international standards (UN SNA 2008).

<sup>\*</sup>Corresponding author: Samer Matta, World Bank – Macroeconomics & Fiscal Management Global Practice, Bourrie House, Allenby Street Down Town, Beirut, Beirut, Lebanon, E-mail: smatta@worldbank.org

To provide a more timely and comprehensive assessment of economic activity in Lebanon, Banque du Liban (BdL) and the International Institute of Finance (IIF) separately developed coincident indexes. The former, which we denote by "BdL-CI", was developed in 1993, immediately following the end of the civil war, and is composed of eight variables. Notwithstanding the profound structural changes in Lebanon's economy that took place since the end of the civil war, the weights of the eight variables in the BdL-CI have remained fixed since 1993. Another caveat of the BdL-CI is the absence of a variable that captures the dynamics of the public administration sector, which represented on average 9.6% of GDP between 2004 and 2011. Meanwhile, the IIF coincident index, denoted by "IIF-CI", follows the same approach as the BdL-CI but includes an additional five variables Iradian & Zouk (2010).

While providing a useful gauge of economic activity in Lebanon, our analysis reveals that the statistical properties of these two coincident indexes – such as accuracy and unbiasedness – could be improved. As illustrated Figure 1, the IIF-



**Figure 1:** Yearly growth rates of BDL-CI, IIF-CI and real GDP. Source: BDL, CAS, IIF and author's own calculations.

<sup>2</sup> These are electricity production (volume terms), imports of petroleum derivatives (volume terms), M3 (in real monetary terms), cleared checks (in real monetary terms), total airport passengers (volume terms), cement deliveries (volume terms) and imports and exports (in real monetary terms).

<sup>3</sup> Jad (2011)(2011) stated that the weights of the variables composing the BdL-CI were fixed in 1993.

<sup>4</sup> These are "real growth in credit to the private sector (instead of growth in deposits), growth in tourist arrivals (instead of passengers arrivals), real growth in government revenues excluding grants, real growth in government consumption (current expenditure minus transfers minus interest payments), and real growth in imports of machinery and equipment" (Iradian and Zouk 2010, 2) (Granger 1969, 428).

CI, consistently underestimated actual GDP growth between 2006 and 2011. On the other hand, the BdL-CI had no systematic estimation error; however, its accuracy has recently been weak as the gap between the BdL-CI and actual growth has been relatively large in several years, and in one year (2006), the BdL-CI also qualitatively misdiagnosed the strength of economic activity (the BdL-CI signaled that the economy was contracting by 1.4% while it actually grew by 1.6%).

timeliness and accuracy of economic activity estimates in Lebanon, we design two new indexes for the Lebanese economy: a coincident (WB-CI) and a leading (WB-LI) index. This study builds upon features from the empirical literature on coincident and leading indices such as Moore and Shiskin (1967), Stock and Watson (1989), Chauvet (1998), Mariano and Murasawa (2002), Issler and Vahid (2006), Pereira (2012) and Issler et al. (2013).

In this paper we add to the literature two main contributions. First, we improve on the NBER-Conference Board approach (Conference Board 2014) by employing a minimization technique to ameliorate the statistical properties of coincident and leading indexes. We do so by calibrating the weights assigned to each variable so that the yearly growth rate of the constructed index (Coincident or Leading) converges to the actual growth rate of the reference variable (in our case GDP) at any point in time. Second, we develop for the first time a leading index for the Lebanese economy that can be used to (i) detect early signs of turning points in economic activity and (ii) forecast GDP growth during the next 12 months.

The rest of this paper is structured as follows. Section 2 presents a brief historical overview of coincident and leading indexes. Section 3 describes the methodologies used to construct the WB-CI and WB-LI. Section 4 presents the results while Section 5 discusses some policy implications derived from these newly developed indexes. Finally, Section 6 presents the caveats and limitations of the indexes and Section 7 concludes.

## 2 Literature Review

Knowing the current and the expected state of the economy is of foremost importance for businesses, policymakers and investors. Depending on the quality of statistics in a given country, two distinct methodologies have been used to develop coincident and leading indexes: (i) the National Bureau of Economic Research (NBER) and/or Conference Board (CB) methodology and (ii) the Stock and Watson (1989) methodology (hereafter denoted by SW). The NBER-CB approach is a non-econometric technique, while the SW methodology is based on advanced statistical properties such as Dynamic Factor and Markov Switching models.

The idea of quantitatively monitoring a business cycle, which "commonly refers to co-movements in different forms of activity, not just fluctuations in GNP" (Stock and Watson 1989, 353), was first introduced in 1938 by a research team at the NBER. This team, which was led by Wesley Mitchell and Arthur Burns, examined the dynamics of some economic variables to see whether these changes lagged, led or coincided with changes observed in US business cycles. Twenty years later, Moore and Shiskin (1967) developed, for the first time and based on Burns and Mitchell's (1946) research, a methodology to construct composite indexes of real economic activity. They designed "a scoring plan that has been developed to help in the evaluation and selection of indicators" (Moore and Shiskin 1967, 3). The scoring plan of each variable was based on (i) statistical adequacy, (ii) timeliness of publication, (iii) smoothness, (iv) economic significance, (v) historical business cycle conformity, and (vi) cyclical timing. This approach, which was adopted by the Conference Board in 1995 and developed later on, is, however, subject to some criticism. First, many econometricians argued that the selected variables were subjectively chosen without any econometric foundation (Marcellino 2005). This is what Koopmans (1947) described as a "measurement without theory". Second, and as argued by Chauvet (1998) indexes constructed with this methodology are constantly revised ex-post and since revisions can be significant in certain cases, realtime assessment of the business cycle may be severely impacted.

In a first attempt to respond to these criticisms, Stock and Watson (1989) developed an econometric model to construct new coincident and leading indexes for the U.S. economy. In their method, the coincident indicator (or Index) is represented by an unobserved reference cycle representing what they referred to as the "state of the economy". The index is then measured using a Dynamic Factor model, where the parameters of the series<sup>5</sup> forming the index are estimated using Maximum Likelihood and Kalman Filter methods. In addition, they developed a leading indicator that forecasts the growth rate of the coincident index over the next six months, using a set of variables<sup>6</sup> in a Vector

**<sup>5</sup>** The four variables that composed the coincident indicator proposed by Stock and Watson (1989) were: employee-hours in nonagricultural establishments, industrial production, real personal income less transfer payments and real manufacturing and trade sales.

**<sup>6</sup>** The variables used in the construction of a leading indicator were: Average weekly hours of production, Average weekly initial claims of state unemployed insurance, Manufacturing new orders, S&P 500, Building permits, M2 and change in business and consumer credit outstanding.

