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Article

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Central Bank Review (CBR)

Provided in Cooperation with:

Central Bank of The Republic of Turkey, Ankara

Suggested Citation: Çepni, Oğuzhan; Hacıhasanoğlu, Yavuz Selim; Yılmaz, Muhammed Hasan (2020) : Credit decomposition and economic activity in Turkey: A wavelet-based approach, Central Bank Review (CBR), ISSN 1303-0701, Elsevier, Amsterdam, Vol. 20, Iss. 3, pp. 109-131, <https://doi.org/10.1016/j.cbrev.2020.06.001>

This Version is available at:

<https://hdl.handle.net/10419/297922>

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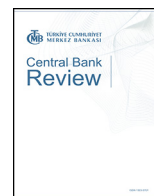
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Credit decomposition and economic activity in Turkey: A wavelet-based approach



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ARTICLE INFO

Article history:

Received 3 March 2020

Received in revised form

4 June 2020

Accepted 13 June 2020

Available online 23 August 2020

JEL classification:

E32

E44

F43

F44

C49

Keywords:

Credit growth

GDP growth

Time variation

Frequency variation

Wavelet analysis

ABSTRACT

This paper aims to investigate the co-movement between the credit growth and gross domestic product (GDP) growth in Turkey over the period January 2004–October 2019. By taking into account alternative credit decomposition and the variations over time and across frequencies using the wavelet analysis, the results show that: i) GDP growth highly synchronizes with credit growth compared to other financial variables such as stock exchange, bonds, and exchange rate. ii) There is a high correlation between commercial loan growth and capital formation and a relatively weak one with consumer loans and consumption. iii) Co-movement stemming from Turkish Lira (TL) credits to GDP growth is stronger than foreign exchange (FX) credits where the latter is significant until 2015. iv) Public and domestic private banks are the main drivers of economic activity while the foreign banks are following them. By showing the differential effects of different types of credit on GDP growth, we specify that shocks to different credit types are crucial to analyze business cycles. For policymakers, this result implies that the dynamics of different credit types are crucial to analyze the impacts of credit cycles on economic activity.

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1. Introduction and literature review

The literature on credit-growth nexus, including Bernanke and Gertler (1989) and Kiyotaki and Moore (1997), has gained interest after the global financial crisis. Schumpeter (1934) is the first study analyzing the effect of financial development on economic growth and indicating the banking sector's supportive role in growth. Although the theoretical linkages are well known between credit growth and economic activity (Harrison et al., 1999; Levine, 2005), empirical findings are mixed because of the endogenous nature of these two variables. The general conclusion in the literature supports the relationship between credit and economic growth, while the direction of causation is still questionable.¹ Some papers show

the existence of causality from credit development to growth (Xu, 2000; Bassett et al., 2014; Rondorf, 2012; Beck and Levine, 2004), others find from growth to credit (Zhu, 2011; Demirci-Kunt et al., 2013; Stolbov, 2017), and some find a bidirectional relationship (Luintel and Kahn, 1999; Ünalımsı, 2002; Demirhan et al., 2011; Antonakakis et al., 2014; Karahan et al., 2018). In addition, some recent papers argue that there is a nonlinear effect of credit on economic growth which means that positive correlation continues until a certain threshold level, and above this threshold, there is a negative relationship between credit and economic growth. Critical points are identified between 80% and 135% of GDP (Cecchetti and Kharroubi, 2012; Law and Singh, 2014; Sahay et al., 2015; Arcand et al., 2015; Lay, 2020). A closely related literature studies the cyclical behavior of two series and investigates the synchronization of business and financial cycles (Avouyi Dovi and Matheron, 2005; Claessens et al., 2012; Haavio, 2012; Akar, 2016; Binici et al., 2016).

As banks include 90.8% of the household financial debt (Financial Stability Report, May 2020), the Turkish financial system has a bank-dominant nature and bank credit is the main source of

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Peer review under responsibility of the Central Bank of the Republic of Turkey.

¹ The supply-leading hypothesis in the literature assumes a causality from finance to growth, while the demand-following hypothesis assumes the opposite.

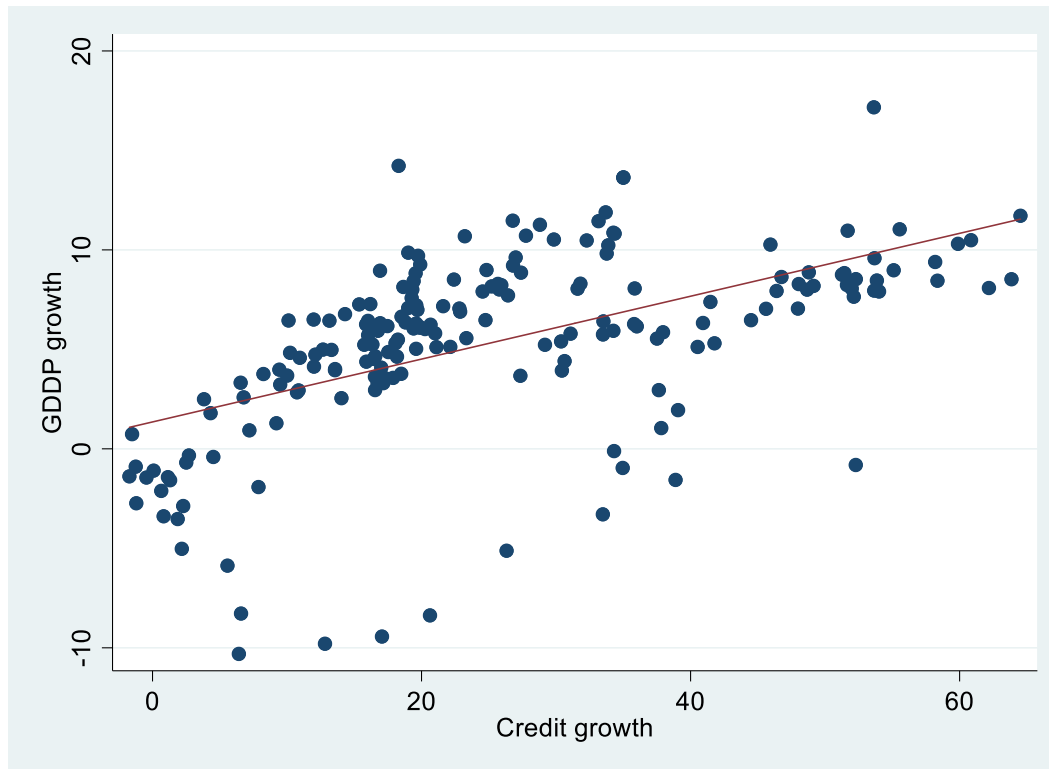


Fig. 1. Credit growth and GDP growth (annual change).
Source: CBRT, BRSA.

funding. Fig. 1 shows a strong correlation between credit² and GDP growth in Turkey for the period January 2004–October 2019. Credit market deepening of the Turkish economy has accelerated after the 2000s due to improved macroeconomic fundamentals, diversified credit products, and increased share of banking loans in bank assets (Aktan and Masood, 2010; Kasman and Kasman, 2015). In addition, financial integration of Turkey to the global economy has sped up in this period, and the past decade became a period of rapid credit growth because of easy global liquidity conditions after the global financial crisis, a strong balance sheet of the banking system, and the high growth rate of GDP (Kara et al., 2014; Kara, 2016; Buyukbasaran et al., 2019).

There are a couple of papers studying the effect of credit on macroeconomic variables such as GDP (Muhsin and Eric, 2000; Ünalmiş, 2002; Acaravci et al., 2007; Ozturk, 2008; Demirhan et al., 2011; Kara and Tiryaki, 2013; Akcelik et al., 2013; Topcu and Çoban, 2017; Karahan et al., 2018; Buyukbasaran et al., 2019), current account deficit (Telatar, 2011; Ganioglu, 2013), and inflation (Ogunc and Sarikaya, 2015) in Turkey. Akcelik et al. (2013) show the explanatory power of credit on GDP growth and nowcasting of GDP. Kara and Tiryaki (2013) find the Medium Term Program's 4% GDP growth correspondence of total credit growth as 15%. Muhsin and Eric (2000) and Ozturk (2008) analyze causality between credit and growth and conclude that growth leads credit while Acaravci et al. (2007) and Topcu and Çoban (2017) show the opposite. In contrast to this, Unalimis (2002), Demirhan et al. (2011), and Karahan et al. (2018) find a bidirectional causality between these variables. Using Bayesian Structural Vector Autoregression (SVAR) Buyukbasaran et al. (2019) investigate the effect of credit supply

² Credits consist of 59.44% of the total assets of the banking system in Turkey as of March 2020.

shocks on real GDP growth and show that the effect is stronger if the credit supply shock includes capital inflows effects which indicate the importance of capital flows in Turkey.

The above mentioned literature utilize total credit which is used by both households and firms and given by all type of banks in the system. Some of the recent papers go beyond this aggregate credit measure and emphasize the importance of decomposition of credits on economic growth (Beck et al., 2012; Garcia-Escribano, and Han, 2015; Bezemer et al., 2016; Bahadir and Gumus, 2016; Bezemer et al., 2017; Bahadir and Valev, 2020).³ For example, Bahadir and Gumus (2016) find evidence that the results in the credit-growth literature in emerging markets (EM) hold for household credit rather than a commercial one.

This paper investigates the GDP growth dynamics generated by different types of credit by using wavelet analysis for Turkey over the period January 2004–October 2019. Although empirical studies in credit decomposition literature mostly mentioning the distinction between household and commercial credits, in addition to the retail-commercial difference we go one step further in this paper and examine business cycle implications of credits based on bank ownership⁴ and currency decomposition. These three different dimensions of credit (the type of borrower, type of currency, and type of banks ownership) may generate different GDP growth

³ In addition to GDP growth effect of credit decomposition, some papers analyze the effect of decomposition on saving (Jappelli and Pagano, 1994; Tunc and Yavas, 2016), inflation (Ogunc and Sarikaya, 2015), current account (Buyukkarabacak and Krause, 2009; Toraganli and Ertugrul, 2016; Hani-Selimi and Eliskovski, 2019), inequality (Piketty, 2014; Seven et al., 2018), financial stability (Jappelli et al., 2013; Jorda et al., 2016), and crisis (Buyukkarabacak and Valev, 2010; Cecchetti et al., 2011; Sutherland et al., 2012; Babecky et al., 2013).

⁴ The effect of foreign/domestic-bank ownership on economic growth was investigated in Owen and Temesvary (2014) as well.

patterns given that commercial credits increase investment while retail credits increase consumption, foreign currency credit can only be used by real sector in Turkey, and different type of banks have different business models. In particular, we try to answer the following questions: Which financial variable is most relevant to business cycles? Does the relationship between loans and growth change according to loan-types (local currency-denominated vs hard currency-denominated, commercial vs consumer loans)? Which types of GDP components are connected to which type of credits? Does the association of bank loans with GDP growth depend on bank ownership types?

Wavelet methodology allows us to analyze the changes in the relationship between credit and the GDP growth not only over time but also across frequencies. The results show that the effects of different types of credit on GDP growth vary both on time- and frequency-scale. For example, the relationship between retail credit growth and consumption at higher frequencies is weaker than the relationship between commercial credit growth and investment. Besides, wavelet methodology also lets us detect transitory effects that are difficult to detect in classical econometric techniques (Aguilar-Conraria et al., 2008). Moreover, without specifying a frequency band, the method shows the changes in the lead-lag relation. To the best of our knowledge, this is the first paper investigating the compositional effects of credit on economic growth in Turkey using wavelet methodology.⁵ By showing the differential effects of different types of credit on GDP growth, we specify that shocks to different credit types are crucial to analyze business cycles. The paper does not claim any causal relationship because of two reasons. First, there is a two-way relationship between credit growth and economic growth and one needs instrumental variables to assert a causal relationship in this context. Second, the wavelet methodology only provides a bivariate analysis which causes an omitted variable bias in the results.

