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Bank of Finland
Research

Bank of Finland Research Discussion Papers
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The Effect of TLTRO-II on Bank Lending[*]

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This version: March 2020

Abstract

This study estimates the effect of the European Central Bank's second series of targeted longer-term refinancing operations (TLTRO-II) on bank lending using bank level data from multiple countries and instrumental variable estimation. Effects on corporate loans and loans for consumption are analysed separately. The cumulative effect of TLTRO-II on participating banks' stock of corporate loans is estimated to be about 20 per cent. The effect on lending for consumption is found close to zero. The positive effects on corporate loans are found to be driven by crisis countries indicating that the effectiveness of monetary policy depends on the economic conditions. Additionally, the effect on government bond purchases is found negative. This result is very different from the earlier results regarding non-targeted liquidity operations.

Keywords: TLTRO, unconventional monetary policy, credit supply, euro area

JEL codes: E44, E51, E52, G21

1.　　　　Introduction

When policy rates have been close to the effective lower bound, central banks have adopted a range of unconventional tools to stimulate the economy. One channel through which these tools operate is bank lending.[1] The unconventional tools have included providing banks with cheap long-term credit. For example, the European Central Bank (ECB) has conducted several longer-term credit operations that have been geared to increasing bank lending to the non-financial private sector in order to stimulate activity in the real economy and accelerate euro area inflation. For example, Andrade, Cahn, Fraisse, and Mésonnier (2018) find that these operations have increased bank lending to non-financial corporations. Though the earlier literature has provided some evidence that support the effectiveness of these tools, many questions have remained unanswered.

For example, the literature has not studied the effects of these liquidity operations to other types of loans. Because the credit market is quite different for households and firms, it is likely that the liquidity operations have very different effects on lending to non-financial corporations and lending to households. In addition, the earlier literature has focused on the effects in single countries, though the effects may be very different in different economic conditions.[2]

In this paper, I show that the ECB's liquidity operations have boosted lending to non-financial corporations, but not the lending to households for consumption. In addition, I show that the positive effects on corporate lending are largely driven by crisis countries. The results are obtained using novel properties of the ECB's second series of targeted longer-term refinancing

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[1] See for example Jiménez, Ongena, Peydró and Saurina (2012), Rodnyansky and Darmouni (2017), Altavilla, Canova and Ciccarelli (2019), Di Maggio, Kermani and Palmer (2019).
[2] García-Posada and Marchetti (2016) study the effects in Spain, Andrade et al., (2018) in France, Benetton and Fantino (2018) and Carpinelli and Crosignani (2018) in Italy.

operations (TLTRO-II). The effects are studied applying a difference-in-differences estimation and using a bank level dataset from multiple countries.[3]

The approach faces two central identification issues. First, banks could choose whether to participate in TLTRO-II or not. Second, one must disentangle credit supply from credit demand.

The first issue is tackled by utilising the institutional setting of TLTRO-II. First, TLTRO-II, launched in June 2016, was mainly used to replace earlier TLTROs that were mainly borrowed in 2014 and in the beginning of 2015.[4] Therefore, the borrowing from the ECB prior TLTRO-II is highly correlated to the borrowing in TLTRO-II, and hence, a strong instrumental variable. The amount of earlier TLTROs is also a valid instrument as it is quite difficult for a bank to forecast its lending opportunities multiple years ahead. In addition, in the first series of TLTROs, the incentive structure was such that it motivated banks to increase their lending at very beginning of the operations.[5] Therefore, it is probable that participation in TLTRO-I was not affected by the expected lending opportunities during the years 2016-2018. Thereby, the amount of TLTRO-I is a valid instrument for the amount of TLTRO-II. As a proxy for the amount of earlier TLTROs, I use the total loans from the ECB prior TLTRO-II as at the time almost all credit from the ECB was TLTROs.

The institutional setting provides also another potential instrumental variable. The maximum amount a bank could borrow in TLTRO-II was based on its amount of loans to non-financial corporations and loans for consumption (so called eligible loans) in January 2016. This constraint was predetermined by the ECB and hence exogenous. Thus, the amount of eligible

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[3] The data are from Austria, Belgium, Cyprus, Estonia, Germany, Greece, Finland, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain. The data cover the period from January 2015 to July 2018.

[4] In the initial operation of TLTRO-II in June 2016, banks borrowed 399 billion euros. Nevertheless, the total stock of TLTROs increased only by 38 billion euros.

