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Stability of deposits in different interest rate regimes

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December 10, 2021

Abstract

We find evidence of the stability of the demand for deposits in Slovenia, even in this exceptional low interest rate environment, which mainly affected the breakdown of deposits by maturity. The aggregate volume of deposits (as well as deposits of up to 2-year maturity) by non-financial customers is cointegrated with GDP and with a reference interest rate that captures the fluctuations in the policy rate. Deposits increase with income and decrease with the reference interest rate. Results of a simulation of the normalization of the interest rates suggest that the expected response of deposits will be smooth over a medium-term horizon. Therefore, banks are assessed to be able to cope with a similar scenario, by raising funding from other sources.

Keywords: deposits, normalization of interest rates, bank funding risk

JEL codes: C22, G21, G32, E41

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Povzetek

Dokaze o stabilnosti povpraševanja po vlogah v Sloveniji najdemo tudi v tem scenariju izjemno nizkih obrestnih mer, ki je vplival predvsem na razčlenitev vlog po ročnosti. Skupni obseg vlog (kot tudi vlog do 2-letne zapadlosti) nefinančnih strank je kointegriran z BDP in z referenčno obrestno mero, ki zajema nihanja politične obrestne mere. Vloge rastejo z dohodkom in padajo z referenčno obrestno mero. Rezultati simulacije normalizacije obrestnih mer kažejo, da bo pričakovani odziv vlog v srednjeročnem obdobju nemoten. Zato ocenjujemo, da so banke sposobne kos podobnemu scenariju z zbiranjem sredstev iz drugih virov.

1. Introduction

The purpose of the present study is to estimate the demand function for bank deposits held by non-financial customers, assess their response to interest rate shocks and assess the impact on deposits of a simulated normalization of the interest rates. The addressed research questions are relevant for several reasons. First, deposits represent the predominant source of funding for Slovenian banks. Second, the recent period of extremely low interest rates might have changed the demand for deposits, inducing a non-linearity in the sensitivity to the interest rates. Third, the interest rates cannot be so low forever and banks should be prepared to face a potential outflow of deposits that might come with the normalization of the interest rates. The ultimate objective of this analysis is to assess to which extent the deposits can be considered a stable source of bank funding, despite possible changes in the interest rates.

Figure 1 and 2 show that during the recent period of low interest rates, in particular since 2014, deposits have been increasing at a sustained pace compared to the past, both in absolute terms and relative to bank total assets. The historically important role of deposits for Slovenian banks' financing has grown from 50% of bank total liabilities in 2011 to 76% in 2020. A look at the breakdown of deposits by maturity buckets (Figure 3) reveals that deposits with very short maturity, namely deposits of up to 3-month maturity and demand deposits, have been increasing while deposits with longer maturity have been decreasing.

In particular, the growth in demand deposits is remarkable since 2014. The observed transformation in the breakdown of deposits by maturity finds an explanation in the flattening of the term structure of the interest rates resulting from the lowering of the policy rate. In other words, facing a reduction in the term premium (or liquidity premium), households and companies prefer to hold more liquidity, for instance in the form of demand deposits or deposits with very short maturity.

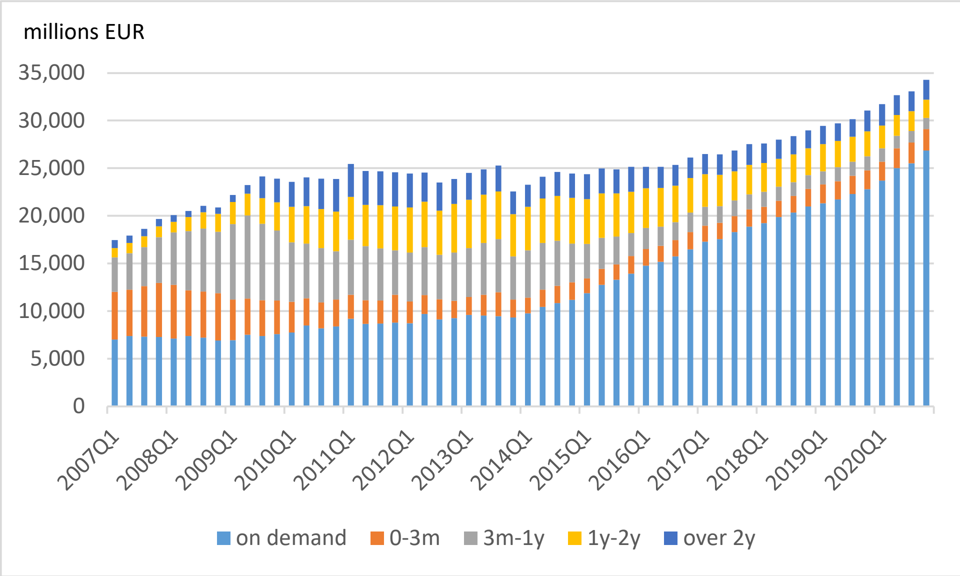

Figure 1. Non-financial customer deposits by maturity buckets.

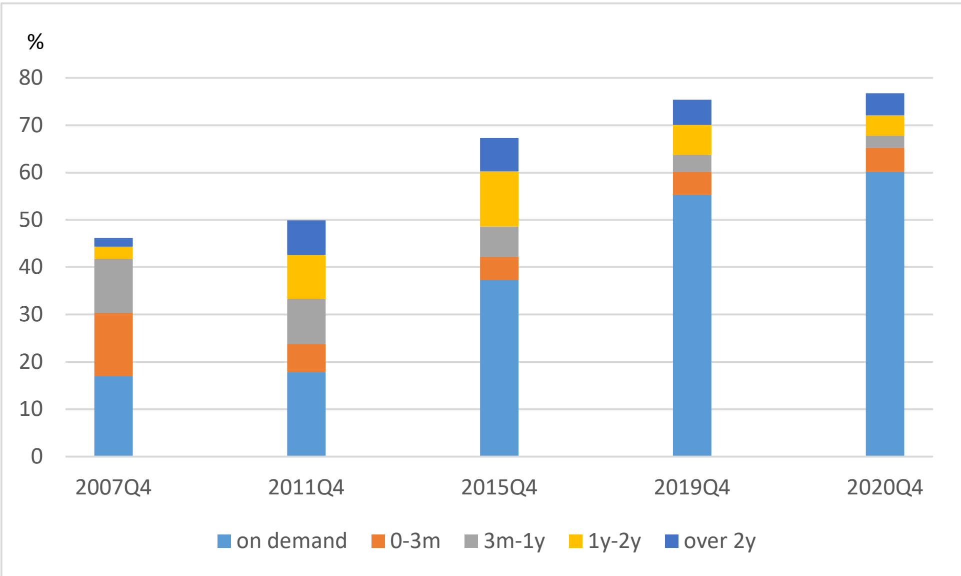

Figure 2. Non-financial customer deposits by maturity buckets as % of bank total assets.

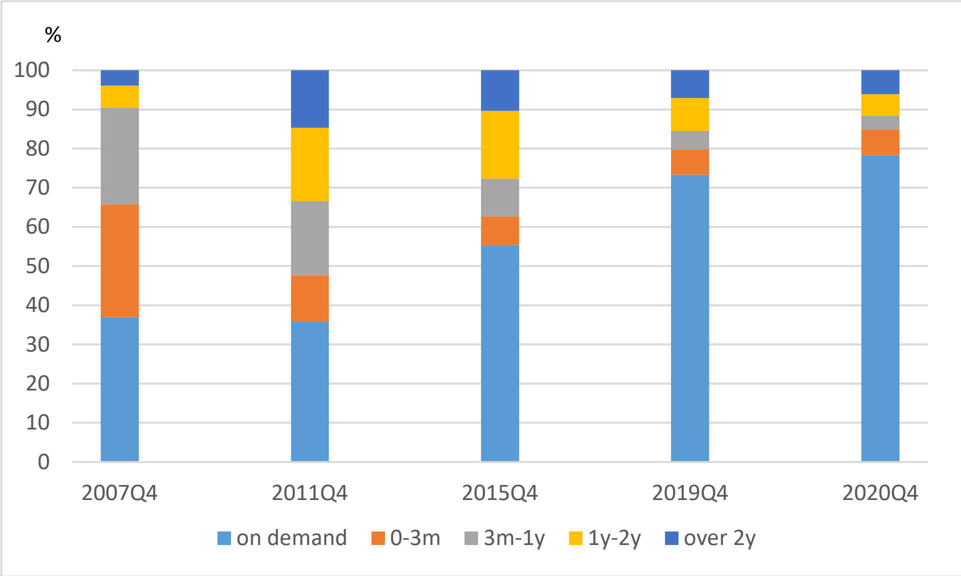

Figure 3. Breakdown of non-financial customer deposits by maturity buckets.