Autoregressive model (VAR). However, the SW approach failed to anticipate the U.S. recession in 1990-1991 because it assumed that expansions and contractions are symmetric in terms of their impact on the economy. For that reason, and in order to account for the fact that recessions are more sudden and shorter than expansions, Chauvet (1998) improved on the SW methodology by capturing nonlinearities in the business cycle using the Markov Switching model as proposed by Hamilton (1989). Other noticeable scholars that tried to improve on the SW econometric methodology are Mariano and Murasawa (2002) who employed a mixed frequency model by adding quarterly real GDP data to the initial set of monthly indicators and Issler and Vahid (2006) who used canonical correlation analysis and an instrumental variable probit model to construct a coincident index of the US economy.

Historically, economic research in this area was focused on developed countries. However, as a result of the improvement in the quality and frequency of data, research examining business cycles in emerging countries increased in recent years. Consequently, economists deepened their understanding of the business cycle in many of these countries by developing coincident and/or leading indexes. For example, Saadi-Sedik and Mongardini (2003) employed a reduced form model of the SW methodology to construct coincident and leading indexes for the Jordanian economy from January 1996 to December 2002. More recently, Pereira (2012) constructed a quarterly coincident index for the Cape Verdean economy, from 2002 to 2010, using the NBER/CB approach, while Issler et al. (2013) designed coincident indexes for Argentina, Brazil, Chile, Colombia and Mexico. Finally, Dorsainvil (2014) designed a coincident index for the Haitian economy using the Principal Component Analysis approach.

Although the SW methodology provides a proper statistical framework, it can't be applied in the Lebanese context due to the absence of long historical time-series. In particular, we only have yearly data for the Lebanese GDP from 2004 to 2011 which only gives us eight observations. Therefore, the law of large numbers, on which the relevant time-series econometric techniques depend, will be violated, hence decreasing the power of these models (higher probability of committing a Type II error). For that reason, we will use an improved NBER-CB approach which can be applied in countries that suffer from weak statistical systems (similar to Lebanon). This approach has the important advantage of being easy to construct, explain and analyze. These are valuable properties in constructing composite indexes aimed at a wide public.

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# 3 Methodology

### 3.1 World Bank Coincident Index for Lebanon (WB-CI)

The construction of the WB-CI starts with the choice of a benchmark series, which in our case is the (recently revised) annual GDP series from 2005<sup>7</sup> till 2011 as published by the Central Administration of Statistics (CAS) in October 2013. The next step is to select the corresponding variables that track as closely as possible the current dynamics of real GDP. The potential variables which satisfy this objective should be, above all, available with a monthly frequency and have a historical series that dates back to the earliest starting point of the new real GDP series published by CAS. This selection is crucial for computing the WB-CI, because if the set of potential variables does not cover all (or most of) the sectors of the Lebanese economy, then the WB-CI will not be a robust estimate of real GDP. Consequently, and in order to account for all the economic sectors, we refer to Lebanon's GDP decomposition, presented in Table 1, and map each sector to a high-frequency variable that reflects its economic dynamics.

The availability of sufficiently long time series is a major constraint in Lebanon. As a result, a relatively small number of variables exist to proxy for economic activity, and many variables used in the literature to develop coincident indexes are not available in the case of Lebanon such as real personal income less transfers and the number of employees on non-agricultural payrolls. According to Anguyo (2011), the former captures consumers' aggregate spending behavior while changes in the latter reflect net hiring in the economy.

#### 3.1.1 Existing Data and Potential Variables for the WB-CI

A set of twenty potential variables, capturing the dynamics of most sectors of the Lebanese economy, was included in the construction of the WB-CI. The rationale

<sup>7</sup> While the new national accounts, compiled by CAS (2013), cover the 2004–2011 period, our sample starts from 2005 because some of the variables such as lending to the private sector and built property tax were not fully reported in 2004.

 $<sup>{</sup>f 8}$  Some of these would clearly not be a first choice in a country with a more developed statistical system.

	Table 1: Lebanon's	GDP	decomposition	from	the	supply side.
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Agriculture and forestry	Industry	Services
Agriculture & forestry	Mining & quarrying	Wholesale & retail trade
Livestock & livestock products; fishing	Manufacturing of food products Beverages & tobacco manufacturing Textile & leather manufacturing Wood & paper manufacturing; printing Chemicals, rubber & plastics manufacturing	Vehicle maintenance & repair Transport Hotels & restaurants Information & communication Financial services
	Non-metallic mineral manufacturing Metal products, machinery & equipment Other manufacturing Electricity Water Supply & waste management	Real estate Professional services Administrative services Public administration Education
	Construction	Health & social care Personal & community services

Source: CAS.

for selecting each of these variables, listed with their corresponding sources in Table 6 in the Appendix, is the following:

- The dynamics of the wholesale & retail trade sector, which is the main sector of the Lebanese economy, representing 14.8 % of GDP in 2011, are captured using cleared checks obtained from BdL and VAT revenues published in the public finance monitor of the ministry of finance.
- The real estate sector, the second biggest sector of the Lebanese economy representing 13.8 % of GDP in 2011 is proxied using (i) real estate registration fees and (ii) tax on property. Data for both variables are also obtained from the public finance monitor published by the ministry of finance.
- The public administration services sector is the third biggest sector of the economy representing 9.6% of GDP in 2011. For activities in this sector, we use the primary spending (total spending minus interest payments) of the central government as a proxy.
- The financial sector, representing 7.3% of GDP in 2011, is measured using M3, lending to the private sector and non-resident private sector deposits, while the construction sector, which constituted 4.5% of GDP in 2011, is captured using cement deliveries and construction permits. Data for both variables are obtained from BdL.

5. Due to the scarcity of variables reflecting the activity of the industrial and agricultural sectors, which represented respectively 3.8 and 13.4% of GDP in 2011, these sectors are measured using net exports of goods (excluding energy imports) calculated based on data provided by the Lebanese customs.

6. Finally, the information and communication, tobacco manufacturing, administrative services, transport, electricity and hotels and restaurants sectors are captured using transfer from the telecom surplus, tobacco excise, administrative fees and charges, private car registration fees, imports of energy and tourist arrivals, respectively. In addition, current economic index, current personal income index and the current security index were used as proxies for consumer sentiment.