[5] In TLTRO-I, the participating banks were motivated to increase their eligible lending by promising a possibility to borrow more TLTRO credit if they increased lending. Because all TLTRO-I credit had to be paid back in 2018, the incentive structure motivated banks to increase their lending in the beginning of TLTRO-I. The reason for this is that the last operations of TLTRO-I had only a maturity of about two years. Thus, it was reasonable to increase lending as early as possible, and then be able to borrow more TLTRO credit with a long maturity.

loans in January is another potential instrument for the participation in TLTRO-II. A similar identification strategy is used by Benetton and Fantino (2018) to analyse the effects of TLTRO-I. In addition to the instrumental variables, the paper considers propensity score matching as a robustness check, and shows that the results are robust to controlling for many observable variables.

When it comes to controlling for credit demand, a standard approach has been to add firm-time fixed effects à la Khwaja and Mian (2008). Related to this approach, credit demand is controlled for using country-time fixed effects in the baseline analysis. To assess the robustness of the results, I exploit the novel feature of TLTROs that loans for house purchase were excluded from the eligible loans. Therefore, it is probable that the variation in the amount of loans for house purchase is driven by credit demand. As a robustness check, I use loans for house purchase as proxy for credit demand. The results are robust in this respect.

The results regarding the effect on lending to non-financial corporations are in line with the earlier literature (e.g. Andrade et al., 2018). However, the results show that the effect is driven by crisis countries. This suggests that the effectiveness of longer-term refinancing operations depends on the economic conditions under which they are implemented. The result is novel as there are no earlier studies that use bank level information about longer-term refinancing operations from multiple countries to analyse the effects on bank lending.

In addition, the earlier studies concerning the effects of TLTROs on bank lending behaviour only deal with the effects on lending to non-financial corporations. However, TLTROs were targeted on loans to non-financial corporations and loans for consumption. Loans for house purchases were excluded. Therefore, it is reasonable to expect that different types of loans are affected differently. The results show that TLTRO-II increased corporate lending. Instead, the effect on loans for consumption is found close to zero. This finding is interesting as the ECB did not favour corporate loans over loans for consumption.

The results also show that TLTRO-II did not increase participating banks' sovereign bond purchases. Instead, the effect is found negative. Crosignani, Faria-e-Castro and Fonseca (2019) find that the earlier VLTROs were largely used to buy government bonds, which was possibly unintended.[6] Thus, the results suggest that the ECB's targeting strategy was effective in this respect.

The remainder of the paper is as follows. Section 2 represents the main features of TLTRO-II. Section 3 describes the data. Section 4 represents the methodology. Section 5 shows the results. Section 6 concludes.

2.   TLTRO-II

TLTRO-II was launched in June 2016 to ease private-sector credit conditions and stimulate credit creation. Four operations, one each quarter, were conducted, with the final operation taking place in March 2017. TLTRO-II loans carry a maturity of four years, so e.g. the first operation matures in June 2020. The borrower banks are also able to repay voluntarily the amounts borrowed at a quarterly frequency starting two years from the settlement of each operation.

Banks could borrow a total amount of up to 30 per cent of a specific eligible part of their loans in January 2016, less any amount previously borrowed and still outstanding under the first two TLTRO-I operations in 2014. Eligible loans included loans to non-financial corporations and households (excluding loans to households for house purchase).

The interest rate of the operations was fixed to match that of main refinancing operations (MROs) prevailing at the time of allotment. Nonetheless, the participating banks were given an incentive to increase their eligible lending by promising a lower rate if the eligible lending was increased enough in the period between February 2016 and January 2018 in comparison to bank

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[6] According to their estimates, VLTRO made banks to buy short-term bonds worth about 11 per cent of the amount outstanding and long-term bonds worth about 3 per cent of the amount outstanding.

specific benchmark. The lowered rate could be as low as the rate on the deposit facility (-0.40 per cent).

The bank-specific benchmark depended on eligible net lending as follows. For the banks with positive eligible net lending in the 12-month period before January 2016, benchmark net lending was set at zero. For the banks with negative eligible net lending, benchmark net lending was the same as eligible net lending in the 12-month period before January 2016.

The incentives in TLTRO-II to increase eligible lending differed from the incentives in TLTRO-I. In TLTRO-I, the banks were pushed to increase their lending by offering them more TLTRO-I credit when they increased their eligible lending. However, the banks were able to reduce their lending after they had borrowed their preferred amount of TLTRO-I credit. A key difference between TLTRO-I and TLTRO-II was also the maturity. TLTRO-I credit borrowed in September 2014 matured after four years, but the last operation of TLTRO-I matured after about two years. The key differences between VLTRO and TLTRO operations are summarised in Table 1.