Demand deposits are associated with multiple equilibria, one of which is a bank run (Diamond and Dybvig, 1983). Bank runs are triggered by doubts about banks' solvency or liquidity. Short-term deposits also expose banks to the risk of a bank run, as the penalty for earlier withdrawal is generally very small. Nevertheless, the existence of a Deposit Insurance and of a Lender of Last Resort are meant to prevent bank runs or at least to limit the probability of their occurrence and their consequences. Following the recapitalization of Slovenian banks and the extensive use of the ECB unconventional measures to support bank liquidity from 2014 onwards, the risk of a bank run is currently assessed to be non-material and is not the issue addressed by this paper.

The question addressed by this study, as mentioned earlier, is whether the low interest rate regime has made deposits more sensitive to interest rates, thus affecting the stability of such source of bank funding. Looking at demand deposits in isolation might be misleading, as their recent noticeable growth might induce to think that the normalization of the interest rates will come with a specular noticeable outflow of such deposits from the banking system. However, the change in the breakdown of deposits by maturity suggests that the normalization of the interest rates will primarily lead to a shift from shorter to longer-term deposits. Therefore, we cannot consider the demand deposits in isolation. On the other hand, however, the speed at which deposits respond to interest rate shocks also depends on their maturity, especially in the case of longer maturities due to the penalty for earlier withdrawal.

Therefore, we decided to conduct our analysis in two steps. First, we consider only deposits of up to 2-year maturity (demand deposits included), which we will also refer to as short-term deposits hereafter. Next, we consider the deposits all together. The short-term deposits represent at least 85% of all deposits throughout our sample period, so they are a significant subgroup of deposits. Most of the shifts across maturity buckets since 2014 occurred within this subgroup, where the most noticeable changes are the fast increase in demand deposits and the decrease in deposits with maturity between 3 months and 2 years. Moreover, the deposits of up to 2-year maturity have a common feature, i.e. they are considered as money, because the penalty for earlier withdrawal, if any, is in general very low. In fact, they are included in the monetary aggregate M2, according to ECB definition.

In accordance with the literature on money demand, we find the existence of a cointegration relationship between short-term deposits, GDP and the (chosen) reference interest rate, which coincides with the euribor rate with 3-month maturity for the period following the entrance of Slovenia in the euro area and with an equivalent domestic interbank rate for the preceding period. Moreover, such a cointegration relationship remains stable during the low interest rate period. A cointegration relationship represents a long-run equilibrium relationship between the cointegrated variables. Short-term deposits depend positively on GDP and negatively on the interest rate, in the long-run. The positive relationship with the GDP captures the transaction motive to hold money. The negative relationship with the reference interest rate is due to the fact that the opportunity cost of liquidity increases with the interest rates, as the term structure of interest rates becomes, in general, steeper when interest rates are rising.

In order to assess the dynamic interrelations between these three variables, we estimate a vector error correction model (VECM) and we conduct the impulse response function (IRF) analysis. Identification is achieved by short-run restrictions, assuming that GDP does not respond to interest rates shocks in the same quarter and, moreover, both GDP and interest rate do not respond to depositors' liquidity shocks (or preference shock) in the same quarter. We identify a permanent output shock and a permanent interest rate shock.

We interpret the response of the short-term deposits to the permanent output shock as capturing the transaction motive to hold money, as higher income is also associated with higher expenditure. Moreover, the short-term deposit response to the interest rate shock reflects the reduction in money demand when the opportunity cost of money increases. In fact, we find that a standard deviation increase (40 basis points increase) in the reference interest rate leads to a negative, although small, response of short-term deposits, which decrease permanently by

0.9%. Moreover, a positive output shock that increases the GDP by 1% on impact and by 2.6% in the long-run induces a permanent positive response of short-term deposits, which increase by 2.7% in the long-run, although they decrease initially, possibly due to the contemporaneous positive response of the reference interest rate.

Finally, we use the estimated VECM to assess the impact on short-term deposits of a simulated normalization of the interest rates. The simulation exercise is based on the assumption of a gradual and permanent rise in the reference interest rate, by 25 basis points each quarter for twenty subsequent quarters. The results of our simulation exercise indicate that the deposits of up to 2-year maturity can decrease by 5% in the first twelve quarters, by 10% in twenty quarters and by 14% in forty quarters.

From the cointegration relationship, we were expecting already a permanent negative response of short-term deposits to a positive permanent interest rate shock. The main point of this exercise is to show that a gradual increase in the reference interest rate until it reaches a value around 5 percentage points – its highest value since 2008Q3 – causes a smooth decrease in the short-term deposits. Such a decrease is smooth enough so that banks are expected to be able to cope with the associated funding risk.

Next, we analyse the deposits all together. First, we check if a cointegration relationship exists also between GDP, the reference interest rate and the total amount of deposits. The data support this assumption. The rest of the analysis follow the same steps as for the analysis of short-term deposits. The results are also qualitatively comparable, as discussed in section 3.2. The rest of the paper is structured as follows. Section 2 presents the main issues addressed by the related literature. Section 3 describes the methodology and the results of our empirical analysis. Section 4 offers concluding remarks.

2. Related literature

Despite the relevance of deposits for bank funding, few papers analyse the dynamic interrelations between deposits, income and monetary policy rates. We take for granted a positive relationship between deposits and income, in a similar way as we believe that consumption and saving increase with income. In fact, demand deposits and short-term deposits are considered as money and the money demand increases with consumption, because money is what you need to make transactions.[1] Deposits with longer maturity, instead, represent a form of saving and, therefore, they are also expected to relate positively with income.

One of the earlier papers assessing the response of deposits to policy interest rate shocks is by Bernanke and Blinder (1992). They use innovations to the Federal funds rate as a measure of changes in monetary policy and present evidence showing that monetary policy works at least in part through credit (i.e. bank loans) as well as through "money" (i.e. bank deposits). Both loans and deposits decrease after a positive interest rate shock. The subsequent literature on the bank lending channel of monetary policy does not analyse the response of bank deposits in greater depth or at a greater level of disaggregation. In a recent paper, Gerlach, Mora and Uysal (2017) assess the impact of monetary policy on the bank funding costs and on deposits and document that demand deposits decrease while term deposits increase following a positive interest rate shock.

The transmission of the policy rate shocks to the deposits balances depends on the reaction of market rates and on how banks adjust their customer rates, because the difference between the return on assets that can be considered as comparable alternatives to deposits and the rates on deposits determines their opportunity cost. Accordingly, Gerlach, Mora and Uysal (2017) include in their model the Fed Funds rate, the 10-year Treasury rate and the rates on non-time, time and foreign deposits, on top of deposits balances and other macroeconomic and financial variables.

However, it is not straightforward to identify assets that can be considered as comparable alternatives to each other. Since the bulk of Slovenian deposits are short-term deposits and these are considered as money, it is useful to review the issues related to the identification of the opportunity cost of money as discussed in the literature. As pointed by Calza et al. (2001), the choice of the appropriate opportunity cost measure is not straightforward, mainly because – for the purpose of portfolio decisions – a variety of assets can be treated as alternative to holding money.[2]

Due to co-movement (and, therefore, collinearity) among rates of return of similar assets, typically only a representative interest rate is included in the analysis. In particular, many papers

[1] The positive relationship between money and income is embodied in the Quantity Theory of money and Keynes (1936) refers to it as the transaction motive to hold money (or transaction money demand). Keynes provides also a further reason for a positive relationship between money and income, which is the precautionary money demand. Keynes assumes that the amount of money that people hold for precautionary reasons, in order to cope with unexpected costs, is positively related to their income.