We proceed in the following steps. First, to evaluate the relevance of cyclical behaviors and to gain deeper knowledge about the suitability of each financial sector as a financial cycle indicator, we plot bivariate wavelet coherence plots for loans, stock exchange, bonds, and exchange rate with respect to economic activity. Second, credit dynamics can vary depending on the purpose of obtainment and the borrower types. Commercial loans and consumer loans are two main sub-categories that tend to differ from each other in terms of maturity, credit risk, collateralization, term structure (fixed or floating rates) and channels with which they contribute to the overall economic activity. To account for such heterogeneities, we proceed to calculate commercial and consumer loan growth rates and compare their coherence with different sectors of economic activity such as consumption and investment. Our loan growth data is in monthly frequency but there is no proper monthly proxies for household consumption and gross capital formation. To overcome this frequency obstacle, we construct the monthly consumption and investment proxies by utilizing principal component analysis (PCA). Third, we implement the same wavelet coherence analysis in currency dominations of loans with

respect to overall economic activity. In particular, we extract coherence plots of TL and FX loans regarding to economic activity. Finally, as the pro-cyclical nature of credit behavior can be subject to alterations across different bank ownership types, we take into account another breakdown of credit growth (in its relation with economic growth) in line with the categorization of public, domestic private, foreign and investment/development banks.

The results show strong presence of the time- and frequency-variation in the relationship. First, we find that among different financial cycle indicators, cyclical behaviour of credit growth and GDP growth are highly correlated, albeit it is not uniform overtime periods and cycle frequencies. In terms of lead/lag relations, until very recent periods, the course of economic activity leads the credit growth. In other words, our results support demand-following hypothesis. However, in recent years and over longer horizons, this relation seems to be mildly reversed. Second, although earlier parts of our sample include significant episodes between consumer loans and consumption in longer terms, after 2011, we observe a weak relationship which could be the result of macroprudential measures taken to restrict households' financial debt. Additionally, commercial loan growth has been highly correlated with capital formation throughout the sample period in lower frequencies involving 32–64 month cycle. Third, while there exists strong comovement, mostly concentrated on the 16–32 month interval, stemming from TL loan growth to GDP growth after the global financial crisis, FX credit growth shows that significant relationship with economic activity holds only for longer terms until 2015. Finally, wavelet coherence plots show that public and domestic private banks have loan growth tendencies which are vastly correlated with the general course of economic activity. In particular, correlation is mostly observed along medium and long-term horizons including 16–32 months and 32–64 month cycles. As the market share of foreign banks in credit allocation started to increase in the post-2012 period in Turkey, there is a significant relationship between foreign bank loan growth and GDP growth at lower frequencies (32–64 month) after this period.

The rest of the paper is organized as follows. In Section 2, we outline the empirical methodology utilized in the paper. In Section 3, we summarize the dataset used in the analysis. Section 4 includes a discussion of our empirical findings. Finally, concluding remarks are collected in Section 5.

2. Empirical methodology

A concept existing on the time-domain but akin to wavelet analysis is the time-series filter. The empirical identification with filtering techniques is mostly used in the business cycle and financial cycle studies. In particular, the cycle component of a macroeconomic/financial series is disentangled from the trend component so that contraction and expansion episodes can be identified and any asymmetries in the episodes can be investigated. The procedure utilized broadly by researchers is the Hodrick-Prescott (HP) filter which computes the cycle component by minimizing the variance of original series around this cycle, subject to a penalty term that includes the second difference of the cycle term (Hodrick and Prescott, 1997). There also exist several band-pass and regression-based filters which diverge from HP filtering in terms of methodological aspects (Çolak et al., 2019). While time-series filters extract the cyclical movements over time dimension, wavelet analysis serves as a tool to obtain such movements both over time and across different frequencies.

The empirical procedure preceding wavelet analysis is Fourier transformation. Being derived from the idea that periodic functions can be represented as an infinite sum of sine and cosine functions evaluated at different frequencies, Fourier transformation is used to

⁵ Studies using wavelet techniques on the Turkish financial data analyze the following relationships: industrial production and sectoral credit defaults (Cifter et al., 2009), exchange rates and interest rates (Ozun and Cifter, 2010; Ozmen and Yilmaz, 2017), sovereign credit risk and economic risk (Kirikkaleli and Gokmenoglu, 2019), money growth and inflation (Tursoy and Mar'i, 2020; Tastan and Sahin, 2020), the Service Sector Index and economic growth (Orhan et al., 2019), contagious effect of Greek Crisis on stock markets (Ercan and Karahanoglu, 2019), depreciation of the lira and sovereign credit default swap (CDS) (Liu et al., 2020), the business cycle synchronization of the Turkish economy with the eurozone and the United States (Akkoyun et al., 2014), comovement of stock markets during the turmoil (Çelik and Baydan, 2017), interactions between financial markets of Turkey (Ozer and Kamisli, 2016).

analyze the impact of the cycles at each frequency on the signal. It incorporates the projection of examined series onto an orthonormal set of trigonometric components (Priestley, 1981; Koopmans, 1995). Fourier transform of a series can be demonstrated as follows:

$$F_x(\omega) = \int_{-\infty}^{+\infty} x(t)e^{-i\omega t} dt \quad (1)$$

where ω represents angular frequency and $e^{-i\omega t} = \cos(\omega t) - i\sin(\omega t)$ according to Euler's formula.

However, this method suffers from several drawbacks. It does not allow the frequency component of the signal to evolve over time, hence it cannot be used in empirical settings in which signals have time-varying features. Furthermore, since Fourier transformation uses windows with constant lengths, such windows tend to embody several high-frequency cycles combined with fewer low-frequency cycle. Thus, it may lead to overrepresentation/underrepresentation of actual frequency components and it cannot provide an adequate resolution for all frequencies.

As a refinement to the abovementioned method, wavelet-based methods permit windows with different sizes which improve the frequency resolution of the low frequencies and the time resolution of the high frequencies (Rua, 2012). Moreover, wavelet analysis can compensate for the weakness of Fourier transform regarding the inability to keep track of the position of cyclical components over time in addition to the period-wise identification (Sleziak et al., 2015). On top of these, our choice of empirical method does not suffer from issues like requirement of stationarity in signal and invalidity introduced if time series is subject to structural breaks.⁶

The continuous wavelet transform which decomposes a time series over time and frequency domains can be defined as follows:

$$W_x(\tau, s) = \int_{-\infty}^{+\infty} x(t)\psi_{\tau, s}^*(t) dt \quad (2)$$

where * stands for complex conjugate and $\psi_{\tau, s}(t)$ represents basis, finite length, oscillatory and real-valued functions called wavelets. These basis functions are obtained from mother wavelet specified as follows.

$$\psi_{\tau, s}(t) = \frac{1}{\sqrt{s}} \psi\left(\frac{t-\tau}{s}\right) \quad (3)$$

This function includes two specific parameters that are τ (which governs the time position) and s (determining the width of the wavelet). As discussed in Percival and Walden (2000) and Rua (2012), the most commonly used mother wavelet for continuous transform is Morlet wavelet which can be written as follows.

$$\psi(t) = \pi^{-1/4} \omega_0^{i\omega_0 t} e^{-t^2/2} \quad (4)$$

The parameter ω_0 dictates the number of oscillations within the Gaussian envelope and can be assigned different values to affect the trade-off between time and frequency localization. To put it differently, higher parameter values can bring better frequency and poorer time localization, while lower parameter values can help to

attain poorer frequency and better time localization.⁷ As discussed by Addison (2017), setting this parameter value to 6 is preferred in practice since the scale of the wavelet becomes almost equal to the Fourier period of the examined time series.

In the univariate case, based on the continuous wavelet transform, one can compute the wavelet power spectrum as an indicator of the localized variance of the examined time series. This indicator defined as $|W_x(\tau, s)|^2$ also measures the contribution to the variance of a series at each specific time period and frequency scale. When we move to the bivariate case involving two variables, an equivalent concept emerges as a cross-wavelet spectrum which describes the covariance between variables in time-frequency space. For instance, considering two time series, named as $x(t)$ and $y(t)$, with corresponding continuous wavelet transforms specified as $W_x(\tau, s)$ and $W_y(\tau, s)$, the cross-wavelet spectrum can be constructed as follows.

$$W_{xy}(\tau, s) = W_x(\tau, s)W_y^*(\tau, s) \quad (5)$$

In this context, our main interest is termed as wavelet squared coherence and is given by:

$$R^2(\tau, s) = \frac{|S(s^{-1}W_{xy}(\tau, s))|^2}{S(s^{-1}|W_x(\tau, s)|^2)S(s^{-1}|W_y(\tau, s)|^2)} \quad (6)$$

where $S(\cdot)$ stands for the smoothing operator functioning over both time and frequency domains. After retrieving this from the data, finally, wavelet coherence $R_{xy}(\tau, s)$ can be created by taking the absolute value of the square root of this expression. It is an analog to the correlation coefficient calculated by normalizing the covariance of two series by respective standard deviations in time series analysis. The output from this analysis is the contour plots representing the degree of coherence in the bivariate setting. These plots are equipped with areal classification displaying at which frequencies and in which time periods relationships get stronger as the coherence levels approach to 1. These areas are drawn with warmer colors and statistical significance testing the null hypothesis of joint periodicity is marked with white solid lines. The areas closer to the beginning and the end of the sample period should be interpreted with caution as a smoothing operator within defined windows artificially filling the missing values for the wavelet filter to function (Torrence and Compo, 1998). The areas subject to edge effects are termed as the cone of influence and demonstrated as shaded parts in coherence plots.

To provide further information about the instantaneous synchronization between two series, phase differences are defined at each localizing time origin and frequency scale. It is represented as follows:

$$\theta(\tau, s) = \tan^{-1} \left(\frac{\Gamma(W_{xy}(\tau, s))}{\varkappa(W_{xy}(\tau, s))} \right) \quad (7)$$

where Γ and \varkappa denote imaginary and real parts, respectively. In our plots, phase-differences are displayed as arrows. If arrows are scattered with the right direction, it means that two series are in-phase (moving together). The upward and downward positions of right arrows point out the relations which are “the first variable leads the second one” and “second variable leads first one”, respectively. In the case of arrows directed to the left side, two series are known to be out-of-phase (moving oppositely).

⁶ We utilize R package named “WaveletComp 1.1” to implement wavelet analysis and derive coherence plots. Coherence results are robust to the choice of different minimum/maximum scale choices. This package also rectifies cross-wavelet power according to Veleda et al. (2012) in bivariate cases to avoid biased results. In this context, “biasedness” can force high-frequency phenomena to be underestimated by conventional approaches.

⁷ Time-frequency localization operators refer to the quantization scheme that maps symbols on R^{2d} to operators and they depend on two window functions (Daubechies, 1990; Bayer and Gröchenig, 2015).

Table 1
Data definitions and sources.

Series	Transformation	Source
GDP Growth	Year-on-year growth rate of monthly GDP obtained from utilizing Fernandez (1981) methodology	TurkStat
Credit Growth	Year-on-year growth rate of total loans adjusted for FX effects	BRSA
Stock Exchange Growth	Year-on-year logarithmic change of BIST100 index	Bloomberg
Bond Rate Change	Year-on-year basis points change in 2-year forward implied yield	Bloomberg
Exchange Rate Change	Year-on-year logarithmic change of exchange rate basket (comprising 70% USD/TRY spot rate and 30% EUR/TRY spot rate)	Bloomberg
Credit Growth (Bank Groups)	Year-on-year growth rate of total loans extended by bank groups (public, domestic private, foreign and investment/development banks) adjusted for FX effects	BRSA
TL Credit Growth	Year-on-year growth rate of TL loans	BRSA
FX Credit Growth	Year-on-year growth rate of FX loans adjusted for FX effects	BRSA
Consumer Credit Growth	Year-on-year growth rate of consumer loans (housing, vehicle and special-purpose loans)	BRSA
Commercial Credit Growth	Year-on-year growth rate of commercial loans adjusted for FX effects	BRSA

3. Data

In this analysis, the sample period covers the January 2004–October 2019 interval. The definition, transformation, and source of data series are presented in Table 1.