#### 3.1.2 Steps Followed to Construct the WB-CI

The WB-CI we construct is based on a methodology that is similar, but not identical, to the NBER-CB approach. The main difference resides in the choice of weights. In contrast to the latter methodology, which computes the weights assigned to each variable as the inverse of its respective standard deviation, the weights in the WB-CI are calibrated in order to minimize the difference between the average yearly growth rate of the coincident index and the actual GDP growth rate as published by CAS. In other words, the weights are selected such that the growth rate of the WB-CI is as close as possible to the GDP growth rate during the same year. In particular, our methodology is based on nine distinct steps. In what follows, t resents the current month while  $x_{i,t}$  denotes the raw data for variable  $i = 1, \ldots, 20$  at period  $t = 1, \ldots, T$ .

- 1. The X-12-ARIMA technique with a multiplicative decomposition is used to remove the seasonal trend from all the variables  $x_{i,t}$ .<sup>10</sup>
- 2. In order to measure the real economic activity, all the variables that are in monetary terms are deflated by the Consumer Price Index (CPI) published by

**<sup>9</sup>** We use tourist arrivals and not the number of airport arrivals, because the latter includes Lebanese expatriates that are not considered as tourists, hence they are not a proxy for the tourism sector. However, the contribution of expatriates to the economy (mainly through remittances) is reflected by the non-resident deposits at commercial banks.

**<sup>10</sup>** Given that Lebanon was hit by several exogenous shocks (political vacuums, internal conflicts, several explosions, war with Israel etc.) over our sample period, we expect the monthly seasonal variation to fluctuate over time. As a result, we use the multiplicative rather than the additive decomposition.

the Consultation and Research Institute (CRI)<sup>11</sup> with December 2006 as the base period/month.

Fiscal variables exhibit unusual volatility at a monthly frequency. To elim-3. inate this "noise" we smooth these series using six months moving averages.

Following the data transformations in steps 1, 2 and 3, all the variables will be denoted by:

$$s_{i,t}$$
 for  $i = 1, ..., 20$  and  $t = 1, ..., T$ .

Then, the month-to-month symmetric percentage change is calculated. <sup>12</sup> If the variable s is an interest rate or in a percentage form, then the percentage change is calculated as:

$$C_{i,t} = S_{i,t} - S_{i,t-1}$$
 for  $i = 1, ..., 20$  and  $t = 1, ..., T$ . [1]

In any other case, the following symmetric percentage change formula is applied.

$$C_{i,t} = 200 * \left( \frac{S_{i,t} - S_{i,t-1}}{S_{i,t} + S_{i,t-1}} \right) \text{ for } i = 1, \dots, 20 \text{ and } t = 1, \dots, T.$$
 [2]

Before proceeding, let  $w_i$  denote the weight assigned to each variable  $s_{i}$  for i = 1, ..., 20.

- Afterwards, (preliminary) random weights  $w_i$  are chosen for each variable  $s_{i,t}$  such that:  $\sum_{i=1}^{n} w_i = 1$ .
- Using steps 4 and 5 the growth rate,  $g_{i,t}$ , of each variable is then calculated using the following formula:

$$g_{i,t} = C_{i,t} * w_i \text{ for } i = 1, \dots, 20 \text{ and } t = 1, \dots, T.$$
 [3]

Next, the growth rates of all the variables are summed in order to get the month-to-month growth rate,  $G_t$ , of the WB-CI such that

$$G_t = \sum_{i=1}^{n} g_{i,t} \text{ for } t = 1, \ldots, T.$$
 [4]

<sup>11</sup> The CRI CPI is used rather than the one from CAS because the latter started to compile their new corresponding CPI series in December 2013 while the WB-CI starts in December 2006. CRI's CPI, however, dates back to January 1988.

<sup>12</sup> The symmetric percentage change formula treats negative and positive changes symmetrically (with the same magnitude). For example, when a variable increases by 1% followed by a 1% decrease, the level of the variable would return to its initial value. This is would not be true with the standard change formula.

8. Assuming that the base year of the WB-CI is the first period (i. e.  $WB-CI_{t=1}=100$ ) the level of the index is calculated recursively using eq. [4] and the below symmetric percentage change formula,

$$WB - CI_t = WB - CI_{t-1} * \left(\frac{200 + G_t}{200 - G_t}\right)$$
 for  $t = 2, ..., T$  [5]

9. Finally the model is calibrated so that the final weights  $w_i$  satisfy eqs [6] and [7] below:

$$\min_{W_i} \text{Average} \left[ \left( \frac{WB - CI_y}{WB - CI_{y-1}} - 1 \right) - \left( \frac{GDP_y}{GDP_{y-1}} - 1 \right) \right] \text{ for } y = 2006, \dots, 2011$$
 [6]

$$\min_{W_i} \text{ Standard deviation} \left[ \left( \frac{WB - CI_y}{WB - CI_{y-1}} - 1 \right) - \left( \frac{GDP_y}{GDP_{y-1}} - 1 \right) \right] \text{ for } y = 2006, \dots, 2011$$
[7]

After following the above steps and calibrating the model using the minimization problems in eqs [6] and [7], the WB-CI is constructed from December 2004 to December 2011 (85 observations). Table 2 shows that the WB-CI is a weighted average of twelve variables with VAT revenues, lending to the private sector, primary spending, administrative fees and charges, and M3 contributing the most, while the other eight variables (not shown in Table 2) were apportioned a zero weight.

Table 2: Variables forming the WB-CI.

Variable	Weight (%)
Net exports of goods without energy products*	0.4
Taxes on real-estate	0.7
Tourist arrivals	3.4
Non-resident private sector deposits	3.7
Tobacco excise	6.1
Cleared checks	6.2
Cement deliveries	6.3
VAT revenues	13.0
Lending to the private sector	13.9
Primary spending	14.7
Administrative fees and charges	15.0
M3	16.6
Total	100.0

Source: Author's own calculations.

<sup>\*</sup> Net Exports of Goods without energy products = Exports - Imports (excluding energy)

## 3.2. World Bank Leading Index of Lebanon (WB-LI)

In a turbulent and volatile environment like Lebanon, a high-frequency leading index is a natural complement to a coincident index. A leading index for the Lebanese economy (WB-LI) would help to (i) detect early signs of turning points in the economic activity and (ii) forecast GDP growth during the next 12 months. To the best of our knowledge, the designed WB-LI would be the only publicly available leading index for the Lebanese economy.

#### 3.2.1 Existing Data and Potential Variables for the WB-LI

The initial steps in constructing the WB-LI are to (i) choose an appropriate reference series and to (ii) determine the relevant components of the WB-LI. We will use the developed WB-CI as the benchmark series because by construction it follows the business cycle of the Lebanese economy very closely. We should note that potential variables that satisfy at least one of the following two conditions can be used in the construction of the WB-LI. The first condition is economic significance, implying that a certain variable has "expectational components that would (under some economic theory) respond rapidly to some shocks to the economy" (Stock and Watson 1989, 365). The second is statistical relevance which means that the correlation coefficient between a certain variable at time t and the reference series at time t + 12 should be larger than 0.5. Based on these two conditions, seventeen potential variables, reported in Table 3, were used to construct the WB-LI. Table 7, in the Appendix, shows the unit and source of these variables.