[2] See e.g. Friedman (1956, 1959).

include a short-term market interest rate as a representative rate on the ground that negotiable instruments with short maturity are the closest substitutes for money. In this respect, it is argued that longer-term assets cannot be treated as substitutes for money, because they have a different risk/return profile.[3,4] Moreover, due to country-specific factors, instruments apparently similar might have a different risk profile in different countries.

For instance, as discussed in Calza et al (2001), '*in countries that have endured fiscal profligacy and high inflation over protracted periods, the probable existence of a large stock of debt with a relatively short maturity may lead to economic agents focusing on short-term negotiable instruments as substitutes for money. By contrast, in countries that have traditionally enjoyed fiscal discipline and low inflation, long-term financial instruments might play a more important role as alternative assets to money*'. Debola et al. (2001) provide some evidence of differences in money demand in individual euro area countries consistent with the above argument.[5]

The correct identification of the opportunity cost of money requires, on top of the representative return on relevant alternative assets, the measurement of the own rate of money, especially for broader monetary aggregates, which include some interest-bearing assets. In order to circumvent the difficulties of retrieving historical data on the rate of money, some studies adopted a short-term market interest rate as a proxy for the own rate of money, while including the long-term bond yield as a representative alternative rate of return. See Coenen and Vega (1999), Brand and Cassola (2000), Levy (1999), Debola et al. (2001), Calza et al (2001).

In summary, the earlier literature focused on a very narrow set of assets – such as sovereign bonds, Treasury bills and some reference money market interest rates – for the purpose of measuring the opportunity cost of money. Starting from the Eighties, many empirical studies documented the breakdown of any stable demand for several alternative monetary aggregates.[6] The widespread evidence on the instability of the money demand has led some to assume the

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[3] Even for long-term assets that are negotiable on markets with characteristics that make them very liquid assets today, the longer the maturity, the more likely it is that conditions responsible for some risks related to these assets appear, making them less liquid in the future. Accordingly, long-term assets – although negotiable – might not be considered as substitute for money.
[4] See Ando and Shell (1975).
[5] On the basis of a panel data study, Debola et al (2001) find that the short-term interest rate is more relevant in Spain and Italy, while the long-term interest rate seems to represent the correct measure of the return on the representative alternative asset in Germany and the Netherlands.
[6] See, for instance, Friedman and Kuttner (1992), Brand and Cassola (2000), Ball (2001), Coenen and Vega (2001), Golinelli and Pastorello (2002) and Carstensen (2006).

existence of money velocity shocks[7,8]. Another strand of the literature, instead, tried to resolve the instability of the money demand by improving the definition of the scale variable - for instance, by including the growth rate of households wealth (Beyer, 2009) – or the definition of the opportunity cost measure.

The observation that breaks in traditional money demand function were contemporaneous to portfolios shifts led to a new approach that considers money demand as part of a broader portfolio allocation problem[9,10]. De Sanctis, Favero and Roffia (2012) follow this approach and characterise the demand for M3 in the euro area as part of a cross-border portfolio allocation problem where domestic and foreign asset prices, namely euro area and US stock and bond prices, influence the demand for M3. By including foreign assets, they obtain a stable demand for M3.[11]

Extensions of the money demand functions to include a broader set of alternative rates of return raise the issue of modelling the market participants expectations on the evolution of these variables, whose dynamics is not known ex-ante (differently from the case of risk-free interest rates) and not easy to model and predict. To measure expectations in the stock market, De Sanctis et al. (2012) exploit a simple model known as the "FED model" - see Lander et al. (1997), Koivu et al. (2005). [12]

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[7] Even before the Eighties, Selden (1956) summarizes his findings as providing little support to the hypothesis that movements in the U.S. money velocity are mainly a result of changes in the cost of holding money, since the opportunity cost of money – according to his findings – cannot account for the major velocity changes between 1919 and 1951. The literature discusses three main sources of velocity shocks: financial deepening, technological advances and institutional changes.

[8] Recently, Altermatt and Benati (2017) show that '*the failure to distinguish between M1 and M2-M1 causes a significant distortion of the inference, erroneously pointing towards a dominant role for M2 velocity shocks*'. In Altermatt and Benati (2017) and in Benati, Lucas, Nicolini and Weber (2016), the authors provide evidence in favor of the stability in long-run money demand in many countries. Altermatt and Benati (2017) conduct their analysis through a cointegrated structural VAR identified *via* long-run restrictions.

[9] As pointed in Papademos and Stark (ECB, 2010), both the experience of exceptional portfolio shifts (in the period 2001-2003) and the correlation between the money stock, the level of asset prices and thus wealth (observed between 2004 and 2009) point to the need to model money as part of a broader portfolio choice decision.

[10] Typically, money demand functions with risky asset prices include the level of the domestic stock prices – for instance, Friedman (1988) and Choudhry (1996) – or 3-year average of domestic quarterly stock returns – Carstensen (2006).

[11] Another source of instability of broad money is represented by non-linearities. This argument can be rationalised on the basis of adjustment costs in reallocating the portfolio, which imply that money balances are readjusted towards the desired target only when the deviations become relatively large. Taking into account these non-linearities, Terasvirta and Eliasson (2001) find a stable broad money demand for the UK.

[12] According to the FED model, the equalization of risk-adjusted long-run returns in the stock and the bond markets implies cointegration between the earnings yield (i.e. the inverse of the price-earnings ratio) and the long-term bond yield. As a consequence, the deviations from the long-run equilibrium should predict future returns in at least one of the two markets. The evidence for the US supports this assumption.

The discussion up to now points to the fact that it is not straightforward to have a proper measure of opportunity cost for a financial asset. Luckily, we do not have evidence of significant portfolio shifts toward risky and foreign assets in the case of Slovenian households, who mostly invest in deposits and in Slovenian sovereign bonds, which would represent the most comparable alternative assets. Moreover, similarly to most of the papers on money demand, we exploit the co-movement between the returns on comparable assets and decide to include only a reference interest rate in the analysis.

3. Empirical analysis

The first part of the analysis aims to assess the stability of the demand for short-term deposits, namely deposits of up to 2-year maturity (demand deposits included). Since these deposits are part of the monetary aggregate M2, the intuition suggests that the demand for short-term deposits depends positively on GDP and negatively on the general level of the interest rates, similarly to the money demand framework.

Changes in the general level of the interest rates usually reflect a change in the policy rate. If market rates and deposit rates would adjust in such a way to leave the opportunity cost of each financial asset unchanged, we should probably not see portfolio-rebalancing effects. However, this is not the case. In general, when the policy rate goes up we observe that the term structure of interest rates becomes steeper, leading to a smaller demand for liquidity. In order to be able to explain where the liquidity flows into, we should identify the assets that people consider as comparable alternatives and take into account the returns on these assets to compute the opportunity cost of money.[13]

As mentioned in the previous section, Slovenian households mainly invest in deposits and in 10-year Slovenian sovereign bonds. Therefore, the opportunity cost of deposits depends on the yield on such bonds and the deposit rates. In order to convert the yield on government bonds into opportunity cost for deposits, we need to subtract the deposit rates. However, deposits rates are available only since 2005Q2. To avoid issues related to small sample size, we decide to

[13] The opportunity cost of short-term deposits should be defined as the difference between the return on a short-term safe investment opportunity, for instance a Treasury bill, and the return on the considered deposits. However, in Slovenia, there are no transactions in the secondary market for the Slovenian Treasury bills and only banks hold these instruments. Therefore, it does not make sense to consider these assets as available alternative investment opportunities for depositors.

include in the model only a representative short-term rate, which is the interbank rate with 3-month maturity.

This choice is justified for two reasons. First, the co-movement among the chosen reference rate, deposits rates and the 10-year sovereign bond yield. Second, we observe that when the reference rate decrease (increase) also the term spread among the aforementioned rates does, therefore, the fluctuations in the reference rate captures the fluctuations in the opportunity cost for the deposits of different maturity buckets. More precisely, the chosen reference interest rate variable coincides with the Euribor with 3-month maturity since 2007, when Slovenia joined the euro area, and with the equivalent Slovenian interbank rate for the preceding period.