The set of candidate financial indicators represent some shifts and structural changes that need to be mentioned before proceeding to the empirical results (Figs. 2–5). First of all, the annual total loan growth rate represents drastic fluctuations during the initial phases of the sample period stemming from the strong base effects. As covered by Kara et al. (2014), the financial deepening in Turkey became more visible after 2007–2008, as measured by the increasing trend in the credit to GDP ratio. Together with stabilization in macroeconomic conditions, enhanced competition in the Turkish banking sector, diversified credit products and increased share of banking loans in bank assets (compared to bonds), financial development is launched which is reflected in more stable loan growth rates (Aktan and Masood, 2010; Kasman and Kasman, 2015). Hence, it is not surprising to comprehend weaker cyclical coherence between credit indicators and economic growth in the abovementioned period. This incompatibility is more evident in the growth rates of foreign bank and TL-denominated loan segments.

Another disruption in the course of financial indicators is observed in bond rates over the 2004–2006 interval. It is known that the Turkish economy had been subject to a structural transformation during that period characterized by a stabilization program aimed to contain the detrimental effects of the 2001 crisis on macroeconomic/financial indicators. The rapid decline in the inflation rate accompanied by sizeable drops in interest rates may weaken the validity of the results specific to that period (Keşkek and Orhan, 2010).

One practical obstacle here is that there are no proper monthly proxies for household consumption and gross capital formation to associate with loan growth data which is in monthly frequency. To overcome this, we construct the monthly consumption and investment proxies by utilizing the PCA. More specifically, we collect 19 and 20 individual series for consumption and investment respectively, which are not only retrieved from survey-based measures, but are also collected from “hard” data for foreign trade, public finance, etc. Detailed variable lists for monthly proxies can be found in Tables 2 and 3. Quarterly averages of candidate series display strong resemblance with the consumption and investment growth in national accounts (Figs. 6 and 7).

Before the extraction of common factors, appropriate transformations including seasonal adjustment, annual accumulation, annual growth, and annual change are applied to individual series. It is seen that the first two principal components account for almost 72% of the total variation in the consumption data set, while

explanatory power of the first two static factors stands at the level of 77% in the investment data set. Hence, we follow the approach of combining the first two factors in each category by calculating the weighted sum of individual series with respect to factor loadings of the first two components.⁸ Time-series plots of consumption and investment indicators are represented in Fig. 8. After this process, bivariate coherence plots between consumption indicator and consumer loan growth rate as well as between investment indicator and commercial loan growth rate are evaluated.

4. Empirical results

4.1. Which financial variable is most relevant to business cycle? The role of credit growth

Wavelet coherence plots of financial cycle indicators and GDP growth rate is presented in Fig. 9. Firstly, it is seen that, credit growth and GDP growth are highly correlated on a cyclical basis. This finding is compatible with the previous studies which also document the cyclical co-movements. Binici et al. (2016) evaluate the performance of the financial cycle in Turkey measured by real credits and conclude that it promotes stronger concordance with the business cycle. However, our findings are not uniform over time and frequencies. Since the period before 2006 in Turkey was characterized with a lower level of financial deepening, lack of macroeconomic stabilization, and ongoing disinflationary process, there had been inadequate financial intermediation activities to channel funding to households and corporates in that period. Wavelet coherence results belonging to that period display mild correlation with some significance around 4 to 8 and 8–16 month cycles (Finding A). The repercussions of the Global Financial Crisis in terms of financial markets and growth even prevented short-run relation to occur, as we observed in the lack of significance around the 2007–2008 period. However, following the crisis episodes, financial deepening has been boosted, credit supply/demand conditions have improved and economy has been on the course of surpassing long-term potential, which all led to the establishment of co-movement between credit and economic activity dynamics in relatively lower frequencies of 16–32 month cycles (Finding B). In fact, medium-to-long-term association between loan market and GDP growth has shifted towards rather longer horizons (especially after 2013) with significant contour areas observed in 32–64 and 64–128 intervals in the subsequent periods (Finding C). When we examine the average maturity of loans extended in the banking sector, it is seen that the maturity of fixed-rate total loans increased

⁸ Factor loadings are presented in the Appendix.



Fig. 2. Time-series plots for financial cycle indicators and economic activity (annual change).
Source: CBRT, BRSA, TurkStat, Bloomberg.

over 30 months, especially after 2010, on the back of improved financial conditions and enhanced access to financing opportunities (see the Appendix). Hence, our findings describing stronger Wavelet coherence over longer-horizons are compatible with the maturity dynamics of the loan market.

Apart from the extent of relation, inferences can be made about the direction of the relation by reviewing phase difference arrows. Without exception, all significant relations between credit growth and economic activity are characterized by in-phase behavior concluding that two series are moving together. In terms of lead/lag

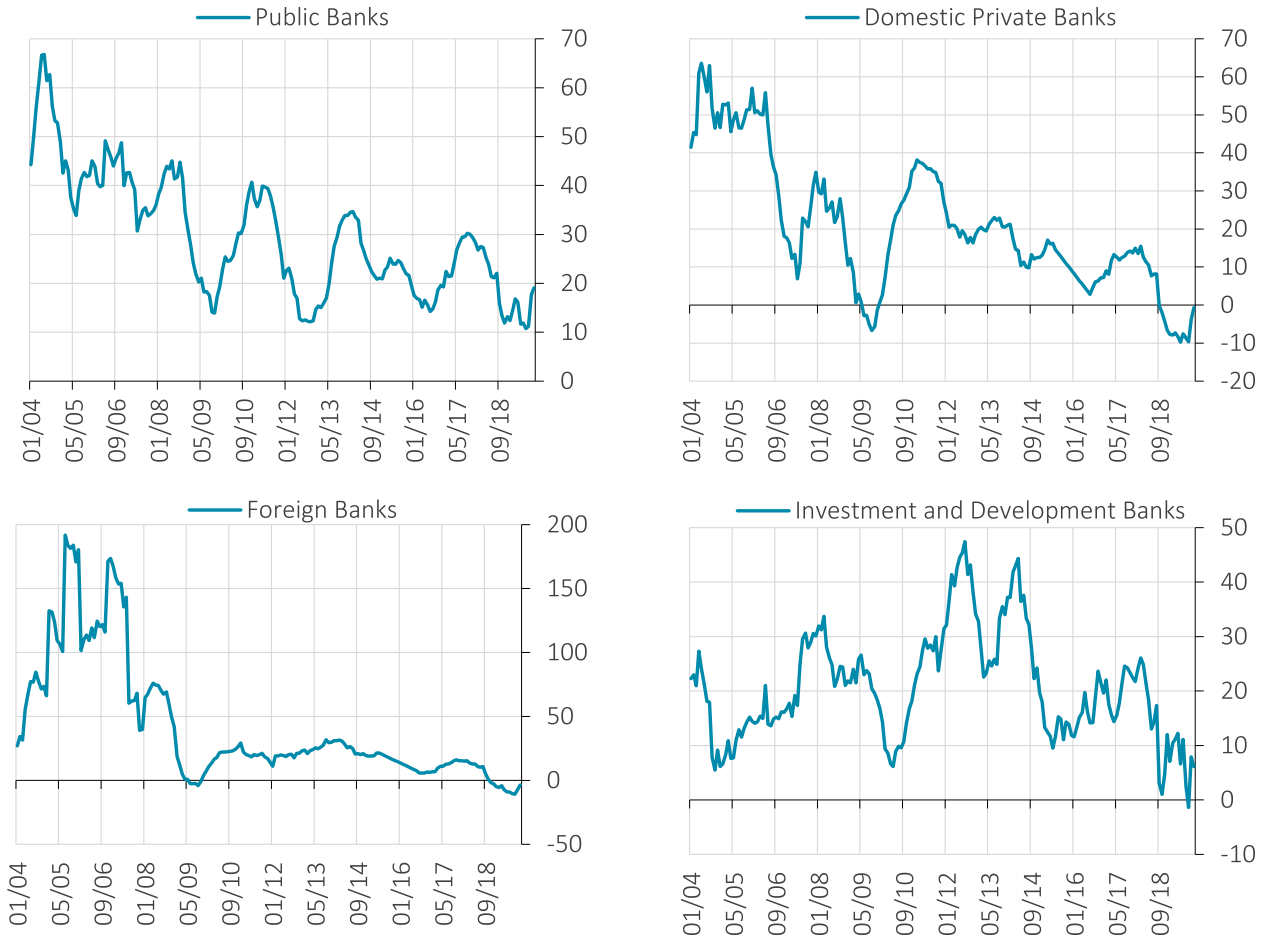


Fig. 3. Credit growth based on bank ownership (annual Percentage change, Adjusted for fx effects). Source: BRSA.

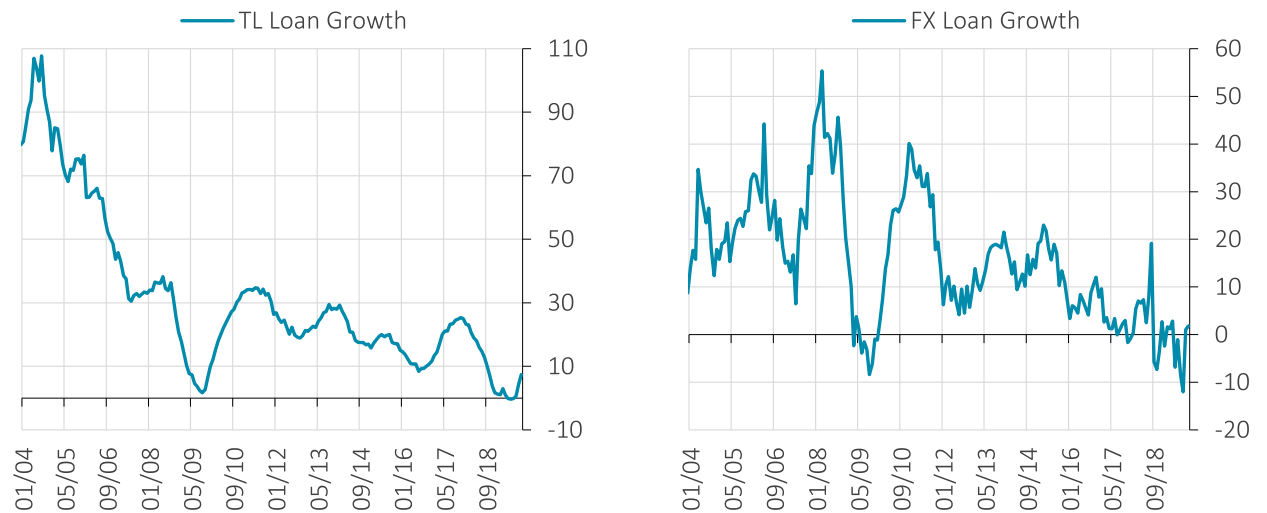


Fig. 4. Credit growth based on currency decomposition (annual Percentage change, Adjusted for fx effects). Source: BRSA.

relations, until very recent periods, the course of economic activity leads the credit growth. In other words, any demand-side shocks occurred in economic activity is manifested in credit behavior within a lag structure. However, in recent years and over longer horizons, this relation seems to be mildly reversed.