While the choice of variables based on the statistical relevance principle depends, solely, on having a correlation coefficient larger than 0.5, the variables that we selected according to the economic significance criteria would warrant a greater analysis. For example, the future economic index reflects the expectations of individuals regarding the future economic environment. On the other hand, an increase in personnel costs<sup>13</sup> implies that workers have more money to save and spend today. Given the high Lebanese interest rates, this implies that a rational person would prefer to save today, earn a high return and then consume in the future. Moreover, higher capital spending suggests that the government is planning to boost economic activity in the future through investing in capital projects today. Meanwhile, freight incoming at the port of Beirut is a leading retail trade indicator as businesses and industrialists import more goods in the

<sup>13</sup> Personnel costs are defined as the total remuneration to public sector employees.

Table 3: Economic significance and statistical relevance of the potential variables of the WB-LI.

Variable	Statistical Relevance*	Economic Significance**
Consumer Confidence Index	× (+0.32)	✓
Cement Deliveries	<b>√</b> (+0.72)	×
EMBIG Spread	<b>√</b> (+0.79)	✓
Custom Revenues	<b>√</b> (+0.58)	✓
Airport Arrivals	<b>√</b> (+0.84)	×
Freight Incoming at the Port of Beirut	$\times$ (+0.37)	✓
Spread between local and Libor interest rate	<b>√</b> (+0.89)	✓
Lending to the Private Sector	<b>√</b> (+0.86)	✓
Personnel Cost	$\times$ (+0.47)	✓
Capital Expenditures	× (-0.07)	✓
Change in Dollarization Rate	× (-0.04)	✓
Public Debt	√ (+0.92)	✓
Blom Stock Index	× (-0.06)	✓
Industrial Exports	√ (+0.69)	×
Construction Permits	$\times (+0.49)$	✓
Construction in Progress	× (-0.02)	✓
Future Economic Index	× (-0.08)	✓

<sup>\*\*</sup>Source: Author's own calculations.

Note: Correlation coefficients are in parenthesis. \*  $\checkmark$  means that the correlation coefficient between the concerned variable at time t and the WB-CI at time t+12 is larger than 0.5 in absolute value. \*\*  $\checkmark$  means that under some economic theory the concerned variable would respond rapidly to some shocks to the economy.

present when expecting an improvement in the general business environment in the future. The stock index reflects investors' appetite to invest in the future while the EMBIG spread captures investors' confidence in sovereign bonds. In addition, the dollarization rate and the spread between local and interest rates can both be considered leading indicators as the former is a proxy for the confidence in the local currency while the latter is a major determinant of future deposit inflows at commercial banks. Finally, an increase in construction permits suggests that investors and contractors expect a pickup in the real estate sector in the long run as it takes several years to construct a building.

#### 3.2.2 Steps Followed to Construct the WB-LI

To develop the WB-LI, we use the same methodology adopted for constructing the WB-CI with the exception of a different minimization problem (step 9). In particular, the weights are calibrated in order to minimize the difference between the growth rate of the leading index at time t and the growth rate of the coincident index at time t + 12. In other words, the weights are selected such that the growth rate of  $WB-LI_t$  is as close as possible to the growth rate of  $WB - CI_{t+12}$ . The rationale for such an approach is to increase (decrease) the forecast confidence (error) of GDP growth for the forthcoming year. The WB-LI is computed and tested against the WB-CI between December 200614 and December 2012 (73 observations) using monthly data of the seventeen potential variables. A prime (') is used to represent the variables corresponding to the WB-LI. Accordingly, eqs [6] and [7] at the 9<sup>th</sup> step of the methodology become,

$$\begin{split} & \underset{w_i'}{\min} \, \text{Average} \left[ \left\{ \textit{Geomean} \left( \frac{\textit{WB} - \textit{LI}_y}{\textit{WB} - \textit{LI}_{y-12}} \times \ldots \times \frac{\textit{WB} - \textit{LI}_{y+11}}{\textit{WB} - \textit{LI}_{y-1}} \right) \right\} \\ & - \left\{ \textit{Geomean} \left( \frac{\textit{WB} - \textit{CI}_{y+12}}{\textit{WB} - \textit{CI}_y} \times \ldots \times \frac{\textit{WB} - \textit{CI}_{y+23}}{\textit{WB} - \textit{CI}_{y+11}} \right) \right\} \right] \\ & y = \textit{Dec} \, \, 2007, \, \ldots, \textit{Dec} \, \, 2011(6') \\ & \underset{w_i'}{\min} \, \text{Standard deviation} \left[ \left\{ \textit{Geomean} \left( \frac{\textit{WB} - \textit{LI}_y}{\textit{WB} - \textit{LI}_{y-12}} \times \ldots \times \frac{\textit{WB} - \textit{LI}_{y+11}}{\textit{WB} - \textit{LI}_{y-1}} \right) \right\} \right. \\ & - \left\{ \textit{Geomean} \left( \frac{\textit{WB} - \textit{CI}_{y+12}}{\textit{WB} - \textit{CI}_y} \times \ldots \times \frac{\textit{WB} - \textit{CI}_{y+23}}{\textit{WB} - \textit{CI}_{y+11}} \right) \right\} \right] \\ & \textit{for} \, \, y = \textit{Dec} \, \, 2007, \, \ldots, \textit{Dec} \, \, 2011(7') \end{split}$$

The adjustment in the methodology and the ensuing calibration generated the WB-LI from December 2006 to December 2012 (73 observations). As shown in Table 4, the constructed WB-LI consists of monthly observations for nine variables (real, external, monetary and fiscal) while the other eight variables (not shown in Table 4) were apportioned a 0 weight as a result of the minimization.

## 4 Results of the WB-CI and the WB-LI

Our results indicate that the designed WB-CI measures the economic activity in Lebanon very accurately. 15 The criteria used to assess the effectiveness of the WB-

<sup>14</sup> Our sample for the WB-LI starts from December 2006 and not December 2004 (as the WB-CI) given that 2006 was subject to an unexpected exogenous shock represented by the War with Israel. Hence, any attempt to forecast, in 2005, the state of the Lebanese economy for 2006 would likely be misleading.

<sup>15</sup> The WB-CI series is available in Table 8 in the Appendix.