Our sample includes quarterly data on GDP, deposits and the aforementioned reference interest rate, for the period 1999Q1-2019Q4. In order to transform in real terms the GDP and the deposit balances, we scale these variables by the GDP deflator. Moreover, deposit balances and GDP are log-transformed. As mentioned in the introduction, we first focus only on short-term deposits and then we consider the deposits all together. The short-term deposits are defined as the sum of demand deposits and deposits of up to 2-year maturity. All these variables are integrated of order 1.[14] Therefore, the first step is to test whether there is cointegration among them. Since our first objective is to assess whether the low interest rate regime is responsible for a break in the demand for deposits, we make cointegration tests over two sample periods, excluding and including the low interest rate period.

3.1 Analysis of short-term deposits

3.1.1 Cointegration test

The data indicate the existence of a cointegration relationship between deposits of up to 2-year maturity, GDP and the chosen reference interest rate, at one percent level of probability, over the period 1999Q1-2014Q4, as well as over the period 1999Q1-2019Q4 (Table 1 and 2). The cointegration relationship is estimated using Johansen (1995) procedure. Moreover, the estimated coefficients are virtually unchanged over the two samples (Table 3). The cointegration relationship captures the long-run level of equilibrium between the variables

[14] Results available upon request.

involved, such that departures from this equilibrium are not persistent. In statistical terms, the cointegration error is stationary.

Figure 4 shows the dynamics of the considered deposits and the corresponding values predicted by the cointegration relationship estimated with data up to 2014Q4. Figure 4 suggests that the cointegration relationship estimated over the shorter sample is still valid afterwards. Moreover, the cointegration residuals for the period 1999Q1-2019Q4 computed by using the cointegration relationship estimated with data up to 2014Q4 are stationary (Table 4). Therefore, we conclude that there exists a stable demand for short-term deposits in Slovenia, which has remained stable during the low interest rate period.

Table 1. Tests of cointegration between deposits of up to 2-year maturity, GDP and the reference interest rate over the period 1999Q1-2019Q4.

Hypothesized No. of cointegration equations	Trace Statistic	Probability	Max-Eigenvalue Statistic	Probability
None	50.31	0.000	35.96	0.000
At most 1	14.35	0.023	11.91	0.038
At most 2	2.44	0.140	2.44	0.140

Table 2. Tests of cointegration between deposits of up to 2-year maturity, GDP and the reference interest rate over the period 1999Q1-2014Q4.

Hypothesized No. of cointegration equations	Trace Statistic	Probability	Max-Eigenvalue Statistic	Probability
None	36.82	0.001	25.52	0.003
At most 1	11.30	0.074	10.77	0.060
At most 2	0.53	0.530	0.53	0.530

Table 3. Cointegration equation between short-deposits (real) GDP (real) and the reference interest rate.

Estimation sample	
1999Q1-2019Q4	$d2_t = \underset{(0.001)}{1.096}y_t - \underset{(0.003)}{0.023}i_t$
1999Q1-2014Q4	$d2_t = \underset{(0.002)}{1.095}y_t - \underset{(0.005)}{0.020}i_t$

Note: $d2_t$ denotes the deposits of up to 2-year maturity, y_t denotes the GDP and i_t stands for the reference interest rate.

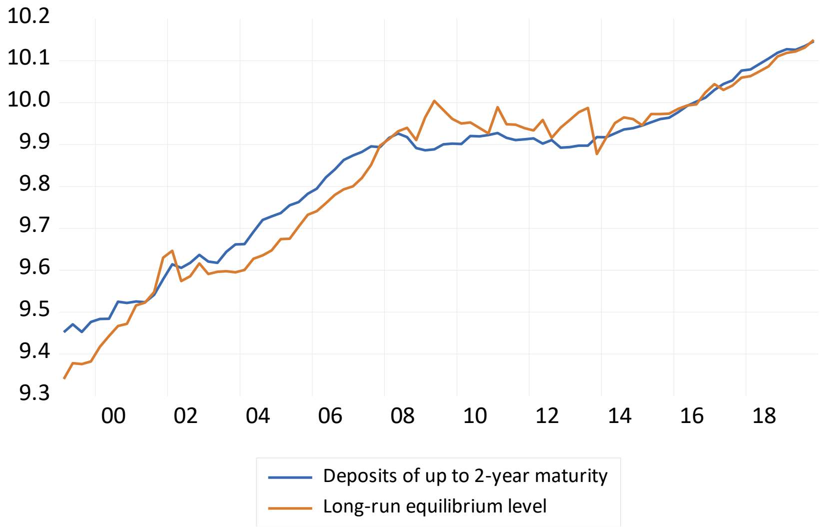
Table 4. Unit root test for the cointegration error relative to deposits of up to 2-year maturity.

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.071628	0.0326
Test critical values:	1% level	-3.511262	
	5% level	-2.896779	
	10% level	-2.585626	

*MacKinnon (1996) one-sided p-values.

Note: the cointegration error is computed as the difference between the level of deposits and the long-run equilibrium level estimated for the period 1999Q1-2014Q4. The test refers to the period 1999Q1-2019Q4.

Figure 4. Short-term deposits (in real terms, million EUR and log-transformed) and their long-run equilibrium level.



Note: the long-run equilibrium level is the predicted value of deposits obtained from the cointegration relationship between deposits, GDP and the reference rate estimated over the sample 1999Q1-2014Q4 (see Table 3).

3.1.2 Vector-error correction model and impulse response function analysis

In order to study the dynamic relations between the variables, we estimate a vector error correction model (VECM). The general form of a VECM is as follows:

$$\Delta X_t = B_0 + B_1 \Delta X_{t-1} + \ldots + B_{p-1} \Delta X_{t-(p-1)} - BA' X_{t-1} + \epsilon_t \quad (1)$$

where X_t is a vector of N series integrated of order 1, Δ denotes the first-difference operator, A is an $(N \times r)$ matrix, whose columns are the cointegration vectors and B is an $(N \times r)$ matrix of 'loading coefficients'. Notice that r is the number of cointegration relationships between the

N considered variables. The coefficients in B specify how the deviations from the long-run equilibrium captured by the cointegration residuals, $A'X_{t-1}$, map into subsequent movements in the variables X_t, so that the system converges back to its long-run equilibrium. Therefore, the term $-BA'X_{t-1}$ is called 'error-correction term'. Finally, ϵ_t is the vector of reduced-form residuals.

In the case considered in this paper, r=1, that is we find only one cointegration relationship between GDP, the reference interest rate and deposits. Therefore, the matrix A boils down to a *3*-dimensional column vector and B becomes a *3*-dimensional column vector as well. We denote them by α and β, respectively. Moreover, only the two lags of the first-difference of X_t enter in our model:

$$\Delta X_t = B_0 + B_1 \Delta X_{t-1} + B_2 \Delta X_{t-2} - \alpha\beta' X_{t-1} + \epsilon_t \qquad (2)$$

The coefficient estimates are not very much of interest, because they do not give a clear understanding of the dynamic interrelations among the variables in the vector-error correction model. Instead, the impulse response functions (IRFs) analysis is a useful tool at this purpose. In order to generate impulse response functions, we need to be able to retrieve the structural VECM

$$\Delta X_t = B_0 + B_1 \Delta X_{t-1} + B_2 \Delta X_{t-2} - \alpha\beta' X_{t-1} + A_0 e_t \qquad (3)$$

from the estimated reduced-form VECM in equation (2). Therefore, identification hypotheses are needed, in order to obtain the structural residuals e_t from the reduced-form residuals ϵ_t. In other words, we need to impose restrictions that allow us to identify the matrix A_0, since $e_t = A_0^{-1}\epsilon_t$.

In principle, different identification strategies are possible. However, for the validity of the chosen identification strategy, the IRFs need to meet some conditions based on economic theory or empirical evidence. First, since the deposits up to 2-year maturity are a proxy for money demand, positive shocks to income (GDP) are expected to cause upward movements in such deposits, due to the transaction motive to hold money. Second, we do not expect a positive response of output to an increase in interest rates.

Moreover, the existence of one cointegration relation between the three considered variables suggests that they are driven by two permanent shocks and one transitory shock. Therefore, we aim to identify a shock to potential output, i.e. a permanent shock to GDP, a permanent shock to the interest rate and a transitory liquidity shock specific to depositors. This is consistent with the existence of a long-run money demand, i.e. a long-run relation between GDP, interest rate and money demand, with short-term deposits used as a proxy for money demand.