Fig. 9 also presents the Wavelet coherence between another financial cycle indicator derived from the stock exchange market and GDP growth. It is found that the co-movement with respect to the market capitalization of traded securities had been strong between 2006 and 2014, whereas phase-differences suggest that the

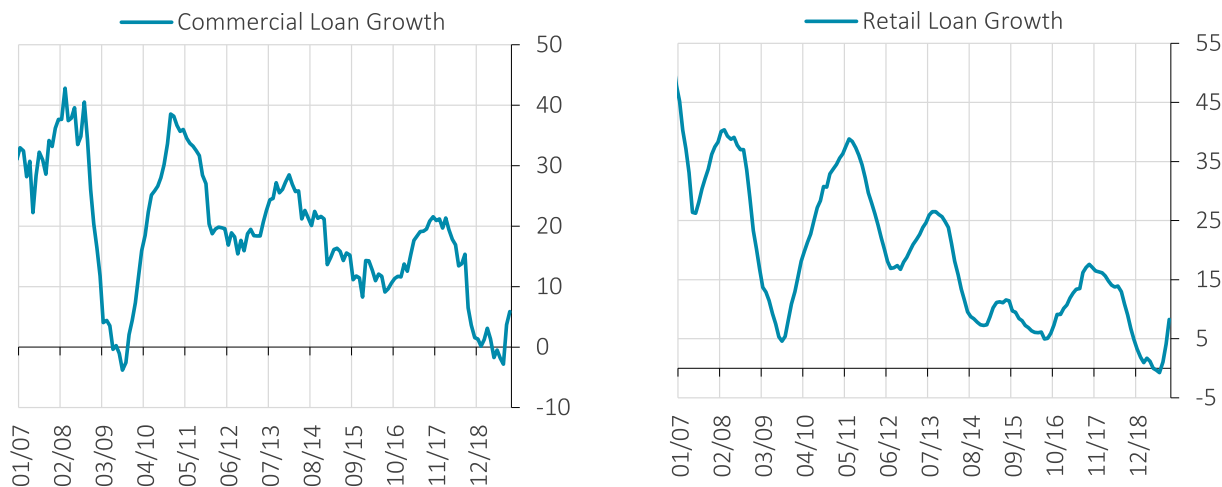


Fig. 5. Credit growth based on borrower segments (annual Percentage change, Adjusted for fx effects).
Source: BRSA.

Table 2
Data definitions and sources for monthly consumption indicator.

Series	Transformation	Source
Business Tendency Survey: Expectation about Employment in Next 3 Months	Seasonally Adjusted, Level	CBRT
Capacity Utilization Rate: Durable Consumer Goods	Seasonally Adjusted, Level	CBRT
Capacity Utilization Rate: Non-Durable Consumer Goods	Seasonally Adjusted, Level	CBRT
Capacity Utilization Rate: Consumer Goods	Seasonally Adjusted, Level	CBRT
Industrial Production Index: Durable Consumer Goods	Seasonally Adjusted, Annual Percentage Change	TurkStat
Industrial Production Index: Non-Durable Consumer Goods	Seasonally Adjusted, Annual Percentage Change	TurkStat
Income Tax	12 Months Cumulative, Annual Percentage Change, Current Prices	Ministry of Treasury and Finance
Domestic Value Added Tax	12 Months Cumulative, Annual Percentage Change, Current Prices	Ministry of Treasury and Finance
Special Consumption Tax	12 Months Cumulative, Annual Percentage Change, Current Prices	Ministry of Treasury and Finance
Consumer Confidence Index	Seasonally Adjusted, Level	CBRT, TurkStat
Consumer Confidence Index: Financial Situation Expectation of Households (Over Next 12 Months)	Seasonally Adjusted, Level	CBRT, TurkStat
Consumer Confidence Index: General Economic Situation Expectation (Over Next 12 Months)	Seasonally Adjusted, Level	CBRT, TurkStat
Consumer Confidence Index: Number of Unemployed Person Expectation (Over Next 12 Months)	Seasonally Adjusted, Level	CBRT, TurkStat
Consumer Confidence Index: The Probability of Saving (Over Next 12 Months)	Seasonally Adjusted, Level	CBRT, TurkStat
Real Sector Confidence Index: Total Employment (Over Next 3 Months)	Seasonally Adjusted, Level	TurkStat
Unemployment Rate	Seasonally Adjusted, Level	TurkStat
Non-Farm Unemployment Rate	Seasonally Adjusted, Level	TurkStat
Youth Unemployment Rate	Seasonally Adjusted, Level	TurkStat
Imports: Durable Consumption Goods	Annual Percentage Change, Nominal	TurkStat
Imports: Non-Durable Consumption Goods	Annual Percentage Change, Nominal	TurkStat

financial cycle leads the economic activity in this case. Furthermore, this relation had been evident not only in medium frequencies (16–32 month cycles) but also in lower frequencies (32–64 and 64–128 month cycles) (Finding D). However, one caveat here is that market capitalization and liquidity conditions in BIST during those episodes were not very deep. When this caveat is combined with the fact that frequent volatilities in quoted firm prices had been observed and the stock exchange was not the primary source of financing for non-financial corporations (NFCs) in Turkey (except for a few larger firms), this significant relation might not reflect true nature of the dynamics between financial and business cycle in Turkish case. The abovementioned relation was diminished after 2015, when capital outflows from stocks and bonds have been observed.

The other indicators stemming from the bond market and spot exchange market are likewise not deemed to be proper indicators

of the financial cycle when their relevance to economic activity is evaluated with Wavelet analysis. Although there are some significant shorter time-frequency domain specifications for bond rate changes (16–32 month cycles) and spot exchange rate changes (4–8 month cycles), significance and phase-differences are not stable alongside the whole sample period (Fig. 9).

4.2. The relationship between loan-types (retail-commercial) and GDP components

Having documented the co-movement between credits and economic activity, we turn our attention to the robustness of this relationship across sub-categories of loans. As discussed in the previous section, to map the impact of commercial and retail loan growth to different components within overall GDP growth, we utilize PCA to create monthly consumption and investment

Table 3
Data definitions and sources for monthly investment indicator.

Series	Transformation	Source
PMI: Manufacturing	Seasonally Adjusted, Level	Bloomberg
Business Tendency Survey: Production Volume in Last 3 Months	Seasonally Adjusted, Level	CBRT
Business Tendency Survey: Amount of Orders Received in Last 3 Months	Seasonally Adjusted, Level	CBRT
Business Tendency Survey: The Level of Current Stocks	Seasonally Adjusted, Level	CBRT
Capacity Utilization Rate: Industrial Production	Seasonally Adjusted, Level	CBRT
Capacity Utilization Rate: Intermediate Goods	Seasonally Adjusted, Level	CBRT
Capacity Utilization Rate: Investment Goods	Seasonally Adjusted, Level	CBRT
Industrial Production Index: Intermediate Goods	Seasonally Adjusted, Annual Percentage Change	TurkStat
Industrial Production Index: Capital Goods	Seasonally Adjusted, Annual Percentage Change	TurkStat
Automobile Production	Seasonally Adjusted, Annual Percentage Change	OSD
Corporate Tax	12 Months Cumulative, Annual Percentage Change, Current Prices	Ministry of Treasury and Finance
Real Sector Confidence Index	Seasonally Adjusted, Level	TurkStat
Real Sector Confidence Index: Total Orders	Seasonally Adjusted, Level	TurkStat
Real Sector Confidence Index: Inventory	Seasonally Adjusted, Level	TurkStat
Real Sector Confidence Index: Production Volume	Seasonally Adjusted, Level	TurkStat
Real Sector Confidence Index: Capital Formation Expenditures	Seasonally Adjusted, Level	TurkStat
Real Sector Confidence Index: General Outlook	Seasonally Adjusted, Level	TurkStat
Imports: Capital Goods	Annual Percentage Change, Nominal	TurkStat
Imports: Intermediate Goods	Annual Percentage Change, Nominal	TurkStat

indicators. Fig. 10 shows the Wavelet coherence between retail loan growth and household consumption. Although the earlier part of our sample includes significant episodes in longer terms, after 2011, the co-movement between consumer loans and consumption activities was slightly weakened (Finding E). It should be noted that Turkish authorities have undertaken a wave of macroprudential measures some of which are directly related to household borrowings (Aysan et al., 2015; Kara, 2016; Uysal, 2017). In addition to preventing households from obtaining FX loans, a wide set of measures have been used including installment restrictions and loan-to-value ratios. The observed weak relation can be related to the imposition of such measures breaking the link between debt and expenditure for households. In contrast, as presented in Fig. 10, commercial loan growth has been highly correlated with capital formation throughout the sample period. This relation has been established in lower frequencies involving 32–64 month cycle (Finding F). Phase-differences show that investment growth leads the commercial credit growth in most of the time episodes. The lack of development in other modes of financing and high course of capacity utilization rates might be the factors behind this finding.

Apart from macroprudential measures designed to alleviate the joint movement between consumption expenditures and retail loan growth, there exist several structural and conjectural factors that are not covered in the binary structure of Wavelet coherence and might weaken the consumption tendencies via credit financing. As argued by the traditional theories of consumption, within the scope of life-cycle model, credit facilities are utilized merely to transfer consumption between time periods and households' current consumption decisions are influenced by the labor income and assets expected to be obtained over the lifetime (Brumberg and Modigliani, 1954; Ando and Modigliani, 1963; Danziger et al., 1982). Therefore, the labor market and employment outlook can deteriorate the income expectations of liquidity-constrained households and lead to a cutback in spending independent of credit-based financing opportunities. In this context, credit demand from financial institutions for consumption purposes can be delayed as those spending decisions are involved with a long-term commitment, particularly durable goods purchases. Overall, the existing empirical literature also documents the disruption in employment preceded by the depression in household spending (Griffith et al., 2013; Hurd and Rohweder, 2016;

Ganong and Noel, 2019). Studies conducted on the Turkish case yielded similar results supporting the argument that there exists a statistically significant and positive relationship between consumption growth and expected income fluctuations (Ceritoğlu, 2003, 2013). In fact, the brief period between 2013 and 2016, when the credit-consumption nexus temporarily disappeared, coincided with an upward-sloping trend in the unemployment rate.

Another factor is related to our empirical setting of Wavelet coherence. In this study, we aim to decipher the contemporaneous association between credit allocation and economic activity. However, it is generally accepted that consumer loan growth contains more information regarding the future course of household consumption than the current outlook. Previous studies confirm that credits actually improve the forecasting accuracy for consumption in upcoming periods (Antzoulatos, 1996; Bacchetta and Gerlach, 1997; Apergis, 2019). Another issue capable of disorienting the credit-consumption relationship is consumer sentiment. The level of consumer confidence about the general economic conditions emerges as an influential determinant of consumption and saving behavior. Especially, the variations in consumer confidence indices during economic, financial, and political volatilities might shape the household spending so they are mostly included in the information set to predict and forecast consumption tendencies (Garner, 1991; Adrangi and Macri, 2011). Concerning the Turkish economy, Aslanoğlu and Çelik (2010) reveal that CNBC-e Consumption Index carries out a statistical significance in predicting household consumption. By using Consumer Tendency Survey (developed jointly by TurkStat and CBRT), Ceritoğlu (2013) display the association between consumer sentiment about job prospects and the growth of consumption in an econometric manner.

Apart from income expectations, employment dynamics, consumer confidence, and time-wise discrepancies, wealth can also affect the household consumption independent from access to credit financing. In relation to life-cycle consumption models, any change in asset prices will be reflected in the value of accumulated wealth and cause an adjustment in current spending. Previous studies also validate the degree of association between wealth and consumption (Byrne and Davis, 2003; Carroll et al., 2011). In the case of financial assets, for instance, any boost in the equity market can be transmitted to higher real wealth and consumption (Ludwig



Fig. 6. Series utilized for consumption indicator and consumption growth (Quarterly averages, Quarterly Year-on-Year growth rate).
Source: CBRT, BRSA, TurkStat.

and Slok, 2002). Although the impact of other forms of wealth has not been extensively investigated in Turkey, possibly due to the lack of proper data sets, the wealth channel of consumption functioning through the housing sector is analyzed. Ceritoğlu (2017) examine the relationship between house prices and consumption by utilizing Household Budget Surveys comprised by TurkStat and conclude that consumption growth is significantly driven by house prices. Similarly, Coşkun et al. (2018) show that wealth increases will alter the consumption plans even if labor income is stable. As a more recent study, Alp and Seven (2019) highlight the importance of equity and housing market wealth channels for the household final

consumption. As our empirical setup is not designed to capture such effects and concentrate merely on the co-movements between credit and economic activity from a time-frequency perspective, they can be influential in the relatively weaker relation.