Table 4: Variables forming the WB-LI.

Variable	Weight (%)
EMBIG spread	0.09
Custom revenues	0.47
Spread between local and Libor interest rate	5.05
Capital expenditures	5.26
Lending to private Sector	10.85
Airport arrivals	15.46
Cement deliveries	15.66
Freight incoming at port of Beirut	22.41
Personnel costs	24.75
Total	100.00

Source: Author's own calculations.

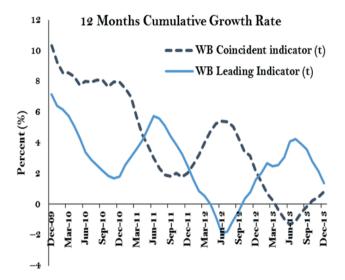
CI in monitoring the Lebanese economic activity is based on calculating the absolute value of the error between the yearly growth rate of the WB-CI and the actual (realized) annual GDP growth rate. When this error tends, on average, to 0 and its standard deviation converges to 0 this implies that the WB-CI accurately reflects the dynamics of the Lebanese real economy. As reported in Table 5, the

Table 5: Error between GDP growth and each of WB-CI, BDL-CI and IIF-CI.

	WB-CI Growth (%)	BDL-CI Growth (%)	IIF-CI Growth (%)	GDP Growth (%)	Absolute value of error between WB-CI Growth and GDP Growth (%)	Absolute value of error between BDL-CI Growth and GDP Growth (%)	Absolute value of error between IIF-CI Growth and GDP Growth (%)
2006	1.6	-1.4	-0.4	1.6	0.0	3.0	2.0
2007	9.4	5.8	5.9	9.4	0.0	3.6	3.5
2008	9.1	10.2	8.2	9.1	0.0	1.1	0.9
2009	10.3	13.8	8.7	10.3	0.0	3.5	1.6
2010	8.0	10.5	7.0	8.0	0.0	2.5	1.0
2011	2.0	2.5	1.8	2.0	0.0	0.5	0.2
2012e	2.2						
2013e	0.8						
2014e	1.2						
Memora	andum ite	ms:					
Average of Error (2006-2011)					0.0	2.4	1.5
Standard deviation of Error (2006-2011)				011)	0.0	1.3	1.1
Correla	tion Coeff	icient			1.0	0.9	1.0

Source: Lebanese authorities and author's own calculations.

average error and the standard deviation between 2006 and 2011 were both equal to 0.0%. This compares favorably to both the BdL and the IIF coincident indexes. For the BdL-CI (IIF-CI), the average growth rate was 2.37 (1.53) % and the standard deviation was 1.29 (1.14) % during the same period. Consequently, the WB-CI is a reliable measure of the current state of the Lebanese economy.



**Figure 2:** The WB-LI is a good tool to detect turning points in the economy.... Source: Author's own calculations.

The one-year ahead forecasting performance of the constructed WB-LI is encouraging.  $^{16}$  As illustrated in Figure 2, the yearly average growth rate of the WB-LI leads the yearly growth rate of the WB-CI by a year. Furthermore, Figure 3 shows that the yearly growth rate of the leading indicator at time t-12 follows almost the same pattern as the yearly growth rate of the WB-CI at time t, suggesting that the WB-LI should be a useful forecasting tool. In fact, between December 2008 and December 2013, the average error between the yearly growth rate of the WB-LI at time t-12 and the yearly growth rate of the WB-CI at time t was only 0.37 %, while the standard deviation of this error was 0.28 %.

To illustrate the importance of having timely and accurate economic data, it is instructive to look at the monetary policy implications of the (new) WB-CI versus that of the existing BdL-CI. As detailed below, the latest reading from the

<sup>16</sup> The WB-LI series is available in Table 9 in the Appendix.

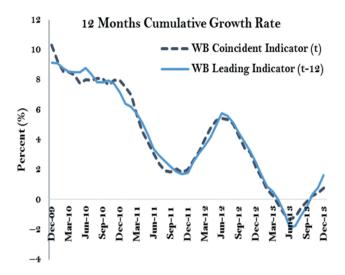


Figure 3: ... and forecast economic growth in the short-run. Source: Author's own calculations.

BdL-CI points to a constant growth in economic activity. The WB-CI, however, is showing an economy that is accelerating. The growth rate of the BdL-CI was constant at 3.2 % between 2013 and 2014, suggesting that the Lebanese economy grew at the same pace. In contrast, the WB-CI showed that the economy grew by 1.2 % in 2014 compared to 0.8 % during 2013, reflecting an acceleration in economic activity. A sustained period with such diverging trends would result in sharply different monetary policy decisions.

# **5 Some Policy Implications**

In this section, we examine the impact of unexpected changes in macroeconomic variables on economic growth using the WB-CI decomposition. We employ a Vector Autoregressive (VAR) model to examine the relationship between the variables forming the WB-CI and real GDP growth as proxied by the growth rate of the WB-CI itself. A necessary condition for VAR models to be econometrically valid is the stationarity of variables. Table 10, in the Appendix, shows that the log differences of WB-CI, tobacco excise (TE), cement deliveries (CD), VAT revenues (VAT), tourist arrivals (TA), taxes on real estate (TR), money supply (M3), lending to the private sector (LP), administrative fees and charges (AC), non-resident deposits (NRD), primary spending (PS), and cleared checks (CC) are found to be stationary at the 10 % level. <sup>17</sup> Let  $\Delta$ WB – CI<sub>t</sub> and  $\Delta$ V<sub>k-t</sub> denote the one period growth rates of the WB-CI and variable kk at time (or month)  $t = \text{Dec} - 2004, \dots, \text{Oct} - 2013$ , respectively. The VAR(k) model is given by:

$$X_{t,k} = c + \beta_{1,k} X_{t-1,k} + \dots + \beta_{L_k,k} X_{t-L_k,k} + \varepsilon_{t,k}; t = \text{Dec} - 2004, \dots, \text{Oct2013}$$
 [8]

where  $X_{t,k} = [\Delta WB - CI_t, \Delta y_{k;t}]$  is the vector of endogenous variables and  $\varepsilon_{t,k}$ denotes the error vector of the VAR(k.) model. In addition,  $L_k$  denotes the optimal lag length of the VAR(k) model as determined using the Akaike Information Criterion (AIC).