Finally, financial variables react to shocks faster than real variables. More precisely, we assume that GDP does not react to interest rate shock within a quarter and, moreover, both GDP and interest rate do not react to the liquidity shock within a quarter. For the purpose of shock identification, we impose these short-run restrictions, by resorting to the Choleski decomposition of the covariance matrix of the reduced form estimation errors. Interestingly, the aforementioned conditions that the IRFs are expected to meet turn out to be satisfied as well (Figure 5).

Figure 5 shows the impulse-response functions to the identified output shock, interest rate shock and liquidity shock. The shock to GDP turns out to be a permanent shock and the only one affecting the GDP in the long-run. Therefore, it represents a shock to potential output. We find that a positive shock to the potential outcome raises permanently the interest rate, as expected because of the effect on the natural rate of interest. A specific case can be an expansion of the potential outcome driven by an increase in capital productivity, which in turn should be reflected in a rise in the cost of capital. In line with the transaction motive to hold money, the short-term deposits increase permanently with a positive shock to the potential output, as the latter implies a higher permanent income.

A positive permanent shock to the interest rate negatively affect the real GDP, although the effect is statistically insignificant, consistently with the long-run neutrality of monetary policy. The main focus of this paper is the response of deposits to the interest rate shock. A positive shock to the reference interest rate has a small negative effect on short-term deposits. In fact, the term premium is generally bigger when the interest rates are higher (i.e. steeper term structure of interest rates), implying a higher opportunity cost of holding liquidity, for instance in the form of short-term deposits. We find that a positive standard deviation shock to the reference interest rate (equivalent to a 40 basis points increase on impact), leading to a permanent increase by roughly 30 basis points in the same rate, has a small negative effect on the short-term deposits, which permanently decrease by 0.9%.

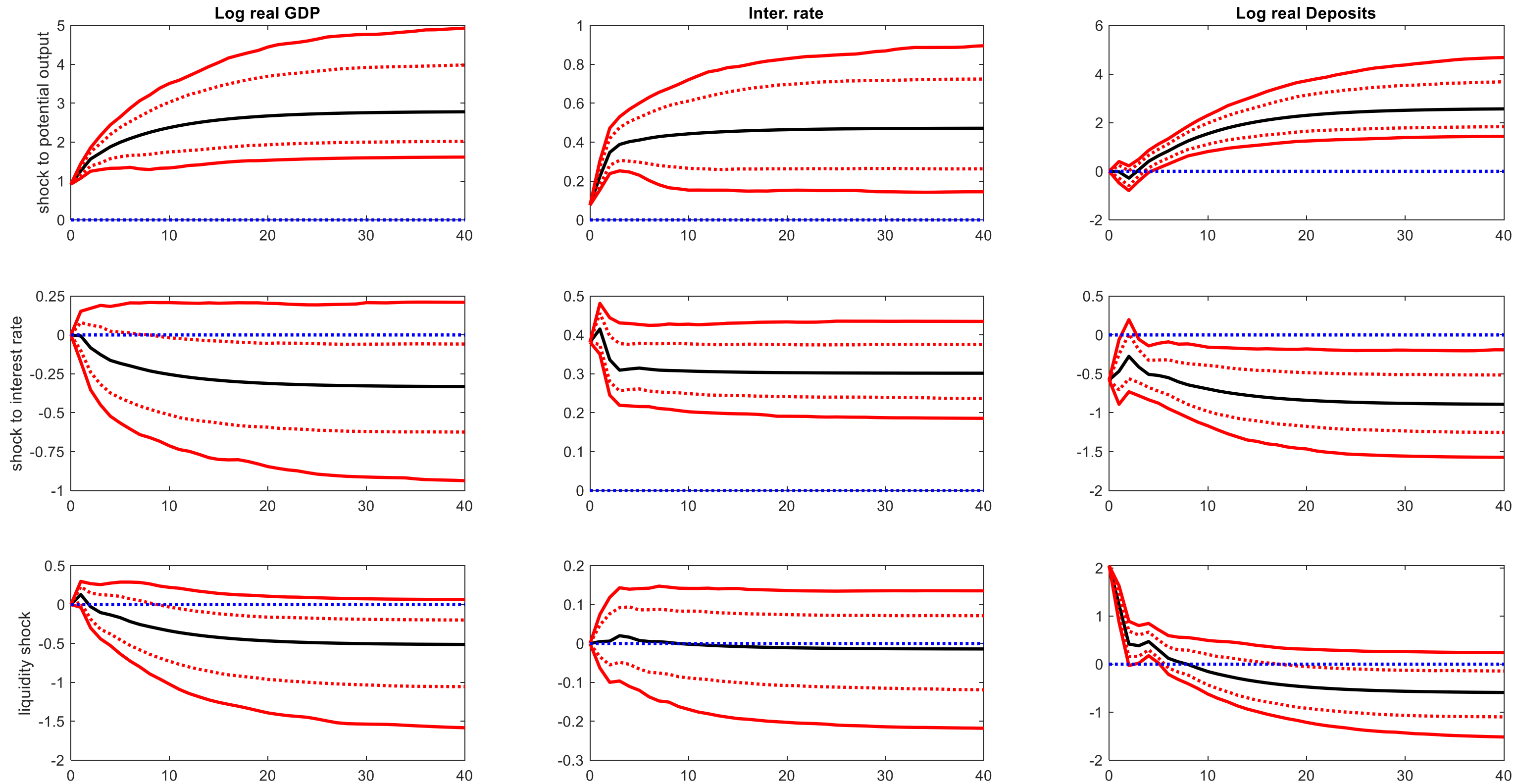
Moreover, the residual shock moving the short-term deposits resembles a transitory liquidity shock, with statistically insignificant effects on real GDP and on the interest rate. It turns out that shocks to potential output and to the reference interest rate are the only shocks affecting the short-term deposits in the long-run.

3.1.3 Simulating the normalization of the interest rates

We make a simulation of the normalization of the interest rates and use the estimated VECM to assess the impact on short-term deposit. For the simulation, we assume a gradual and permanent rise in the reference interest rate, by 25 basis points each quarter for twenty subsequent quarters. After that, the interest rate adjust as prescribed by the model. Our results indicate that the deposits of up to 2-year maturity can decrease by 5% in the first twelve quarters, by 10% in twenty quarters and by 14% in forty quarters (Figure 6).