One particular structural factor that may break the strength of the link between credit-based financing and consumption preferences in Turkey is the relatively low level of household debt, compared to other economies. Data provided in the Appendix present the ratio of credits extended to households to GDP for Turkey and aggregate country groups. Despite the surge in financial inclusion in Turkish case supported by rising income levels and the

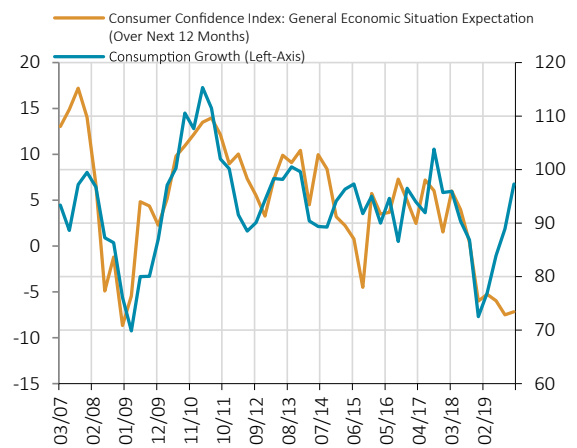
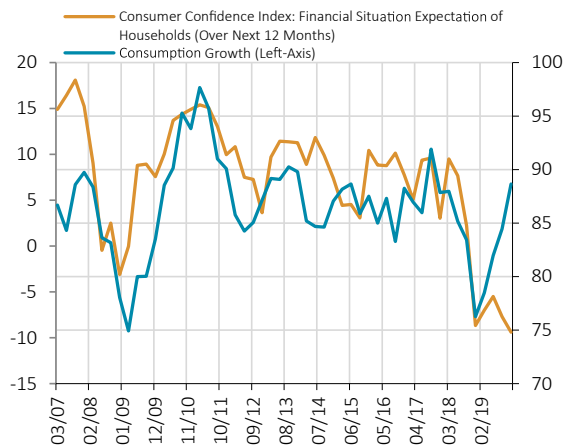
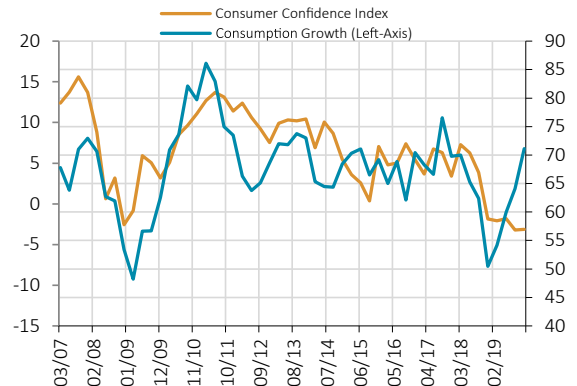
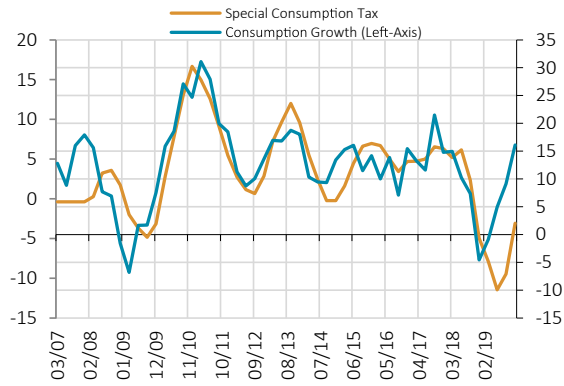
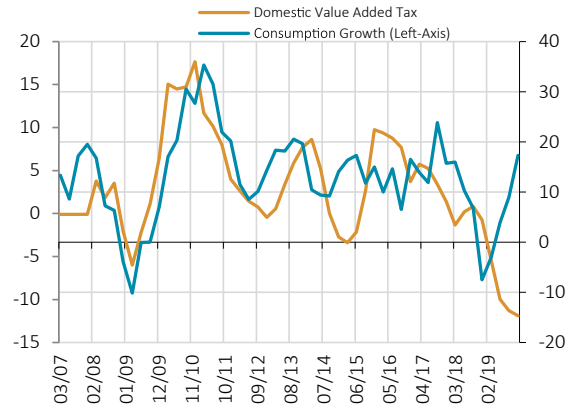
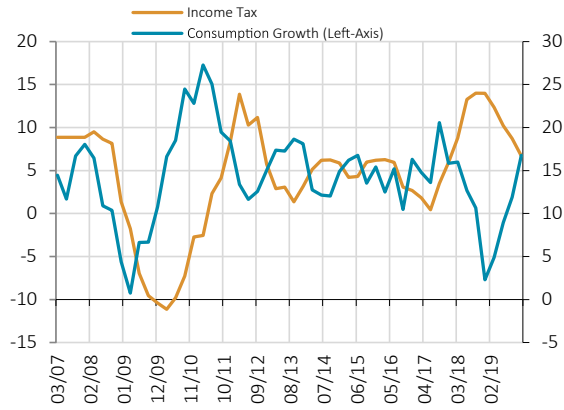


Fig. 6. (continued).

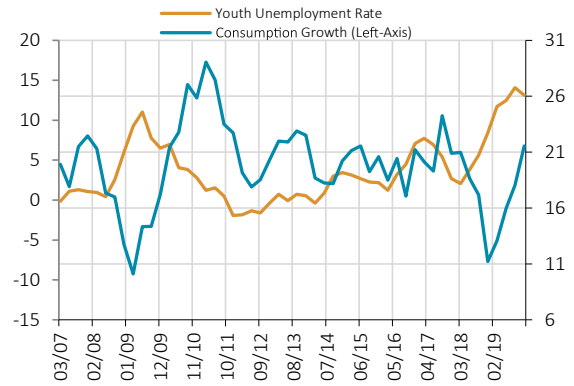
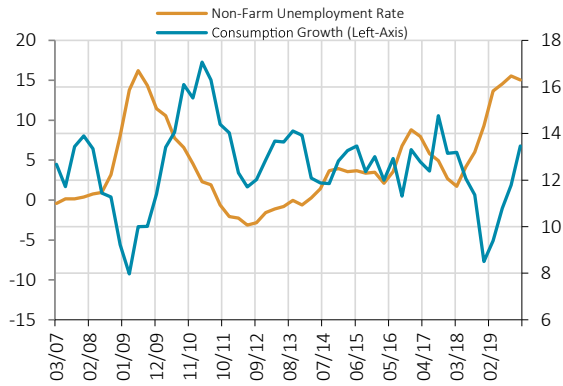
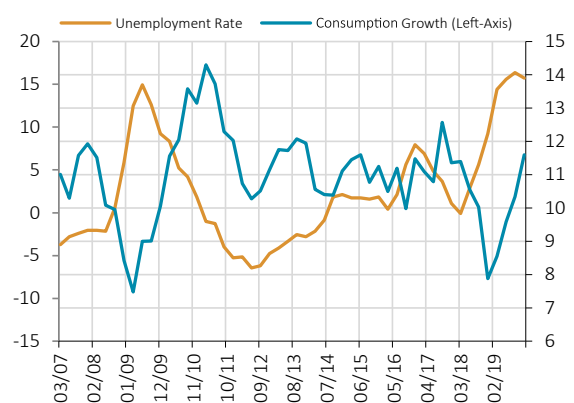
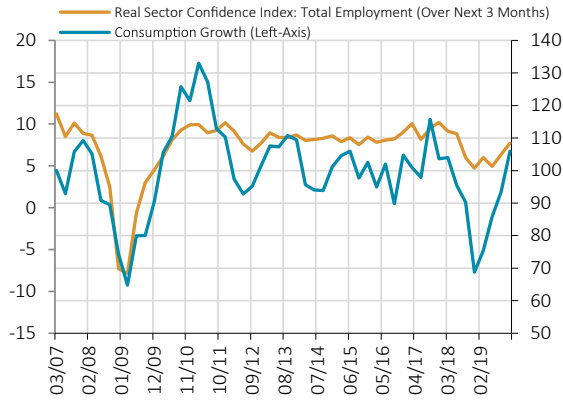
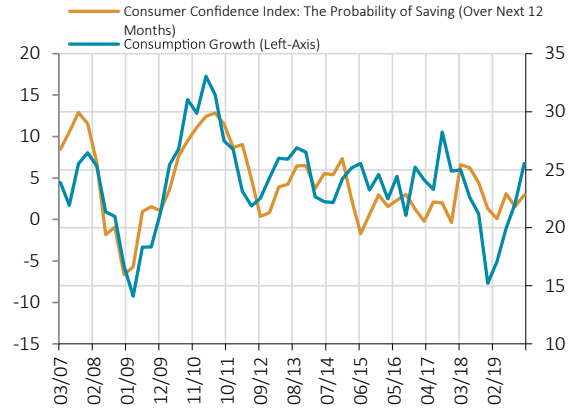
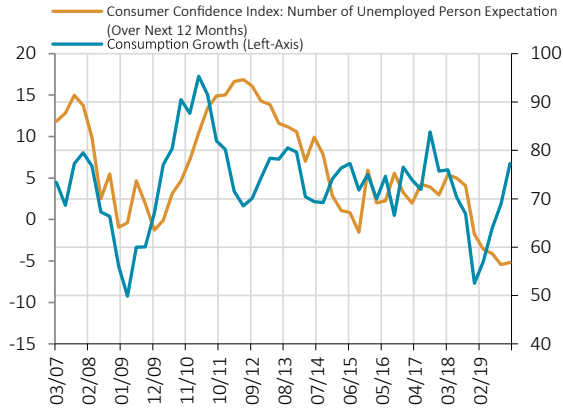


Fig. 6. (continued).

diversification of offered financial products, household debt levels in Turkey diverged from emerging counterparties as well as developed markets, which might dampen the transmission of credit market disturbances to household spending (Sarma and Pais, 2011; Yorulmaz, 2013; Terzi, 2015; Seven et al., 2020). It should also be considered that some households tend to abstain from engaging in traditional financing activities due to religious reasons and are more prone to benefit financial services provided by participation banks. Hence, their consumption decisions will not be influenced by the credit conditions of the traditional banking system. Essentially, the role of this factor could be more pronounced in the later phases of the sample period given the increasing market share of Islamic finance institutions (Aysan et al., 2017).

The commercial loans in Turkey comprise several sub-segments depending on the purpose of financing. Business loans are mostly assumed on shorter horizons, priced with variable interest rates, and denominated in TL. This group of loans is usually used to roll-over the financing of working capital needs arising from general and administrative expenses. As firm-level working capital management practices depend heavily on demand and revenue expectations, which are shaped by macroeconomic outlook, we expect business sub-segment of commercial loans to contribute extensively to the closer relationship with economic growth. More relevant to our results, another sub-segment which is called investment loans can potentially determine the coherence between credit developments and gross capital formation. This group of loans is generally taken on longer horizons and denominated in foreign currencies as long-term TL financing opportunities are not advanced in the Turkish banking sector, whereas they are utilized by companies to expand production capacity, improve machinery-equipment and undertake new projects. This integration also creates a feedback mechanism involving global financial conditions and capital flows which determine the volume and cost of foreign financing that could be channeled into investment loans.

4.3. The relationship between loan-types (TL-FX) and GDP growth

Fig. 11 shows that TL credit growth seems to be more associated with GDP growth than FX credit growth. After 2008, there exists strong co-movement stemming from TL loan growth, mostly concentrated on the 16–32 month interval (Finding G). In this relation, longer horizons are also determined to be significant such as 32–64 and 64–128 month cycles (Finding H). While FX credit

growth also confirm significant associations with economic activity in long terms until 2015, contemporary periods do not indicate the same relation (Finding I). It can be speculated that worsened capital flows, narrowed down external financing opportunities, rising awareness about FX risk management among companies, ongoing firm deleveraging in Turkish NFCs, and depressed investment tendencies can be reasons behind the disappearance of this relation.

4.4. The relationship between loan-types (bank ownership) and GDP growth

Another sub-category included in this empirical analysis is bank groups. Credit behavior is known to drastically deviate from aggregate trends depending on the bank ownership types. In Fig. 12, wavelet coherence plots show that public and domestic private banks have loan growth tendencies which are vastly correlated with the general course of economic activity. Another finding is that this correlation is mostly observed along medium and long-term horizons including 16–32 month and 32–64 month cycles (Finding J). For private banks, this relation is also extended to much longer horizons involving 64–128 month cycles (Finding K). One striking finding is that the lack of support coming from public banks to economic activity in the years 2015 and 2016 have been compensated by the introduction of the credit guarantee fund scheme and state banks-driven credit programs. Another key finding is that both for public and domestic private banks, the nature of the relationship in the past had been established such that economic activity leads loan growth, while recent cases indicate that loan growth leads the course of economic activity, as confirmed by phase-differences.