[TABLE 1]

3. Data

The main data are taken from the ECB's individual balance sheet items (IBSI) database. The data are monthly and at bank level. The used data are from January 2015 to July 2018. The IBSI data are linked to confidential information about bank's total borrowing in TLTRO-II.

IBSI data offer several advantages. First, they make it possible to analyse TLTRO-II in multiple countries. Additionally, as the data are monthly and cover a sufficiently long time period after the treatment, it is possible to analyse how possible effects evolve over time. While IBSI does not cover all euro area banks the sample is quite large and includes about 300 large banks that are from all the euro area countries. The final dataset covers 187 banks from 18 countries due

to missing data.[7] However, the data are still quite representative as the interpreted bank covered about 62 per cent of the total corporate loans in the euro area prior TLTRO-II. Some key descriptive statistics of the assessed banks, grouped by the decision to participate TLTRO-II, are shown in Table 2.

[TABLE 2]

Figure 1 shows the average development of loans to non-financial corporations, loans for house purchase and loans for consumption by groups. The solid lines show the development of the TLTRO banks and dashed lines the developments of non-TLTRO banks. The TLTRO banks increased corporate lending compared to other banks after the beginning of TLTRO-II. Instead, it is rather difficult to observe significant diverging in other types of loans.

[FIGURE 1]

Figure 2 shows the average development of loans to non-financial corporations, loans for house purchase and loans for consumption among the banks that participated in TLTRO-II. Now, the grouping is based on the share of TLTRO-II in total liabilities. The size of balance sheet is from May 2016 (before TLTRO-II). The solid lines show the development of the banks that had the share of TLTRO-II above the median and dashed lines the developments of the banks that had a ratio below the median. The differences between groups remain rather constant. This suggests that the allotted amount of TLTRO-II was not essential.

[FIGURE 2]

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[7] All the banks that have missing data from necessary variables are excluded. Also, banks that experience periods during which they have not had any corporate credit, loans for consumption or loans for house-purchase are excluded because these variables are analysed in logs. This sample selection limits generalisation of the results, but makes the analysed banks more alike. All the banks from France are excluded because the data about central bank credit are missing.

This preliminary analysis has not taken into account the fact that banks could choose whether to participate in TLTRO-II or not. Additionally, this analysis has not considered the role of credit demand. These issues are assessed in the remaining sections.

4.　　　　Methodology

The paper applies a difference-in-differences approach to study the effects of TLTRO-II on bank lending. To be concrete, the baseline specification is:

$$\ln(Y_{ict}) = \alpha_{ic} + \tau_{ct} + x_{ict}'\beta + z_{ict}'\gamma + e_{ict}, \tag{1}$$

where Y_{ict} is the stock of credit on the balance sheet of bank i in country c at time t, α_{ic} includes bank fixed effects and τ_{ct} country-time fixed effects. The vector z_{ict} includes time-varying bank-specific control variables that are the size of balance sheet in logs and equity ratio in the baseline analysis. The vector x_{ict} includes interactions between a dummy that equals 1 if the bank participated in TLTRO-II and month-dummies: $TLTROII_{ic} * 2015Jan_t, \dots, TLTROII_{ic} * 2018Jul_t$. June 2016 is the reference month. This means that the regression coefficients in the vector β tell how the credit granted by TLTRO banks differed from other banks in a given month relative to the difference between the groups in June 2016.

A similar approach is used by Rodnyansky and Darmouni (2017) to investigate the effects of quantitative easing on bank lending behaviour in the United States. This specification is useful because it is not realistic to assume that the effect was the same in every month after treatment as is assumed in standard difference-in-differences models. If the effect was the same every month after treatment, it would mean that the stock of credit in TLTRO participant banks jumped immediately after June 2016 and remained the same thereafter. Additionally, the estimates for the interactions before the beginning of TLTRO-II should be zero. Otherwise, the assumption of common trends would not be credible. Adding these interactions in the regression allows testing the common trend assumption.