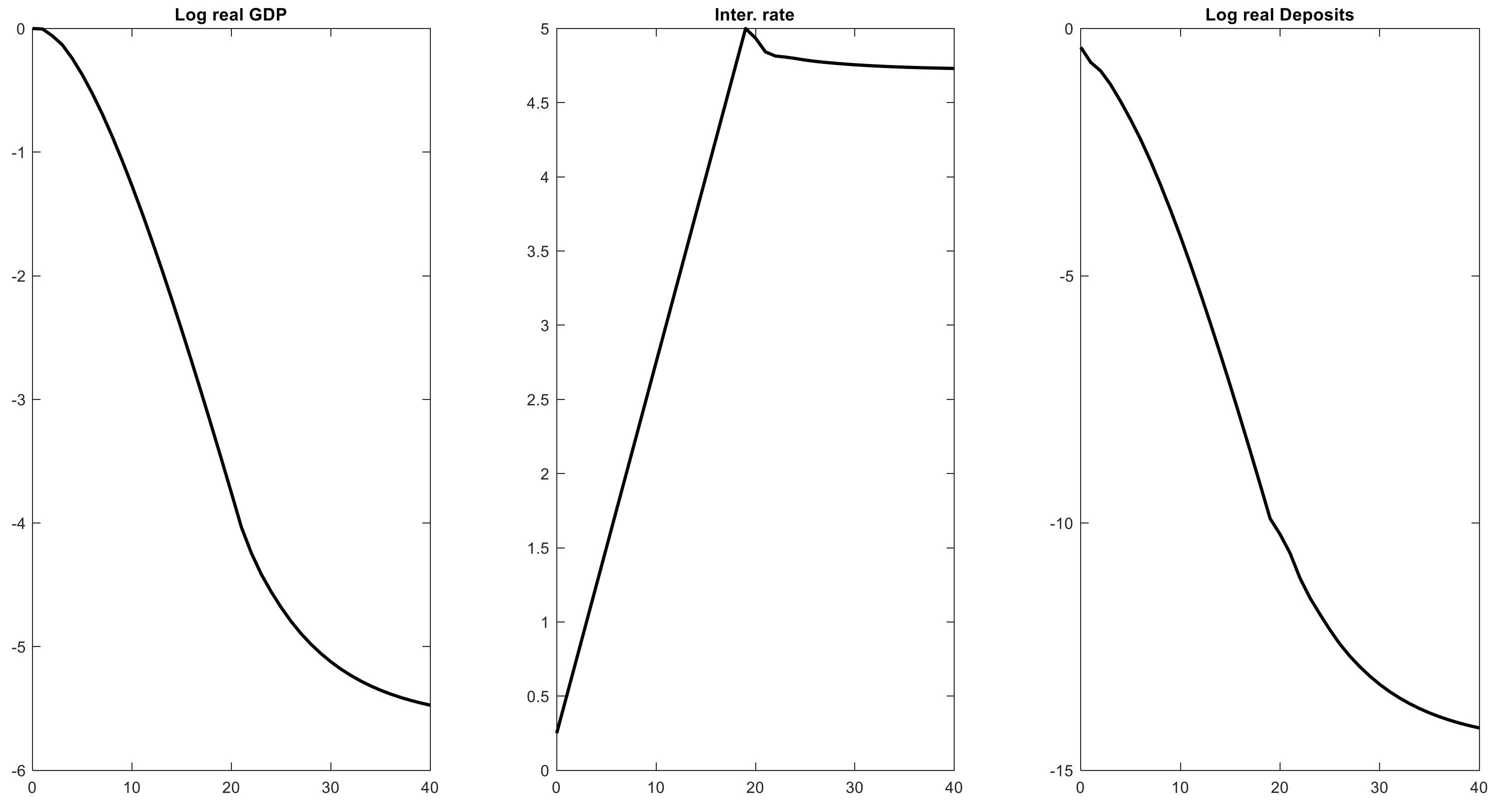
From the cointegration relationship, we were expecting already a permanent negative response of short-term deposits to a positive interest rate shock. The main point of this exercise is to show that a gradual increase in the reference interest rate until it reaches a value around 5 percentage points – its highest value since 2008Q3 – causes a smooth decrease in the short-term deposits. Such a decrease is smooth enough so that banks are expected to be able to cope with the associated funding risk.

Figure 5. Impulse response functions identified through short-run restrictions on the VEC-model for the short-term deposits.



Note: GDP and deposits are in real terms and log-transformed, therefore the IRFs represent their growth rate (in %, in real terms), in response to shocks. The interest rate variable is in percentage points. Black line represent the estimated IRFs. Red lines (dashed lines) represent the bootstrapped 90% (68%) confidence bands.

Figure 6. Simulation of a gradual increase in the reference interest rate: impact on short-term deposits from non-financial sector customers.



Note: GDP and deposits are in real terms and log-transformed, therefore their simulated path represent their growth rate (in %, in real terms), in response to a sequence of shocks to the reference interest rate. The interest rate variable is in percentage points. Short-term deposits include demand deposits and deposits with maturity of up to 2 years.

3.2 Analysis of the aggregate amount of deposits

As noted in the introduction, if we exclude some maturity buckets from our analysis of deposits, we cannot draw conclusions on the stability of deposits as a source of bank funding, because we would not take into account the shifts across maturity buckets. Therefore, we make an analysis also for the aggregate amount of deposits. We follow the same steps described in section 3.1 for the short-term deposits. First, we test the assumption of cointegration between real GDP, the reference interest rate and the real deposits balance. We find evidence for the existence of one cointegration relationship (Table 5 and 6), both in the period prior to the low interest rate regime (1999Q1-2014Q4) and in the entire sample period (1999Q4-2019Q4).

The estimated coefficients of the cointegration relationship (Table 7) are very similar in the two samples. In particular, the coefficient on the interest rate is virtually unchanged. Figure 7 shows the time series of deposits and the long-run equilibrium level obtained from the cointegration relationship estimated with data up to 2014Q4. Moreover, Table 8 presents the results of the unit root test for the cointegration residual. These results indicate that the cointegration error for the period 1999Q1-2019Q4 obtained by using the cointegration relationship estimated with data up to 2014Q4 are stationary. Overall, Figure 7 and Table 7-8 suggest that the demand for deposits in Slovenia has remained stable during the low interest rate period.

Table 5. Tests of cointegration between deposits, GDP and the reference interest rate over the period 1999Q1-2019Q4.

Hypothesized No. of cointegration equations	Trace Statistic	Probability	Max-Eigenvalue Statistic	Probability
None	43.64528	0.0001	35.12316	0.0001
At most 1	8.522116	0.1989	5.434193	0.4185
At most 2	3.087923	0.0934	3.087923	0.0934

Table 6. Tests of cointegration between deposits, GDP and the reference interest rate over the period 1999Q1-2014Q4.

Hypothesized No. of cointegration equations	Trace Statistic	Probability	Max-Eigenvalue Statistic	Probability
None	32.87	0.003	24.95	0.004
At most 1	7.91	0.243	7.54	0.206
At most 2	0.38	0.601	0.38	0.601

Table 7. Cointegration equation between deposits (real), GDP (real) and the reference interest rate.

Estimation sample	
1999Q1-2019Q4	$d_t = \beta_0 + \underset{(0.123)}{0.86y_t} - \underset{(0.006)}{0.05i_t}$
1999Q1-2014Q4	$d_t = \beta_0 + \underset{(0.122)}{0.99y_t} - \underset{(0.005)}{0.05i_t}$

Note: d_t denotes the deposits, y_t denotes the GDP and i_t stands for the reference interest rate. Deposits and GDP are log-transformed.

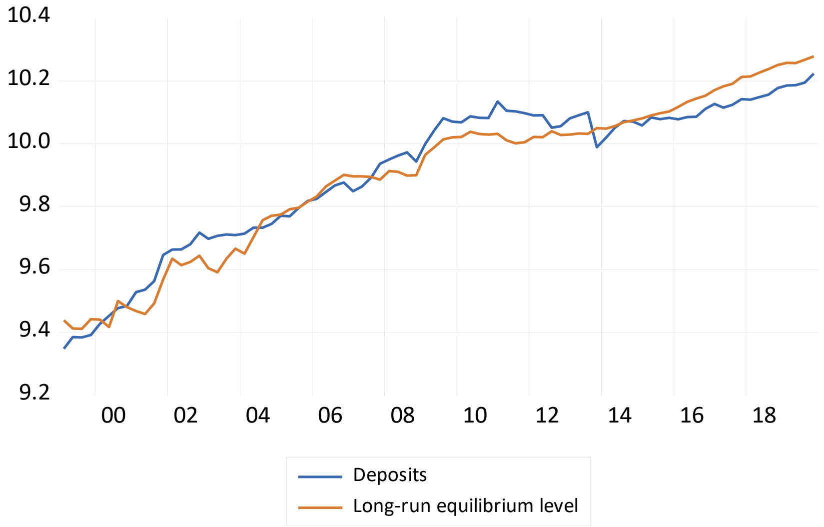
Table 8. Unit root test for the cointegration error in the model for deposits (total).

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.997404	0.0390
Test critical values:	1% level	-3.507394	
	5% level	-2.895109	
	10% level	-2.584738	

*MacKinnon (1996) one-sided p-values.

Note: the cointegration error is computed as the difference between the level of deposits and the long-run equilibrium level estimated for the period 1999Q1-2014Q4. The test refers to the period 1999Q1-2019Q4.

Figure 7. Deposits (in real terms, million EUR and log-transformed) and their long-run equilibrium level.



Note: the long-run equilibrium level is the predicted value of deposits obtained from the cointegration relationship between deposits, GDP and the reference rate estimated over the sample 1999Q1-2014Q4 (see Table 7).