In the past, foreign banks did not have considerable market shares in credit allocation activities. As this situation has been reversed, the post-2012 period in our sample coincides with the significant relation between foreign bank loan growth and GDP growth at lower frequencies (32–64 month) (Finding L). As expected, since it is not their core business, investment and development bank loan growth is irrelevant to the economic activity (Fig. 13).

It should be noted that, public banks are less sensitive to general economic conditions in lending practices so the credit growth rate in that category surpasses other bank types, particularly in recent years. Although overall economic activity has recorded downward movements in the second half of 2016 and the end of 2018, the credit



Fig. 6. (continued).



Fig. 7. Series utilized for investment indicator and investment growth (Quarterly averages, Quarterly Year-on-Year growth rate).
Source: CBRT, BRSA, TurkStat.

growth of state-owned banks was not narrowed down significantly, which might weaken the Wavelet coherence between credit outlook and economic growth. Such countercyclical nature is well documented in the studies focusing on other EMs (Meriläinen, 2016; Brei and Schclarek, 2017; Huang et al., 2019; Hamid, 2020). The lower level of sensitivity in state bank loans to economic activity is also prominent in the Turkish case since those banks serve as intermediaries of the credit-based economic stimulation measures and are less bounded by credit risk in making credit allocation decisions.

5. Conclusion

This paper analyzes the co-movement between credit growth and GDP growth in Turkey over the period January 2004–October 2019. Using Wavelet analysis, we take into account the time and frequency variation, and the results strongly show the presence of the time- and frequency-variation in the relationship. Specifically, the results show that for a group of financial variables, credit growth is highly correlated with GDP growth. Bank lending is



Fig. 7. (continued).

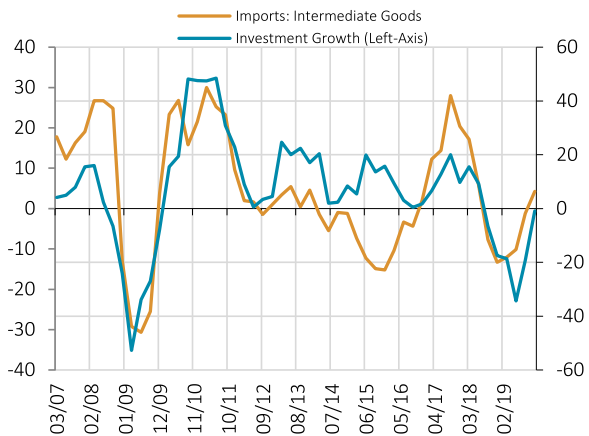
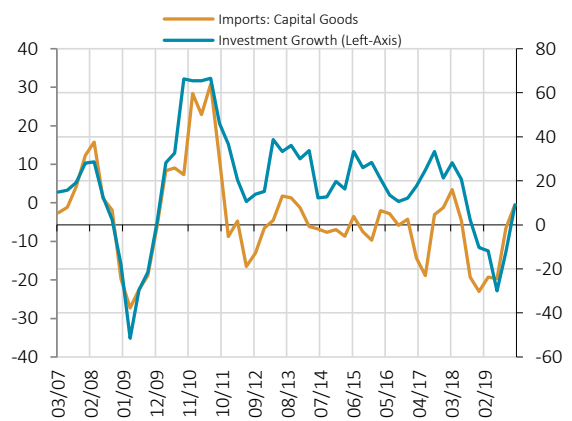
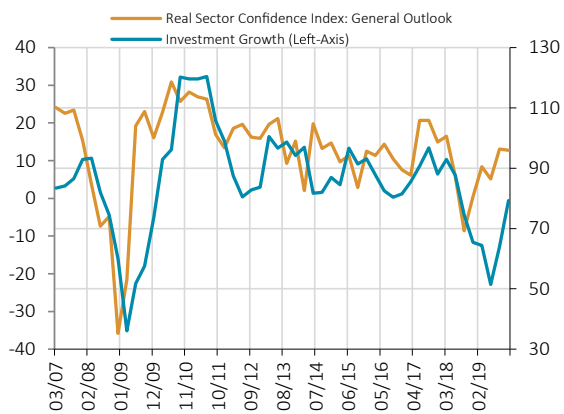
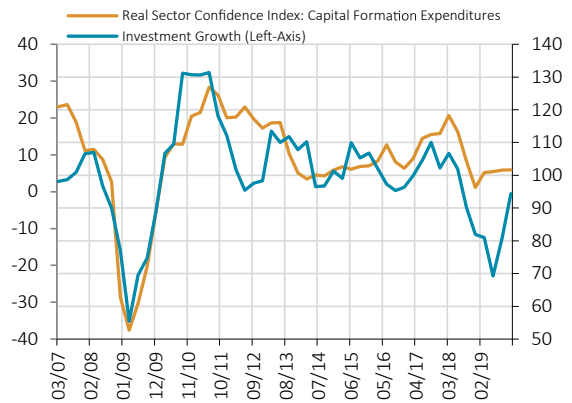
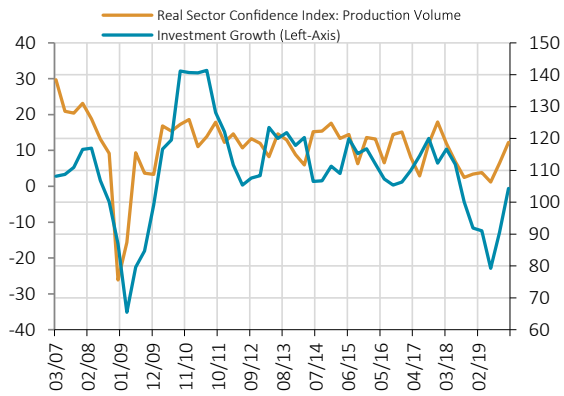
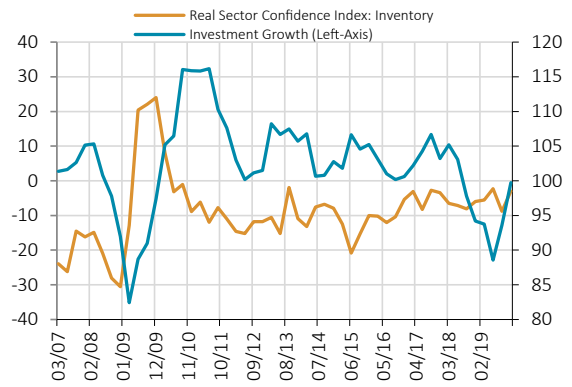
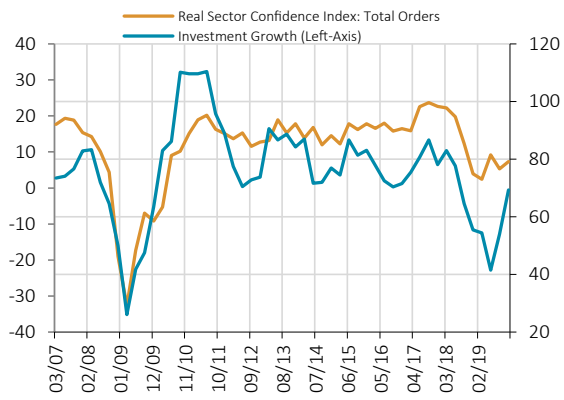


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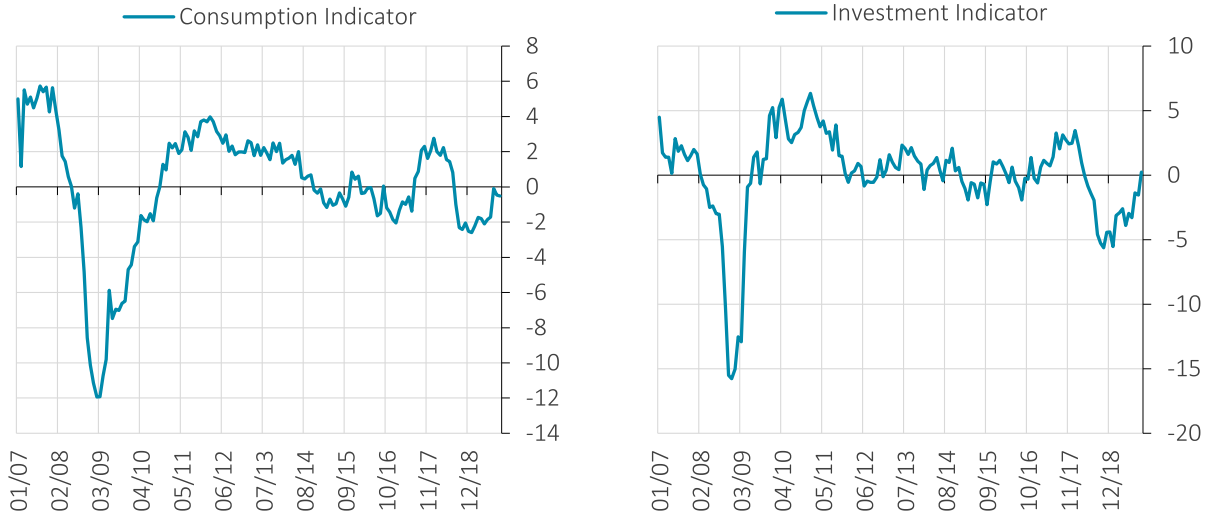


Fig. 8. Time-series plots for monthly consumption and investment indicators obtained from PCA analysis. Source: Authors' Calculations.

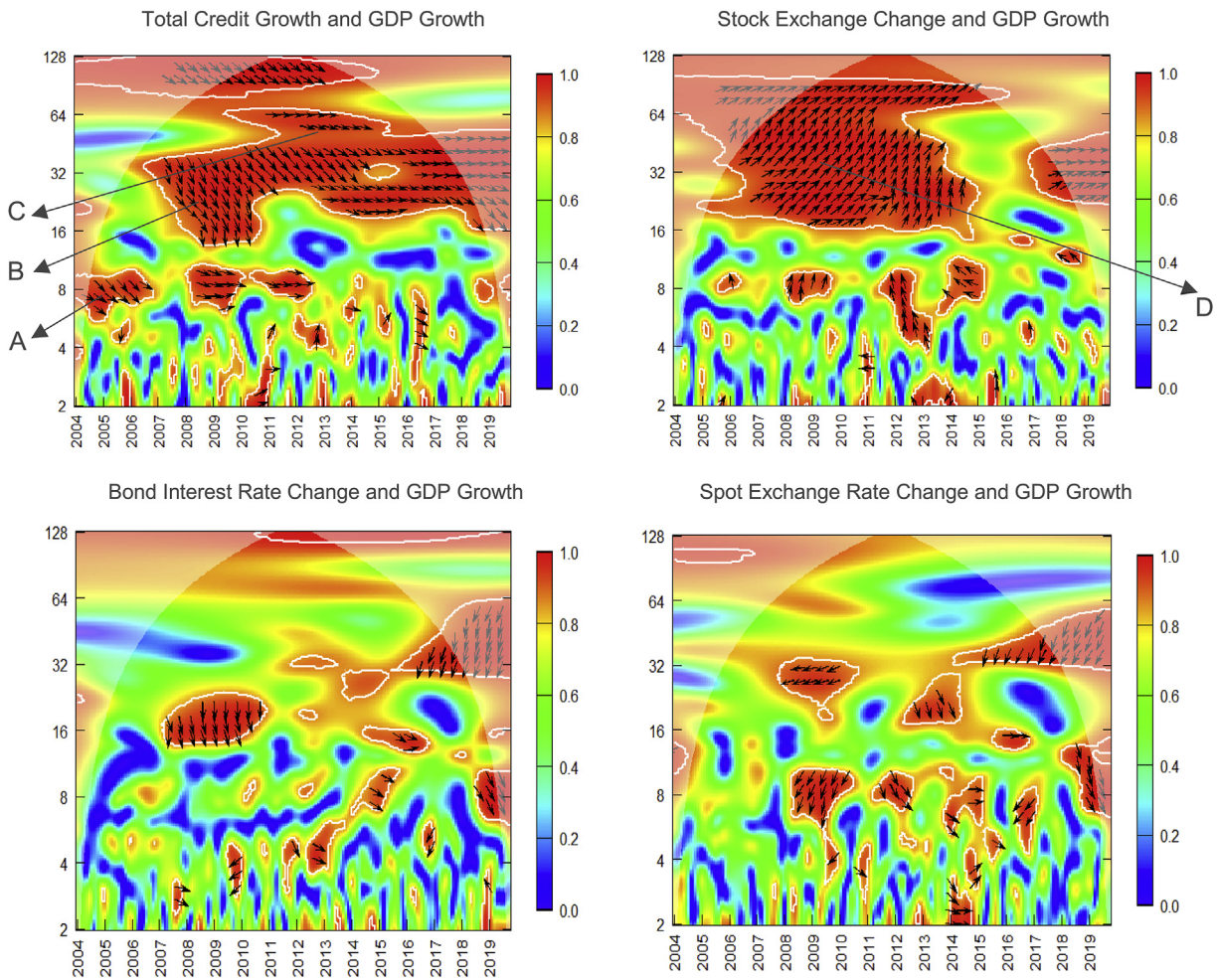


Fig. 9. Wavelet coherence plots for financial cycle indicators and GDP growth total Credit growth and GDP growth.