To assess whether the allotted amount of TLTRO-II was important, I use a specification slightly different from equation (1). The modified model is:

$$\ln(Y_{ict}) = \alpha_{ic} + \tau_{ct} + x'_{ict}\beta^* + z_{ict}'\gamma + e_{ict}, \qquad (2)$$

where x_{ict} includes interactions: $\log(TLTROII\ amount)_{ic} * 2015Jan_t, \dots, \log(TLTROII\ amount)_{ic} * 2018Jul_t$.

A central challenge in this study is justifying the assumption of common development of TLTRO banks and other banks if TLTRO-II had never been conducted. Banks were free to decide whether they wanted to borrow TLTRO-II credit or not, so banks that participated in TLTRO-II may have increased their lending anyway. The coefficients may also be biased downwards, if participating banks had strong deleveraging pressures.

To mitigate this selection bias, I use instrumental variable estimation. I utilise two different novel properties of TLTRO-II. First, TLTRO-II was mainly used to replace earlier TLTROs. In May 2016, TLTRO-I covered about 83 per cent of the total credit from the ECB. Therefore, the amount of credit from the ECB prior TLTRO-II is highly correlated to the amount borrowed in TLTRO-II. It is also unlikely that the amount borrowed from the ECB prior TLTRO-II had a direct effect on bank lending during TLTRO-II as explained in the introduction. In equation (1), where the treatment is binary, I use $\frac{Credit\ from\ the\ ECB\ in\ May\ 2016}{Balance\ sheet\ in\ May\ 2016}_{ci}$ as an instrument for the participation in TLTRO-II. In equation (2), the used instrument is $\log(Credit\ from\ the\ ECB\ in\ May\ 2016)_{ci}$.

Another novel property of TLTRO-II is the fact that the amount a bank could borrow was predetermined by the ECB. This property provides another potential instrumental variable. Because all the banks in the sample had eligible loans in January 2016, the share of eligible loans in total assets is a weak instrument. Therefore, the amount of eligible loans is used as an

instrument only in equation (2) where the treatment is continuous. Specifically, the used instrument is $\log(Eligible\ loans\ in\ January\ 2016)_{ci}$.

In addition to the selection bias, another problem is the role of credit demand which is difficult to control for. Many earlier studies have utilised the approach of Khwaja and Mian (2008) and controlled the demand at firm level. Because I have no data about firms or households that had loans from multiple banks I use country-time fixed effects. The problem in the approach of Khwaja and Mian (2008) and country-time fixed effects is the possibility of capturing supply side effects as well. If TLTROs increased the lending of all the banks and not just the lending of participating banks, then country-time fixed effects (or firm-time fixed effects) would unintendedly capture these indirect effects as well. The problem with country-time fixed effects is also the assumption that all the banks within a country faced identical credit demand. To mitigate these concerns, I test the robustness of my results replacing τ_{ct} by τ_t and adding $log(Loans\ for\ house\ purchase)_{ict}$ into the vector of control variables, z_{ict}. The idea behind this control variable is the following. Loans for house purchase were excluded from the eligible loans. Therefore, it could be possible that changes in loans for house purchase actually reflect only changes in credit demand.

5.   Results

5.1   Baseline results

First, I estimate equation (1) using 2SLS. The instrument I use is the average share of central bank credit in total liabilities in May 2016. Specifically, I instrument the interactions x_{it} by

$$\frac{Credit\ from\ the\ ECB\ in\ May\ 2016}{Balance\ sheet\ in\ May\ 2016}_{ci} * 2015Jan_t, \dots, \frac{Credit\ from\ the\ ECB\ in\ May\ 2016}{Balance\ sheet\ in\ May\ 2016}_{ci} * 2018Jul_t.$$ The

banks that participated in the first series of TLTROs were likely to participate also in TLTRO-II. Therefore, it is not surprising that the F-statistics of the first-stage regressions are about 41. Thus, weak instruments are not an issue.

Figure 3 shows the estimated values of the vector β, i.e. the estimated effects of TLTRO-II in various months for different types of credit. The solid lines represent the point estimates, and the dashed lines 90 per cent confidence intervals. In every month before June 2016, the estimated effects do not differ from zero, which supports the common trend assumption. The effect on corporate loans is positive and statistically significant. F-statistic for the joint significance of interactions from July 2016 to July 2018 is 2.9 (p=0.001). The cumulative effect of TLTRO-II on participating banks' corporate lending is estimated to exceed 20 per cent. Instead, the estimated effect on loans for consumption is actually negative, though not statistically significantly. F-statistic for the joint significance of interactions from July 2016 to July 2018 is 0.6 (p=0.935). This is surprising as TLTROs were also targeted on loans for consumption.