Next, we estimate a VEC-model including the GDP, the reference rate and the aggregate volume of deposits (with GDP and deposits in real terms and log-transformed). We apply the same short-run restrictions described in section 3.1 and we compute the impulse response functions to a permanent income shock, a permanent interest rate shock and a residual transitory shock specific to deposits that we interpret broadly as a depositors' preference shock, although it encompasses also the more specific liquidity shocks to depositors (as in the previous section). We allow for a broader interpretation of these transitory shocks for the following reasons. Liquidity shocks affecting depositors can cause a shift from long-term deposits to shorter term deposits, with no effect on the total volume of depositors. However, the total volume of deposits might increase, even with no change in income and interest rates, if there is a higher preference for deposits. This can occur, for instance, if there is uncertainty in the economy and savers prefer to keep their saving in deposits, because they are protected by the Deposit Guarantee Scheme. The results are qualitatively the same as in the case of short-term deposits (Figure 8).

Namely, a positive permanent shock to output causes a permanent increase in the interest rate and in deposits. As explained in section 3.1, the positive response of the interest rate reflects the fact that the cost of capital (captured here by the reference interest rate) depends on its productivity and a positive permanent shock to output can interpreted as a positive productivity shock, which in turn translates into a higher cost of capital. The positive response of deposits to the income shock is made of two components. First, the positive response of the short-term deposits, which represents the increase in the demand for liquidity for transaction purpose. Second, the positive response of saving that flows into deposits with longer maturity. Furthermore, a positive standard deviation shock to the interest rate (roughly a 40 basis point increase) has a small permanent effect on the total volume of deposits, which undergo a permanent decrease by 1.5%. Moreover, the transitory preference shock moving the deposits has a small effect on real GDP and insignificant effect on the interest rate.

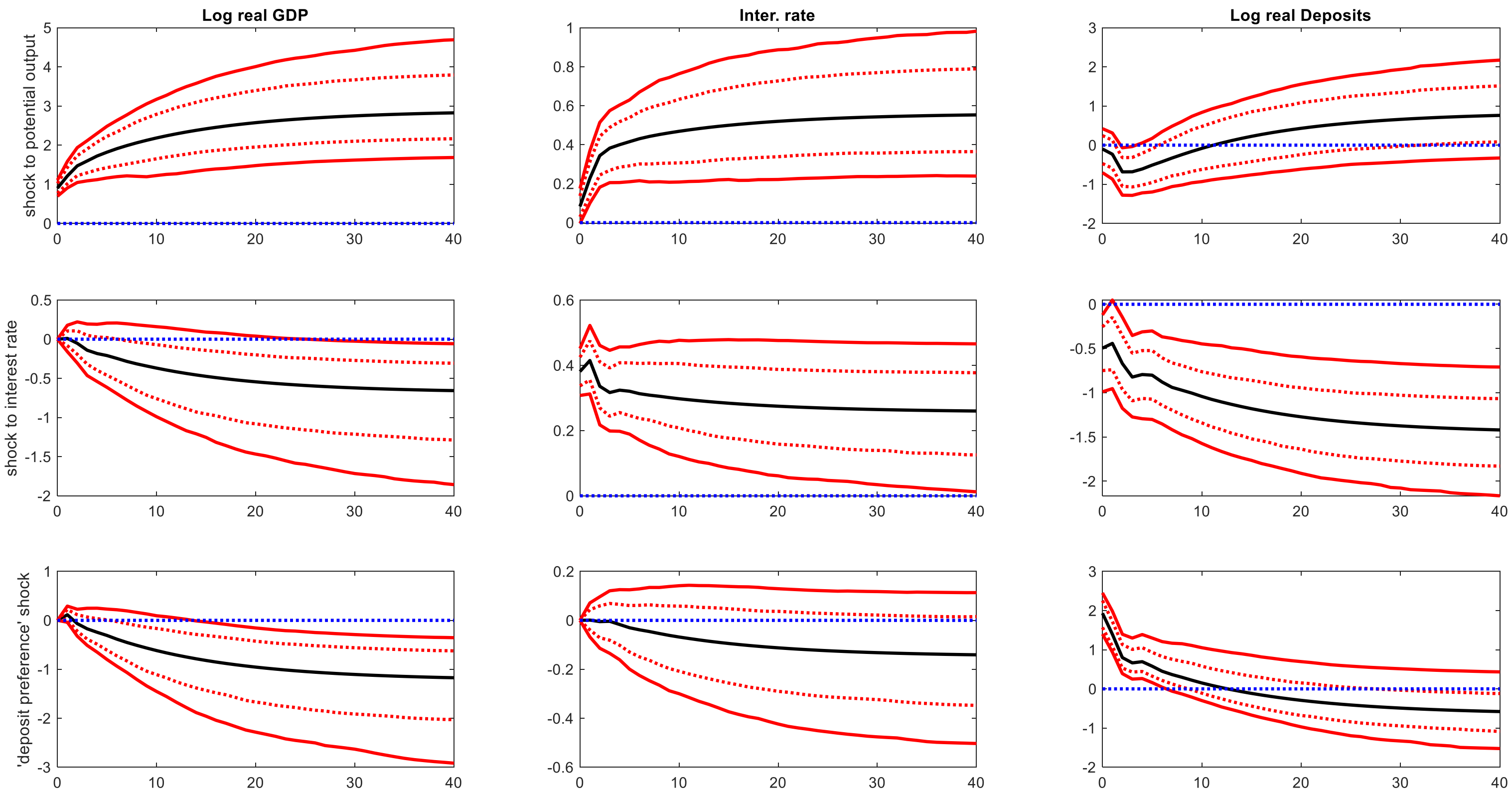
Finally, we assess the impact on the total volume of deposits of the simulated normalization of the interest rates, as described in section 3.1 (Figure 9). The impact on the aggregate deposits does not differ significantly from the impact on the short-term deposits. In response to the simulated rise in the reference interest rate, deposits are expected to decrease by 1.6% in the first four quarters, by 4% in the first eight quarters and by 15% in the twenty quarters of gradual upward adjustment of the interest rate. The deposits will continue to decrease smoothly until reaching a decrease by roughly 22.5% after 40 quarters since the start of the process of normalization of the interest rate in our simulation.

4. Concluding remarks

In this paper, we analysed the dynamic interrelations between deposits, GDP and a reference interest rate in Slovenia. The results suggest that the demand for deposits by Slovenian households and non-financial companies has remained stable during the low interest rate period. Deposits are positively related to GDP and negatively related to the general level of the interest rates. The response to a permanent and positive shock to the interest rate by one standard deviation (i.e. by 40 basis points) has a small effect on (total) deposits, which undergo a permanent fall by 1.5%.