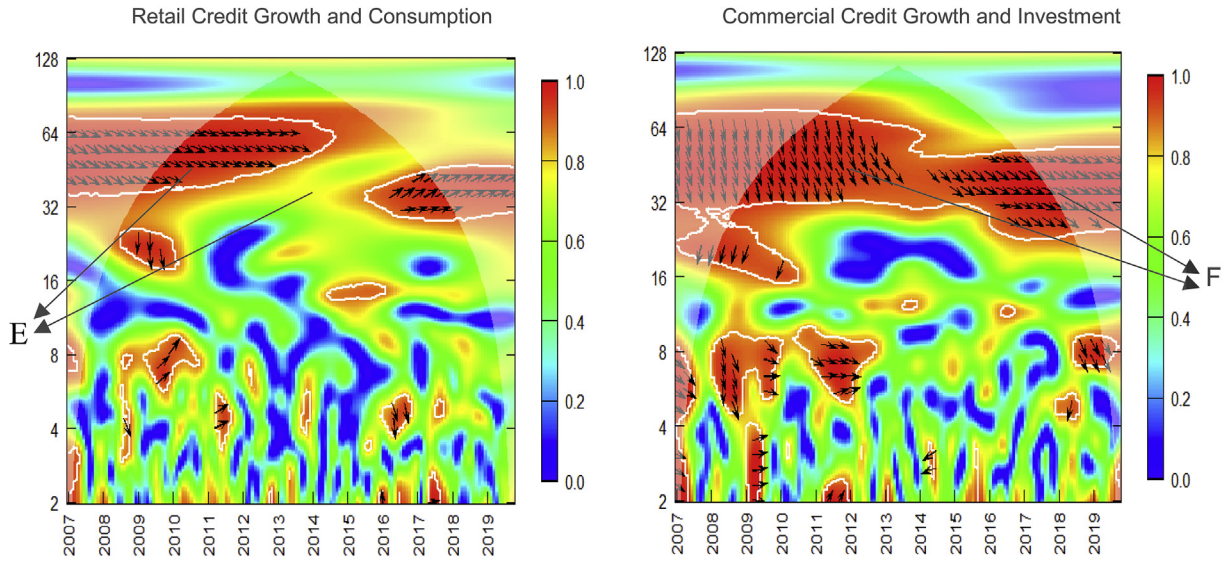


Fig. 10. Wavelet coherence plots for Extracted economic activity components: Consumption and investment retail Credit growth and consumption.

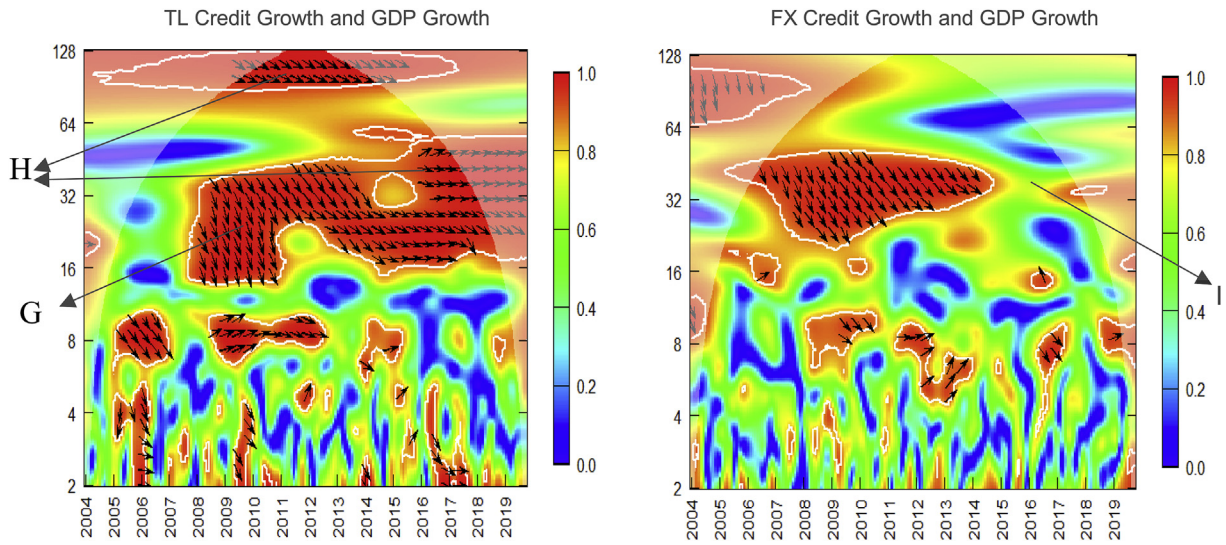


Fig. 11. Wavelet coherence plots for sub-categories of loans (TL and fx loans).

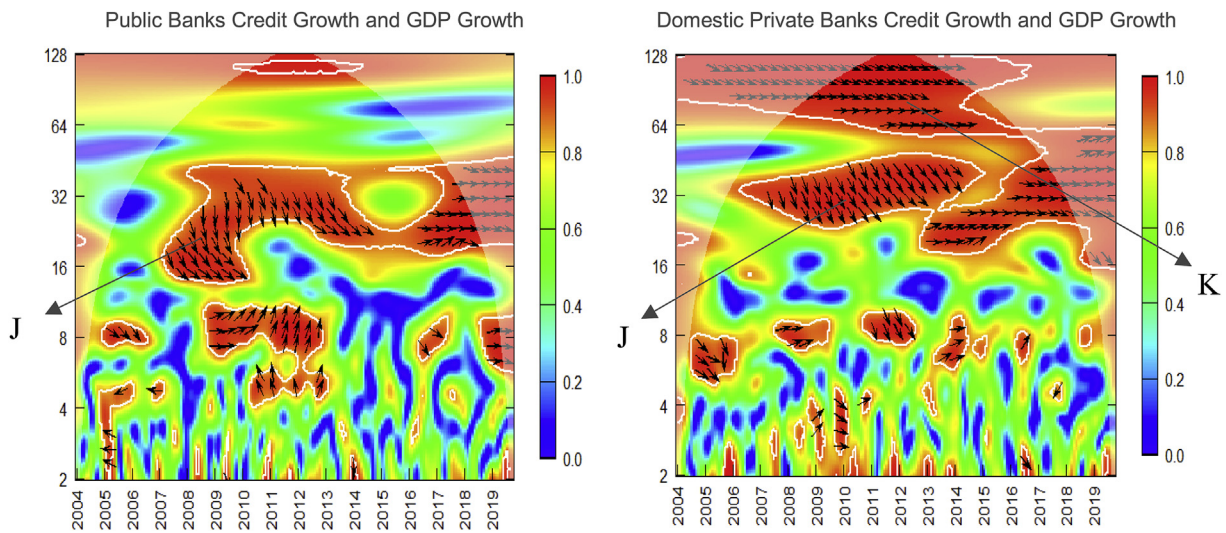


Fig. 12. Wavelet coherence plots for public and domestic private banks public banks Credit growth and GDP growth.

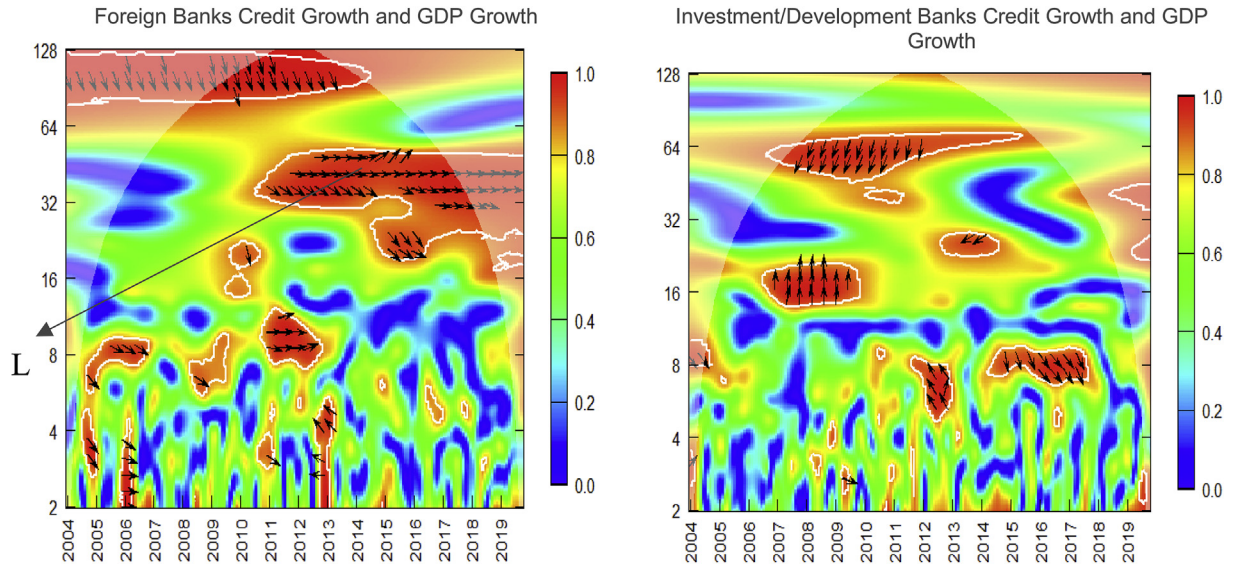


Fig. 13. Wavelet coherence plots for foreign and investment banks foreign banks Credit growth and GDP growth.

lagging economic activity while the lead/lag relation is mildly reversed in recent years.

Second, by decomposing the credits into consumer and commercial credits and deriving monthly consumption and investment series using PCA, we find evidence that earlier parts of our sample include significant episodes between consumer credits and consumption in longer terms, after 2011, we observe a weak relationship which could be the result of macroprudential measures taken to restrict households' financial debt. However, commercial credit growth has been highly correlated with capital formation throughout the sample period in lower frequencies involving 32–64 month cycle. Third, after the global financial crisis, while there exists strong co-movement stemming from TL loan growth to GDP, spillovers between FX credit growth and GDP growth holds for long terms until 2015. Because of the slowdown in external financing of banks, FX credit regulations for companies, and rising

awareness of FX risk management for companies in recent periods, FX credit growth - GDP growth relationship weakens after 2015. Finally, public and domestic private banks have credit growth tendencies that are vastly correlated with the general course of economic activity although with bank-type differences across the frequency spectrum.