[FIGURE 3]

In the sample, the banks that took up TLTRO-II had lent about 50 per cent of the outstanding corporate loans in June 2016. If this share could be generalised to the whole population and if TLTRO-II did not affect to the banks that did not participate, it would mean that TLTRO-II increased the total stock of corporate credit about 10 per cent cumulatively from June 2016 to July 2018.

5.2   The amount of TLTRO-II

So far, I have only considered the effects of a decision to participate in TLTRO-II. However, one might expect that the more a bank borrowed from the central bank, the more it increased its lending to non-financial corporations and to households for consumption. This kind of relationship is quite challenging to observe (see Figure 2). The correlation between TLTRO-II borrowing and growth in lending to non-financial corporations is practically zero (-0.02).

To further asses this relationship, I drop all banks that did not participate in TLTRO-II from the baseline analysis (entire control group) and add the natural logarithm of total TLTRO-II

borrowing to the vector of interactions, β (see equation (2)). In other words, I analyse only the banks that participated in TLTRO-II (97 banks) and group them by their TLTRO-II amounts. I instrument the (log) total take-up in TLTRO-II by the (log) amount of central bank credit in May 2016. Additionally, I use the (log) amount of eligible loans in January 2016 as an alternative instrumental variable.

Figure 4 shows the estimated effects. The estimates on the left-hand side are based on the amount of central bank credit in May 2016 and the estimates on the right-hand side are based on the amount of eligible loans in January 2016. The estimates based on eligible loans suggest that the allotted amount of TLTRO-II had an impact on bank lending. Instead, the estimates that are based on the amount of central bank credit are insignificant. The values of F-statistics for these two alternative instruments are about 14 and 269. Thus, assuming that both instrumental variables are valid, one should give more weight to the results based on the stronger instrument: amount of eligible loans in January 2016.

[FIGURE 4]

5.3 Cross-country differences

There are large cross-country differences when it comes to the state of banking sector or economic conditions. Therefore, it is likely that the effects of TLTRO-II were different in different countries. To assess this question, I calculate a dummy variable that equals 1 if the bank's home country is Spain, Italy, Greece or Portugal. These countries form a group that I call "crisis countries". I replace the interactions of vector x_{it} in equation (1) by interactions: $crisis_c * TLTROII_{ic} * 2015Jan_t, \dots, crisis_c * TLTROII_{ic} * 2018Jul_t$. This means that the treatment group consists of the banks that participated in TLTRO-II and were located in the crisis countries. Otherwise, model specification and estimation are as in the baseline analysis.

The coefficient estimates are shown in Figure 5. The results hint that the effect on bank lending has been stronger in the crisis countries than elsewhere. This result indicates that it is

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problematic to generalise results obtained from a single country to euro area level. There is definitely need for studies that analyse the effectiveness of the ECB's policy tools in multiple countries.

[FIGURE 5]

5.4   Effect on sovereign bond purchases

Crosignani et al. (2019) find that a large part of VLTROs went to buying sovereign bonds in Portugal. The fact that VLTROs was used to buy bonds in crisis countries was possibly one reason why the ECB chose to target its TLTROs. To investigate whether targeting worked as intended, I estimate the equation (1) as in the baseline analysis, but use the natural logarithm of sovereign bond holdings as a dependent variable and include crisis-dummy into vector x_{it} as in the previous section. The results are shown in Figure 6.

[FIGURE 6]

The results suggest that TLTRO-II worked as intended. TLTRO-II did not increase government bond holdings. Instead, the operations seem to have had a negative effect. However, the reason for this result is not necessarily the design of TLTRO-II. The different effect from Crosignani et al. (2019) might be driven, for example, by different macroeconomic conditions.

5.5   Robustness

As was shown earlier, the banks included in the sample were quite heterogeneous, for example, when it comes to their size (Table 2). To analyse, if the results are driven by the differences in the treatment and control group, I use propensity score matching. Specifically, I estimate a logit model that predicts the participation in TLTRO-II based on banks' observable characteristics before TLTRO-II. Thereafter, the banks that borrowed in TLTRO-II are matched with other banks based on their estimated likelihood to participate using nearest-neighbour algorithm with replacement and calliper of 0.1.