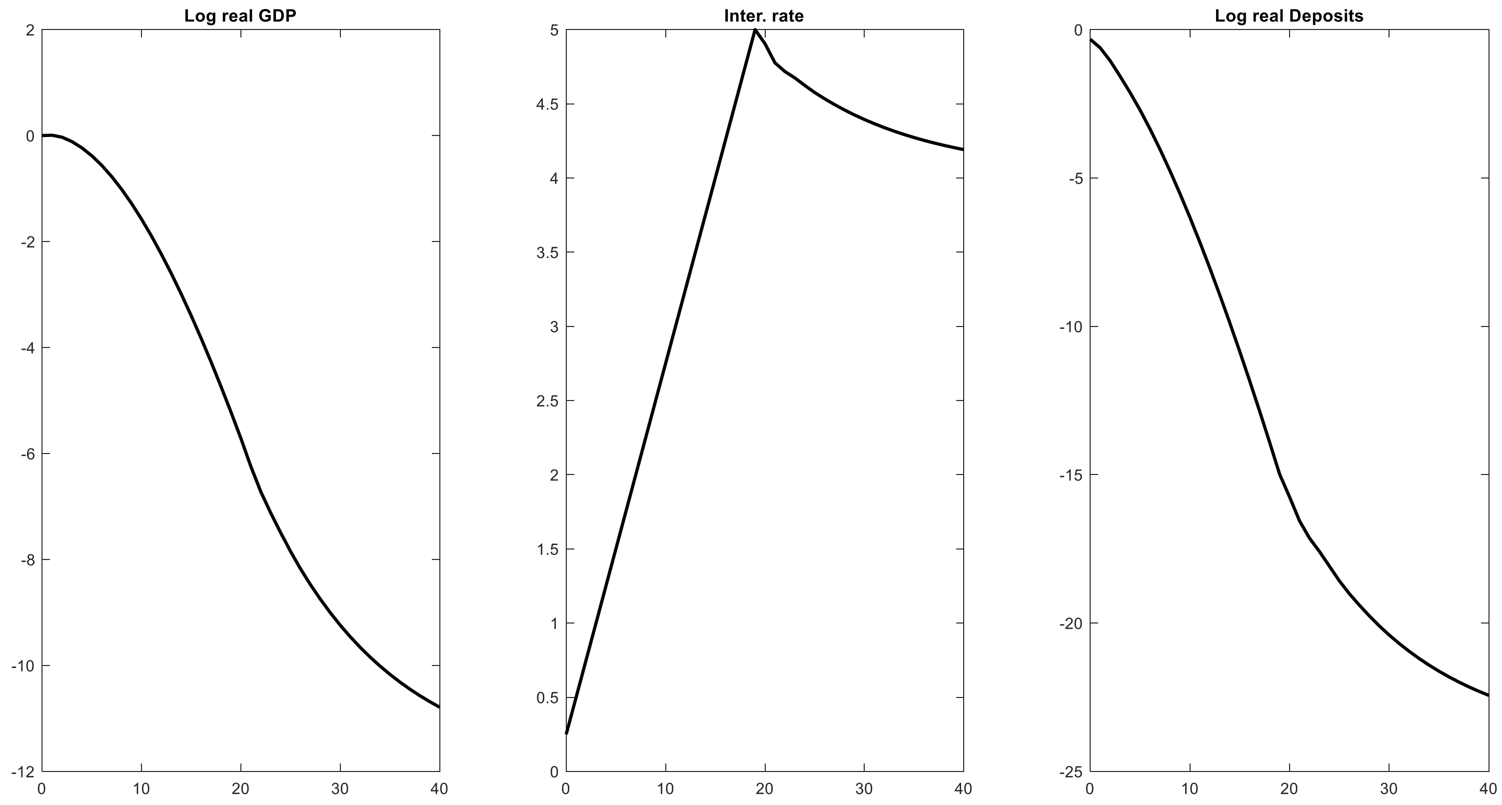
We also conduct a simulation exercise by assuming that a gradual normalization of the interest rates is carried out by increasing the reference rate by 25 basis points each quarter for twenty subsequent quarters. The results of the simulation indicate that deposits will decrease smoothly in response to the normalization of the interest rates. Banks are expected to face a decrease in deposits by 15% after 20 quarters of upward adjustments of the interest rates. Although the size of the outflow cannot be ignored, the estimated speed at which it is expected to occur is rather low, so that banks are deemed to be able to cope, by raising funding from alternative sources.

Figure 8. Impulse response functions identified through short-run restrictions on the VEC-model for deposits (total).



Note: GDP and deposits are in real terms and log-transformed, therefore the IRFs represent their growth rate (in %, in real terms), in response to shocks. The interest rate variable is in percentage points. Black line represent the estimated IRFs. Red lines (dashed lines) represent the bootstrapped 90% (68%) confidence bands.

Figure 9. Simulation of a gradual increase in the reference interest rate: impact on deposits from non-financial sector customers.



Note: GDP and deposits are in real terms and log-transformed, therefore their simulated path represent their growth rate (in %, in real terms), in response to a sequence of shocks to the reference interest rate. The interest rate variable is in percentage points.

References

Altermatt S. and L. Benati (2017), “What Drives Money Velocity?”.

Ando A. and K. Shell (1975), “The Demand for Money in a General Portfolio Model in the Presence of an Asset that Dominates Money” in Fromm G. and L.R. Klein (eds.), The Brookings Model: Perspective and Recent Developments, North-Holland, Amsterdam, pp. 560-563.

Baba Y., D. Hendry and R. Starr (1992), “The Demand for M1 in the USA, 1960-1988”, Review of Economic Studies, Vol. 59 (1), pp. 25-61.

Ball L. (2001), “Another Look at Long-Run Money Demand”, Journal of Monetary Economics, 47, 31-44.

Benati L., R.E. Lucas, J.P. Nicolini and W. Weber (2016), “International evidence on long run money demand”, NBER Working Paper Series, No. 22475.

Bernanke B.S. and A.S. Blinder (1992), “The federal funds rate and the channels of monetary transmission”, The American Economic Review, 901-921.

Beyer A. (2009), “A stable model for euro area money demand: Revisiting the role of wealth”, ECB Working Paper Series, No 1111.

Brand C. and N. Cassola (2000), “A Money Demand System for Euro Area M3”, ECB Working Paper No. 39 (Frankfurt: European Central Bank).

Calza A., D. Gerdesmeier and J. Levy (2001), “Euro Area Money Demand: Measuring the Opportunity Costs Appropriately”, IMF Working Paper WP/01/179.

Carstensen K. (2006), “Stock market downswing and the stability of European Monetary Union money demand”, Journal of Business and Economic Statistics, 25: 395-402.

Choudhry T. (1996), “Real stock prices and the long-run money demand function: Evidence from Canada and the USA”, Journal of International Money and Finance, 15: 1-17.

Coenen G. and J. L. Vega (1999), “The Demand for M3 in the Euro Area”, ECB Working Paper No. 6 (Frankfurt: European Central Bank).

Damjanovic M. (2019), “A Country perspective on the Monetary Policy Transmission in the Euro Area: the Case of Slovenia”, Banka Slovenije Working Paper 1/2019.

Debola L., E. Gaiotti and L. Silipo (2001), “Money Demand in the Euro Area: Do National Differences Matter?”, Banca d’Italia, Temi di Discussione, No. 405.

De Sanctis R.A., C.A. Favero and B. Roffia (2012), “Euro Area Money Demand and International Portfolio Allocation: A Contribution to Assessing Risks to Price Stability”.

Diamond D.W. and P.H. Dybvig (1983), “Bank Runs, Deposit Insurance and Liquidity”, Journal of Political Economy, Jun. 1983, Vol. 91, No. 3, pp. 401-419.

Friedman M. (1956), “The Quantity Theory of Money: A Restatement”, in Friedman M. (ed.), Studies in Quantity Theory of Money, Chicago University Press, pp. 3-21.

Friedman M. (1959), “The Demand for Money: Some Theoretical and Empirical Results”, Journal of Political Economy, Vol. 67, August, pp. 327-351.

Friedman M. (1988), “Money and the stock market”, Journal of Political Economy, 96: 221-245.

Friedman B. M. and K.N. Kuttner (1992), “Money, Income, Prices and Interest Rates”, American Economic review, 82(3), 472-492.

Gerlach J.R., N. Mora and P. Uysal (2017), “Bank funding costs in a rising interest rate environment”.

Golinelli R. and S. Pastorello (2002), “Modelling the demand for M3 in the euro area”, European Journal of Finance, 8, 371-401.

Gonzalo J. and T. H. Lee (1998), “Pitfalls in Testing for Long-Run Relationships”, Journal of Econometrics, Vol. 86, pp. 129-154.

Keynes, J. M. (1936). “The General Theory of Employment, Interest and Money”, London: Macmillan (reprinted 2007).

Koivu M., T. Pennanen and W.T. Ziemba (2005), “Cointegration analysis of the FED model”, Finance Research Letters, 2: 248-259.

Lander J., A. Orphanides and M. Douvogiannis (1997), “Earnings, forecasts and the predictability of stock returns: evidence from trading the S&P”, Journal of Portfolio Management, 23: 24-35.

Levy J. (1999), “Own Return of M3 and the Demand for Money in the Euro Area”, ECB, mimeo (Frankfurt: European Central Bank).

Muller C. and E. Hahn (2000), “Money Demand in Europe: Evidence from the Past”, Discussion Paper No. 204, Deutsches Institut fur Wirtschaftsforschung, Berlin, April.

Papademos L.D. and J. Stark (2010), ECB, mimeo (Frankfurt: European Central Bank).

Selden R.T. (1956), “Monetary Velocity in the United States” in M. Friedman (ed.), Studies in the Quantity Theory of Money, University of Chicago Press, pp. 405-454.

Terasvirta T. and A.C. Eliasson (2001), “Non-linear error correction and the UK demand for broad money, 1878-1993”, Journal of Applied Econometrics, 16: 277-288.