We proceed to generate, the Impulse Response Functions (IRFs) for the VAR(k) model. The results of the IRFs, illustrated in Figure A1 (in the Appendix), trace the response of real economic activity (proxied by the WB-CI) to one standard deviation shocks in each variable k over a 24 months period. We only comment on the IRFs that are statistically significant. 18 In particular, the WB-CI reacts positively to a shock in M3 and CD suggesting that the monetary policy (conducted by BdL though M3) and the real-estate sector are major drivers of growth in Lebanon. As such, BdL is encouraged to maintain its expansionary monetary policy aimed at boosting economic activity. Moreover, higher business activity, proxied by a positive shock in CC, enhances growth. Therefore, improving the political and security conditions, which tend to positively affect consumers' and investors' sentiment, as well as improving the business environment are key to stimulate growth. Finally, the IRFs of WB-CI to shocks in TA, TE and VAT are also positive. To show the relative importance of the (statistically significant) shocks to the variation of the WB-CI, we generate the Forecast Error Variance Decomposition (FEVD). The FEVD analysis, illustrated in Table 11, reveal that all the k'k' variables explain a large part of the variation in real economic activity in the short and long run.

In order to examine causality between the k' variables and the real economic activity, we apply Granger Causality tests to the VAR(k') model of eq. [8]. 19 As shown in Table 12, the results show that there is a bi-directional Granger causality between WB-CI and each of tobacco excise, cleared checks, cement deliveries, administrative fees and charges and VAT revenues over current real economy. On the other hand, there is a unidirectional causality from with WB-CI Granger causing M3.

<sup>17</sup> Stationarity tests are performed using the Augmented Dickey-Fuller test with the null hypothesis being that a variable has a unit root.

<sup>18</sup> The response of WB-CI to a positive shock on primary spending, taxes on real estate, lending to the private sector and non-resident deposits is not statistically significant.

**<sup>19</sup>** According to this approach, variable  $x_t$  is said to Granger causes  $y_t$  ( $x_t \rightarrow y_t$ ) ("if we are better able to predict $x_t$ , using all available information than if the information apart from  $y_t$  had been used" (Granger 1969, 428).

Finally, and based on the significant IRFs and the Granger causality tests, the economy would be expected to grow, as show in Table 13, by 0.03, 0.2, 0.21, 0.21 and 0.32 percentage points next year if we observe a one percentage point increase in cement deliveries, cleared checks, tobacco excise, administrative fees and charges and VAT revenues respectively this year.

## 6 Caveats and Limitations

While the newly developed indexes reveal promising statistical properties in terms of estimating and forecasting real economic activity in Lebanon, analysts and policy makers should be aware of the following limitations of the model when interpreting the results:

- First, not all the sectors of the economy were adequately represented in the pool of potential variables due to data limitations. Most notably, good proxy variables were not available to accurately account for the agriculture and industry sectors, which combined accounted for 18.6 % of GDP in 2011.
- Second, due to data limitations we deflated all the monetary variables into real terms using the CRI consumer price index that only account for the price dynamics in the greater capital area (greater Beirut). However, the Central Administration of Statistics (CAS) has recently (March, 2014) rebased Lebanon's inflation data to December 2013 and now provides (i) a much more comprehensive breakdown of prices (prices for rent are now collected on a monthly basis) and (ii) an updated weighting scheme to the inflation basket. As a result, this improved CAS CPI series could be preferable to the one currently used, once the old (2007) CPI index is rebased to the new (2014) index in order to have a continuous and comparable CPI series.
- Third, the lag period of the WB-CI and the WB-LI appeared to be larger (4–5 months) than initially expected due to the infrequent and lagged release of the fiscal data from the ministry of finance.
- Fourth, and as illustrated in figure 4, economic activity in Lebanon is highly volatile and subject to frequent exogenous shocks of political and security nature. However, this volatility is not captured by the WB-LI as it is hard to predict sudden changes in the political and/or security conditions. As a result, analysts should take into account any recent political developments rather than interpreting the results mechanically.
- Fifth and most importantly, the yearly growth rate of the newly constructed indexes were only tested against six actual GDP growth observations (2006–2011) because longer time series were not available. As a result, some non-

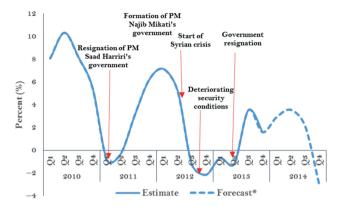


Figure 4: Estimated quarterly growth based on WB-CI and WB-LI (yoy). Source: Author's own calculations.

negligible margin of error is expected to remain in the estimates and results. In order, to improve the efficiency of the estimates, the model will be recalibrated whenever new national accounts data are published by CAS.

## 7 Conclusion

This paper presents a new coincident index (WB-CI) and a 12-months leading index (WB-LI) for the Lebanese economy. These indexes, which can be used as monthly proxies for the evolution of real GDP, were constructed using an improved methodology based on the NBER-CB approach.

Notwithstanding the relatively small sample period, the results reveal promising statistical properties that should make these new indications valuable coincident and leading (one-year ahead) indexes for monitoring the Lebanese economy. However, given limitations on the length of time series in Lebanon, the accuracy and reliability of these indexes in tracking the business cycle of the Lebanese economy is expected to improve over time as more data points become available. To take into account the statistical value of these new data points, both indexes will be re-estimated periodically. It is therefore likely that the composition of the WB-CI and the WB-LI will change in the coming years and become more stable as actual GDP series from national authorities are published. Furthermore, and rather than analyzing the results of these indexes mechanically, analysts should incorporate into their assessment of economic activity historical, political and cultural factors that do not easily lend themselves to quantification.

Finally, this new approach of adding a minimization problem to the original NEBR-CB methodology may provide a useful roadmap to analyze business cycles in countries that have weak economic statistics.

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## **Appendix**

Table 6: Potential variables for inclusion in the WB-CI.

Variable	Unit	Source
Administrative fees and charges	LBP bln	Ministry of Finance
Car Excise	LBP bln	Ministry of Finance
Cement Deliveries	thousands of tons	Banque du Liban
Cleared checks	LBP bln	Banque du Liban
Construction Permits	$m^2$	Banque du Liban
Current Economic Index	Index	ARA marketing research and consultancy
Current Personal Income Index	Index	ARA marketing research and consultancy
Current Security Index	Index	ARA marketing research and consultancy
Energy Imports	LBP bln	Lebanese Customs
Exports of Goods	LBP bln	Lebanese Customs
Imports of Goods without energy products	LBP bln	Lebanese Customs
Lending to the private sector	LBP bln	Banque du Liban
M3	LBP bln	Banque du Liban
Primary spending	LBP bln	Ministry of Finance
Private car registration	LBP bln	Ministry of Finance
Non-Resident Private sector deposits	LBP bln	Banque du Liban
Taxes on real-estate*	LBP bln	Ministry of Finance
Tobacco Excise	LBP bln	Ministry of Finance
Tourist arrivals	number	Ministry of Tourism
VAT revenues	LBP bln	Ministry of Finance

<sup>\*</sup> Taxes on real-estate = Built Property Tax + Real Estate Registration Fees.