In the logit model, I include average growth rates of different types of lending before TLTRO-II to make the common trends assumption more reliable. I also include the average size of the banks before TLTRO-II as the participating banks were much larger than the others. Additionally, I also consider the share of cash, share of household deposits and equity ratio. The estimated logit model is reported in Table 3, and Figure 7 shows the results from the propensity score matching. The matching drops 7 banks from the treatment group (participants) and 40 from the control group (non-participants).

[TABLE 3]

[FIGURE 7]

The results from the baseline analysis with this subsample of banks is shown in Figure 8. The results remain roughly the same. Actually, the positive effect on corporate lending is now even more clearly statistically significant. The effect on lending for consumption is still close to zero and statistically insignificant.

[FIGURE 8]

Figure 9 shows the results when country-time fixed effects are replaced by time fixed effects and $log(Loans\ for\ house\ purchase_{ict})$ is added to the vector of control variables, z_{ict}. The estimation is done using the full sample. This modification lowers the estimate for the effect on corporate lending a bit. The estimated effect on lending for consumption is still close to zero and statistically insignificant.

[FIGURE 9]

6.   Conclusions

The results show that the effect of TLTRO-II on bank lending was positive. In particular, TLTRO-II boosted credit to non-financial corporations, while the effect on loans for

consumption is estimated to be close to zero and statistically insignificant. This result is surprising as TLTRO-II was targeted equally at both consumption lending and corporate lending. The explanation for the result might be related to, for example, differences in market power in different credit markets. Benetton and Fantino (2018) find some evidence that market power of banks lowers the effectiveness of TLTROs.

The results also suggest that the effects of TLTROs have not been the same in all the countries. According to the results, the effects have been strongest in countries most affected by the crisis. The results show as well that TLTRO-II did not increase the government bond purchases of the participating banks in crisis countries. Thus, the effect of TLTRO-II was quite different from the effect of the VLTROs (see Crosignani et al., 2019), and suggests that the targeting of credit operations mattered.

While TLTRO-II did not induce unwanted sovereign bond purchases, it does not mean that targeting is a policy panacea. Instead, the policy implication is that if a central bank wishes to target its credit operations, the design of TLTRO-II may provide a good point of departure.

References

Altavilla, C., Canova, F., & Ciccarelli, M. (2019). Mending the broken link: heterogeneous bank lending rates and monetary policy pass-through. *Journal of Monetary Economics*. In press.

Andrade, P., Cahn, C., Fraisse, H., & Mésonnier, J. S. (2018). Can the Provision of Long-term Liquidity Help to Avoid a Credit Crunch? Evidence from the Eurosystem's LTRO. *Journal of the European Economic Association*, 17(4), 1070-1106.

Benetton, M., & Fantino, D. (2018). Competition and the pass-through of unconventional monetary policy: evidence from TLTROs. *Bank of Italy Temi di Discussione*, 1187.

Carpinelli, L., & Crosignani, M. (2018). The Design and Transmission of Central Bank Liquidity Provisions. *mimeo*.

Crosignani, M., Faria-e-Castro, M., & Fonseca, L. (2019). The (unintended?) consequences of the largest liquidity injection ever. *Journal of Monetary Economics*. In Press.

Di Maggio, M., Kermani, A., & Palmer, C. J. (2019). How Quantitative Easing Works: Evidence on the Refinancing Channel. *mimeo*.

García-Posada, M., & Marchetti, M. (2016). The bank lending channel of unconventional monetary policy: The impact of the VLTROs on credit supply in Spain. *Economic Modelling*, 58, 427-441.

Jiménez, G., Ongena, S., Peydró, J. L., & Saurina, J. (2012). Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications. *American Economic Review*, 102(5), 2301-26.

Khwaja, A. I., & Mian, A. (2008). Tracing the impact of bank liquidity shocks: Evidence from an emerging market. *American Economic Review*, 98(4), 1413-42.

Rodnyansky, A., & Darmouni, O. M. (2017). The effects of quantitative easing on bank lending

behavior. *The Review of Financial Studies*, 30(11), 3858-3887.

Tables

Table 1. Main features of the ECB's longer-term refinancing operations in recent years.