By showing the differential effects of different types of credit on GDP growth, we specify that shocks to different credit types are crucial to analyze business cycles. For policymakers, this result implies that the dynamics of different credit types are crucial to analyze the impacts of credit cycles on economic activity.

Appendix

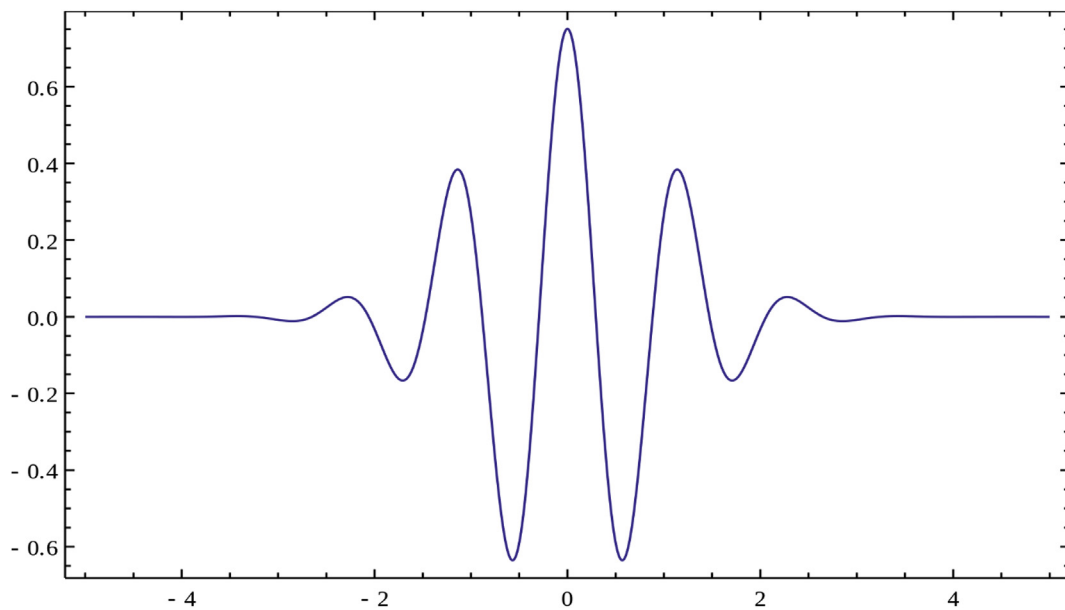
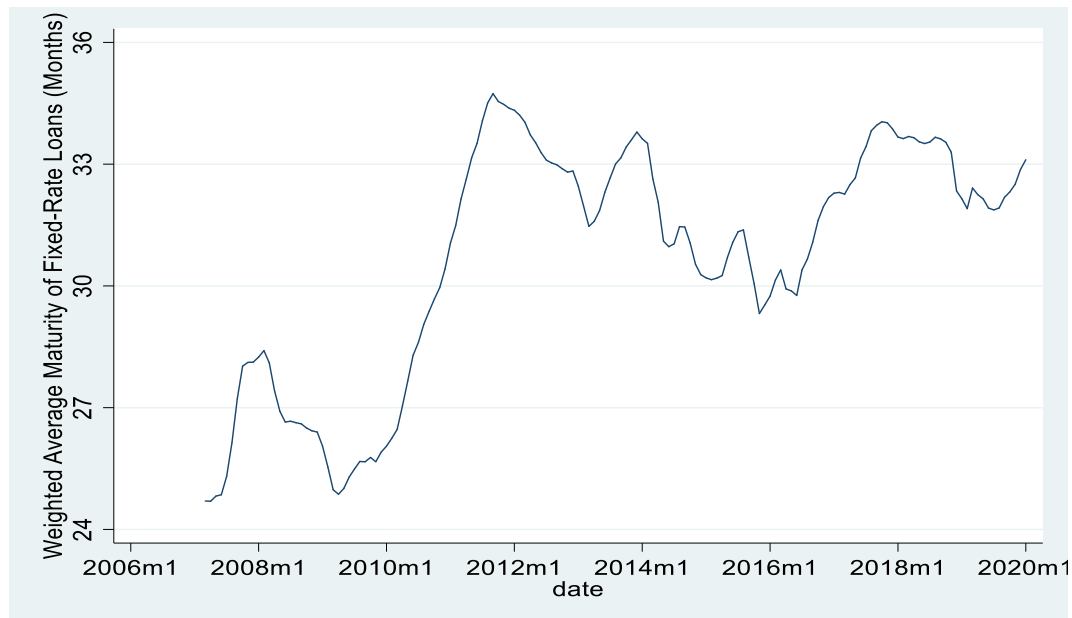
Table A1
Factor Loadings for PCA Analysis (Monthly Consumption Indicator)

Series	Loadings on Component 1	Loadings on Component 2
Business Tendency Survey: Expectation about Employment in Next 3 Months	0.252	0.147
Capacity Utilization Rate: Durable Consumer Goods	0.247	0.055
Capacity Utilization Rate: Non-Durable Consumer Goods	0.158	0.425
Capacity Utilization Rate: Consumer Goods	0.215	0.387
Industrial Production Index: Durable Consumer Goods	0.156	-0.104
Industrial Production Index: Non-Durable Consumer Goods	0.227	0.016
Income Tax	0.044	0.504
Domestic Value Added Tax	0.160	-0.360
Special Consumption Tax	0.199	-0.256
Consumer Confidence Index	0.284	-0.148
Consumer Confidence Index: Financial Situation Expectation of Households (Over Next 12 Months)	0.254	-0.289
Consumer Confidence Index: General Economic Situation Expectation (Over Next 12 Months)	0.274	-0.193
Consumer Confidence Index: Number of Unemployed Person Expectation (Over Next 12 Months)	0.256	-0.023
Consumer Confidence Index: The Probability of Saving (Over Next 12 Months)	0.250	-0.041
Real Sector Confidence Index: Total Employment (Over Next 3 Months)	0.253	0.148
Unemployment Rate	-0.263	-0.059
Non-Farm Unemployment Rate	-0.262	-0.111
Youth Unemployment Rate	-0.256	0.006
Imports: Durable Consumption Goods	0.168	0.040
Imports: Non-Durable Consumption Goods	0.134	-0.036

Table A2

Factor Loadings for PCA Analysis (Monthly Investment Indicator)

Series	Loadings on Component 1	Loadings on Component 2
PMI: Manufacturing	0.225	0.279
Business Tendency Survey: Production Volume in Last 3 Months	0.274	0.086
Business Tendency Survey: Amount of Orders Received in Last 3 Months	0.054	-0.463
Business Tendency Survey: The Level of Current Stocks	0.278	0.108
Capacity Utilization Rate: Industrial Production	0.241	-0.293
Capacity Utilization Rate: Intermediate Goods	0.261	-0.240
Capacity Utilization Rate: Investment Goods	0.225	-0.293
Industrial Production Index: Intermediate Goods	0.256	0.142
Industrial Production Index: Capital Goods	0.276	0.028
Automobile Production	0.160	0.154
Corporate Tax	0.025	-0.254
Real Sector Confidence Index	0.295	0.115
Real Sector Confidence Index: Total Orders	0.270	-0.102
Real Sector Confidence Index: Inventory	-0.054	0.463
Real Sector Confidence Index: Production Volume	0.250	0.085
Real Sector Confidence Index: Capital Formation Expenditures	0.278	-0.069
Real Sector Confidence Index: General Outlook	0.207	0.307
Imports: Capital Goods	0.217	0.050
Imports: Intermediate Goods	0.238	-0.054

**Fig. A1.** Real-Valued Morlet Wavelet Function**Fig. A2.** Weighted Average Maturity of Fixed-Rate Loans
Source: BRSA, Authors' Calculations.

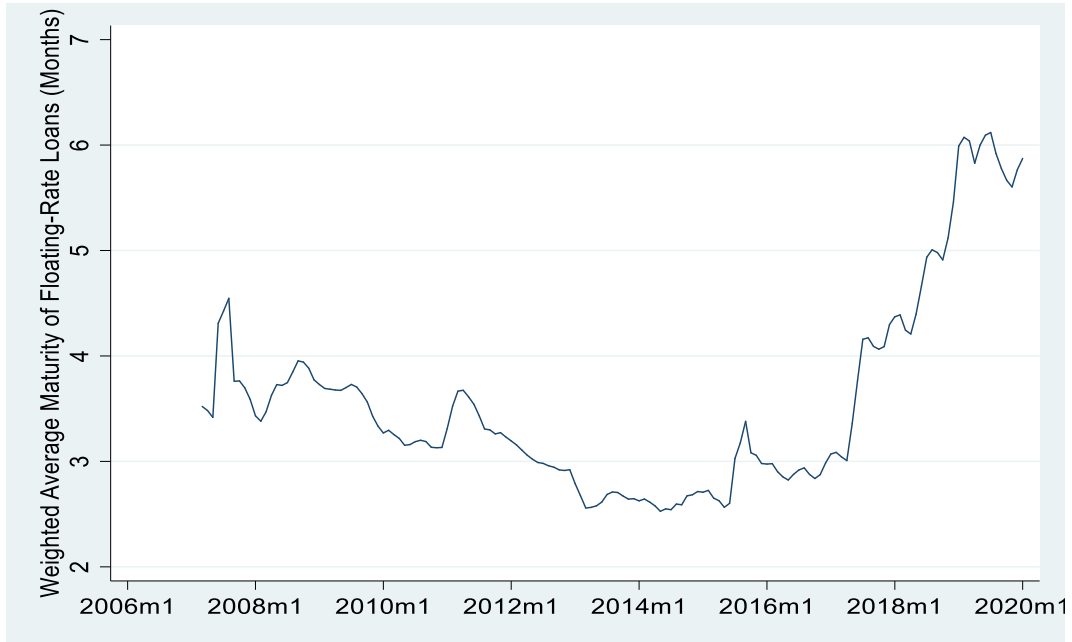


Fig. A3. Weighted Average Maturity of Floating-Rate Loans
Source: BRSA, Authors' Calculations.

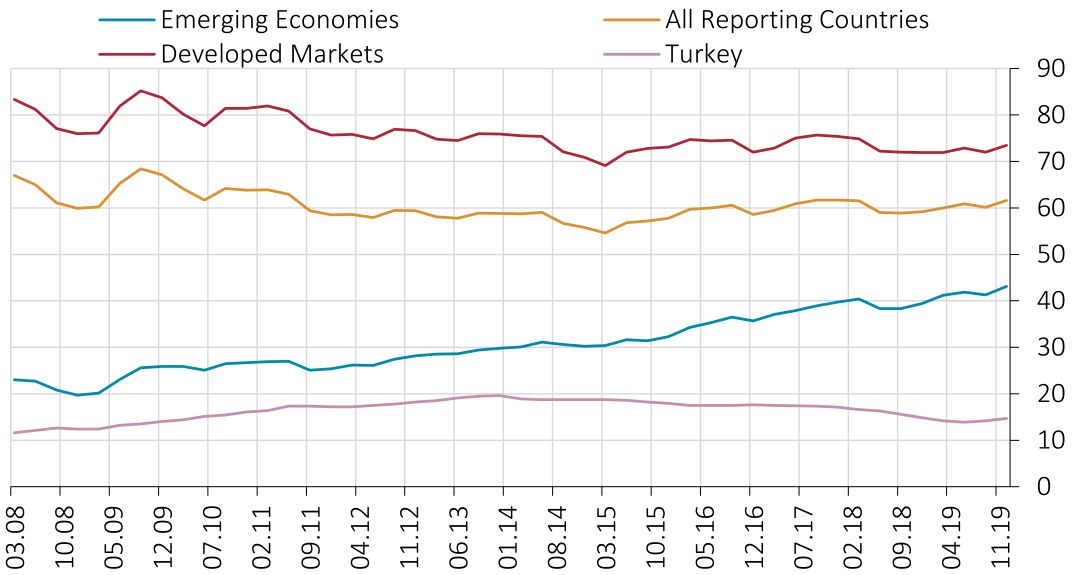


Fig. A4. Household Credits/GDP Ratio (Percentage)
Source: BIS.

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