Table 7: Potential variables for inclusion in the WB-LI.

Variable	Unit	Source
Consumer confidence index	Index	ARA Research & Consultancy
Cement deliveries	thousand tons	Banque du Liban
EMBIG spread	bps	JP Morgan; WB staff calculations
Custom revenues	LBP bln	Ministry of Finance
Airport arrivals	number	Banque du Liban
Freight incoming at the port of Beirut	tons	Banque du Liban
Spread between local and Libor interest rate	bps	Banque du Liban; WB staff calculations
Lending to private sector	LBP bln	Banque du Liban
Personnel costs	LBP bln	Ministry of Finance
Capital expenditures	LBP bln	Ministry of Finance
Change in dollarization rate	bps	BDL; WB staff calculations
Public debt	LBP bln	Banque du Liban
Blom stock index	Index	BLOM Bank
Industrial exports	mln USD	Ministry of Industry
Construction permits	$m^2$	Banque du Liban
Construction in progress	LBP bln	Ministry of Finance
Future Economic Index	Index	ARA Research & Consultancy

Table 8: WB-CI data.

Date	Value	Date	Value	Date	Value
WB-CI (Dec-2	004 = 100)				
Jan-05	98.1	Jan-08	112.8	Jan-11	141.7
Feb-05	93.7	Feb-08	116.1	Feb-11	141.8
Mar-05	93.6	Mar-08	115.5	Mar-11	142.2
Apr-05	95.2	Apr-08	115.2	Apr-11	144.4
May-05	97.0	May-08	116.1	May-11	144.6
Jun-05	101.4	Jun-08	121.6	Jun-11	147.8
Jul-05	103.0	Jul-08	122.6	Jul-11	149.0
Aug-05	104.6	Aug-08	126.1	Aug-11	147.4
Sep-05	107.2	Sep-08	124.1	Sep-11	152.3
Oct-05	101.7	Oct-08	125.8	Oct-11	153.2
Nov-05	100.8	Nov-08	130.1	Nov-11	148.7
Dec-05	104.4	Dec-08	130.6	Dec-11	156.0
Jan-06	103.6	Jan-09	134.1	Jan-12	152.2
Feb-06	108.7	Feb-09	133.0	Feb-12	153.0
Mar-06	110.4	Mar-09	130.3	Mar-12	150.9
Apr-06	114.0	Apr-09	131.6	Apr-12	153.9
May-06	114.8	May-09	133.9	May-12	153.2
Jun-06	109.8	Jun-09	131.5	Jun-12	152.5
Jul-06	77.0	Jul-09	134.8	Jul-12	149.3
Aug-06	78.8	Aug-09	134.1	Aug-12	145.4
Sep-06	99.3	Sep-09	133.2	Sep-12	148.4

(continued)

Table 8: (continued)

Date	Value	Date	Value	Date	Value
Oct-06	97.1	Oct-09	137.5	Oct-12	148.7
Nov-06	108.6	Nov-09	134.2	Nov-12	149.1
Dec-06	106.5	Dec-09	137.2	Dec-12	150.2
Jan-07	105.3	Jan-10	141.4	Jan-13	150.6
Feb-07	110.4	Feb-10	141.6	Feb-13	150.1
Mar-07	111.1	Mar-10	146.5	Mar-13	152.2
Apr-07	110.8	Apr-10	147.0	Apr-13	152.6
May-07	111.9	May-10	144.9	May-13	151.4
Jun-07	110.5	Jun-10	146.1	Jun-13	150.1
Jul-07	111.1	Jul-10	147.5	Jul-13	152.9
Aug-07	112.9	Aug-10	144.3	Aug-13	154.5
Sep-07	113.3	Sep-10	143.1	Sep-13	151.3
Oct-07	110.2	Oct-10	143.4	Oct-13	151.5
Nov-07	113.9	Nov-10	143.4	Nov-13	153.3
Dec-07	112.4	Dec-10	144.3	Dec-13	150.3

Table 9: WB-LI data.

Date	Value	Date	Value	Date	Value	Date	Value
WB-LI (Dec-2006 = 100)							
Jan-07	101.7	Jan-09	119.8	Jan-11	129.9	Jan-13	132.0
Feb-07	106.2	Feb-09	118.0	Feb-11	128.5	Feb-13	134.0
Mar-07	105.5	Mar-09	119.7	Mar-11	127.2	Mar-13	129.3
Apr-07	104.5	Apr-09	121.1	Apr-11	128.3	Apr-13	129.2
May-07	104.8	May-09	122.4	May-11	129.9	May-13	130.3
Jun-07	106.6	Jun-09	122.8	Jun-11	129.5	Jun-13	131.0
Jul-07	101.7	Jul-09	122.7	Jul-11	125.4	Jul-13	132.5
Aug-07	98.7	Aug-09	121.4	Aug-11	122.1	Aug-13	132.5
Sep-07	100.9	Sep-09	121.3	Sep-11	124.1	Sep-13	130.5
Oct-07	104.6	Oct-09	121.5	Oct-11	123.3	Oct-13	129.5
Nov-07	103.7	Nov-09	122.7	Nov-11	127.3	Nov-13	128.2
Dec-07	107.6	Dec-09	123.9	Dec-11	124.8	Dec-13	127.1
Jan-08	110.5	Jan-10	119.4	Jan-12	127.8		
Feb-08	114.0	Feb-10	119.3	Feb-12	126.6		
Mar-08	113.8	Mar-10	119.9	Mar-12	129.7		
Apr-08	112.8	Apr-10	120.4	Apr-12	128.0		
May-08	113.4	May-10	120.5	May-12	126.4		
Jun-08	112.5	Jun-10	120.7	Jun-12	122.7		
Jul-08	114.2	Jul-10	125.1	Jul-12	127.8		
Aug-08	112.9	Aug-10	125.0	Aug-12	129.5		
Sep-08	110.6	Sep-10	127.6	Sep-12	129.9		
Oct-08	112.0	Oct-10	126.7	Oct-12	132.2		
Nov-08	114.0	Nov-10	129.3	Nov-12	132.4		
Dec-08	119.5	Dec-10	130.2	Dec-12	132.1		

Table 10: Unit Root test results.