	VLTRO	TLTRO-I	TLTRO-II
Implementation	2 operations (12/2011 and 2/2012)	8 operations between 9/2014 and 6/2016.	4 operations between 6/2016 and 3/2017.
Interest rate	Average MRO rate	First operations: MRO rate + 10bp at time of allotment. Subsequent operations: MRO rate only.	MRO rate at time of allotment. Possibility for lowered rate if eligible net lending increased sufficiently.
Maturity	Both operations carried maturities of 3 years.	All operations mature in 9/2018.	Every operation has a maturity of 4 years.
Amount	Full allotment	9/2014 and 12/2014: Max. 7 % of eligible loans in 4/2014. 2015-2016: Max. 3 x eligible net lending relative to bank-specific benchmark.	Max. 30 % of eligible loans in 1/2016, less any amount previously borrowed and still outstanding under the first two TLTRO operations in 2014.

Table 2. Descriptive statistics grouped by decision to participate in TLTRO-II.

The statistics are calculated from bank-level January 2015 to May 2016 averages, i.e. before TLTRO-II. Thus, statistics represent how the banks that participated in the credit operations and the other banks differed before treatment.

	TLTRO-II participant (n=97)		TLTRO-II non-participant (n=90)	
Variable	Mean	Median	Mean	Median
Balance sheet (million €)	106 989	40 043	72 290	14 203
Central bank credit to total liabilities	4.4 %	2.5 %	0.7 %	0.0 %
Household deposits to total liabilities	25.5 %	24.3 %	33.7 %	36.5 %
Equity ratio	10.4 %	9.1 %	10.0 %	8.2 %
Eligible credit to total assets	26.0 %	24.9 %	27.1 %	27.0 %

Table 3. Logit model used in the propensity score matching.

The used variables are calculated from bank-level January 2015 to May 2016 averages, i.e. before TLTRO-II.

	Participation in TLTRO-II
Predictors	*Log-Odds*
(Intercept)	-3.30 [*]
Dlog(Loans to non-financial corporations)	-0.96
Dlog(loans for house purchase)	-16.58
Dlog(loans for consumption)	1.97
log(Balance sheet)	0.33 [**]
Cash to total assets	-7.72
Household deposits to total liabilities	-0.91
Equity ratio	2.82
Observations	187
R^2 Tjur	0.100

* p<0.05   ** p<0.01   *** p<0.001

Figures

Figure 1. The development of different types of credit in the treatment (solid line) and control (dashed line) groups in comparison to the situation as of June 2016.

The credit stocks are in logs. The treatment group includes 97 banks and the control group 90 banks.
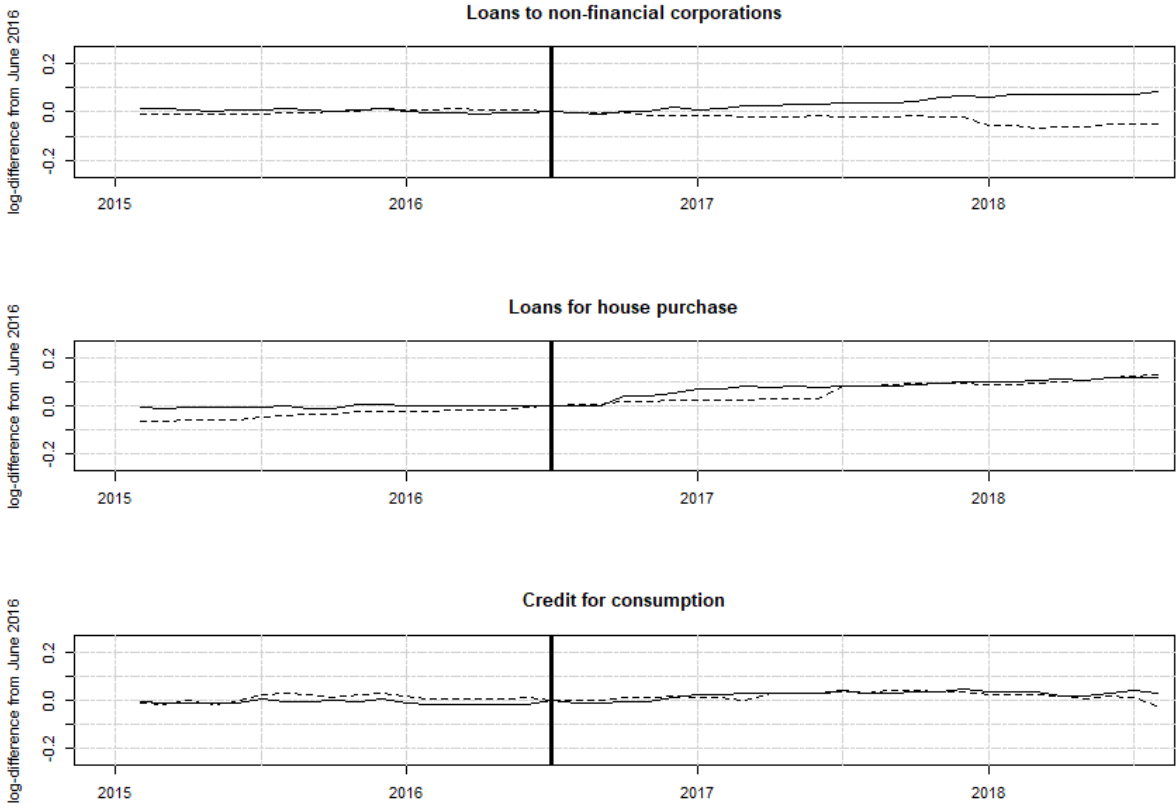
Figure 2. The development of different types of credit in the high-intensity participants (solid line) and low-intensity participants (dashed line) groups in comparison to the situation as of June 2016.