Variable	ADF-Test (p-value)
ld_WB_CI	1.055e-017 ***
ld_Tobacco_Excise	2.7e-005 ***
ld_Cement_Deliveries	1.835e-023***
ld_VAT_revenues	6.573e-014 ***
ld_Tourists_Arrivals	1.068e-017***
ld_Real_estate_tax	9.575e-005***
ld_M3	0.07188*
ld_Lending_private	0.01208**
ld_Administrative_Charges	5.18e-009***
ld_non-resid Deposits	4.598e-012***
ld_Primary_Spending	0.009343***
ld_Cleared_Checks	2.29e-016***

Source: Author's own calculations.\*, \*\*, \*\*\* indicate significance levels of 10 %, 5 %, and 1 %, respectively.

**Table 11:** Contribution of a shock in variable k' on the variance decomposition of WB-CI (%).

Month	ld_M3	ld_TA	ld_TE	ld_CC	ld_CD	ld_AC	ld_VAT
M1	19.6	30.7	4.7	33.1	29.1	38.8	8.6
M2	19.6	31.6	27.7	35.0	28.8	38.6	83.1
M3	17.2	31.8	36.6	32.1	27.5	39.1	83.3
M4	17.1	31.8	38.2	33.6	27.9	38.1	85.5
M5	18.4	32.4	36.7	32.2	28.5	43.1	83.2
M6	18.4	32.3	36.5	32.2	28.9	43.2	83.5
M7	19.0	32.3	36.7	32.4	28.8	43.9	83.5
M8	23.0	32.3	36.7	32.4	28.7	43.3	83.7
M9	23.1	32.3	36.5	32.1	33.4	43.3	83.5
M10	23.7	32.3	36.5	32.3	33.1	43.1	83.5
M11	23.7	32.3	36.5	32.4	33.7	43.1	83.5
M12	23.9	32.3	36.4	32.4	33.4	43.1	83.5
M13	23.9	32.3	36.4	32.5	33.1	43.2	83.5
M14	24.5	32.3	36.4	32.6	33.0	43.2	83.5
M15	24.7	32.3	36.5	32.6	32.9	43.2	83.5
M16	24.6	32.3	36.4	32.6	33.0	43.2	83.5
M17	24.6	32.3	36.4	32.6	33.0	43.2	83.5
M18	24.7	32.3	36.4	32.6	33.4	43.2	83.5
M19	24.7	32.3	36.4	32.6	33.2	43.2	83.5
M20	24.8	32.3	36.4	32.6	33.2	43.2	83.5
M21	24.9	32.3	36.4	32.6	33.1	43.2	83.5
M22	25.0	32.3	36.4	32.6	33.1	43.2	83.5
M23	25.0	32.3	36.4	32.6	33.1	43.2	83.5
M24	25.0	32.3	36.4	32.6	33.1	43.2	83.5

Source: Author's own calculations.

Table 12: Granger causality test.

Null Hypothesis: No Granger Causality	p-value	No. of Lags (AIC)	
M3 and WB-CI:			
M3 Granger causes WB-CI	0.128	7	
WB-CI Granger causes M3	0.0006***	7	
TA and WB-CI:			
TA Granger causes WB-CI	0.246	3	
WB-CI Granger causes TA	0.0000***	3	
TE and WB-CI:			
TE Granger causes WB-CI	0.0000***	5	
WB-CI Granger causes TE	0.0000***	5	
CC and WB-CI:			
CC Granger causes WB-CI	0.015**	5	
WB-CI Granger causes CC	0.0000***	5	
CD and WB-CI:			
CD Granger causes WB-CI	0.0003***	8	
WB-CI Granger causes CD	0.0000***	8	
AC and WB-CI:			
AC Granger causes WB-CI	0.0000***	4	
WB-CI Granger causes AC	0.0326**	4	
VAT and WB-CI:			
VAT Granger causes WB-CI	0.0000***	4	
WB-CI Granger causes VAT	0.0000***	4	

Source: Author's own calculations.

Note: The number of lags (months) is determined using the Akaike.

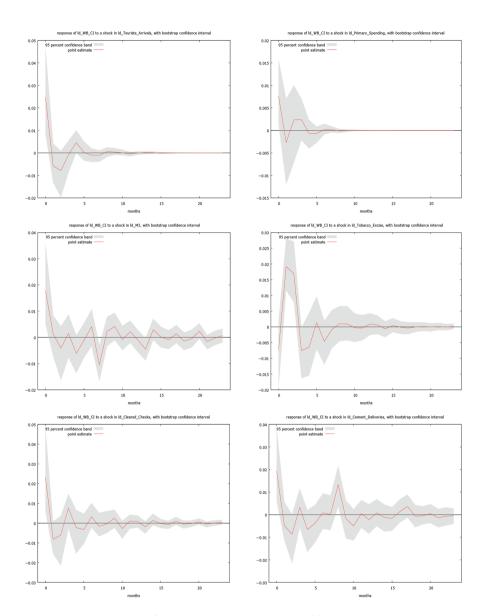
Information Criterion (AIC).

Table 13: Impact of a one percentage point shock on the WB-CI growth rate.

	Value in	1 pp shock in	Change in WB-CI Growth (%)	
	2012 (LL bln)	Dec 2012 (LL bln)	2013	2014
CD	5299	53	0.03	-0.01
VAT	2434	24	0.32	0.02
CC	79159	792	0.15	0.00
TE	382	4	0.21	0.02
AC	434	4	0.21	-0.01

Source: Author's own calculations.

<sup>\*, \*\*, \*\*\*</sup> indicate significance levels of 10 %, 5 %, and 1 %, respectively.



**Figure 5:** Impulse response functions of WB-CI to each *k* variable. Source: Author's own calculations.

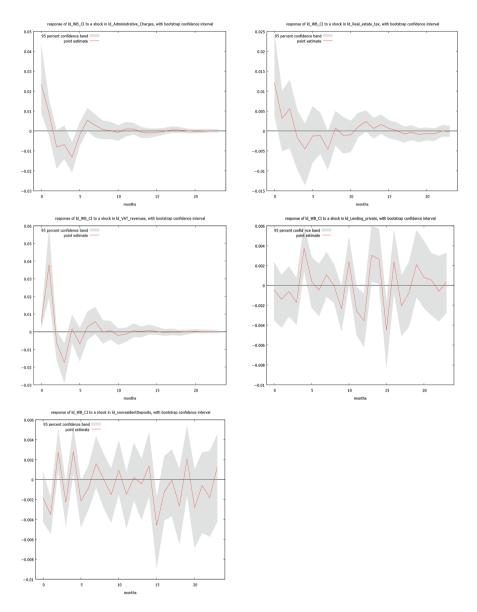


Figure 5: (continued)

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