The credit stocks are in logs. The high-intensity group includes 49 banks and the low-intensity group 48 banks. High-intensity participants are those that had the ratio of TLTRO-II take-up to total liabilities (in May 2016) above the median. Low-intensity participants are the banks that borrowed in TLTRO-II, but had the ratio below the median.
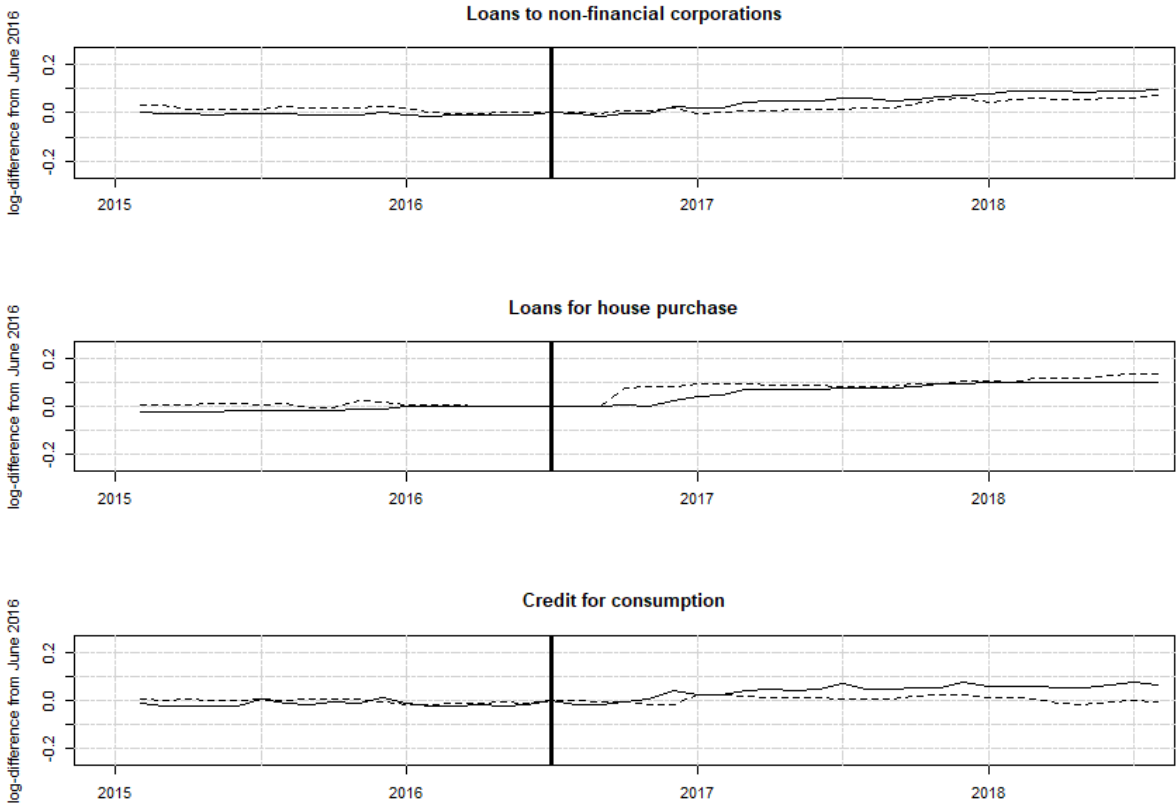
Figure 3. The estimated effects of TLTRO-II (parameters in vector β) on different types of credit.

The dashed lines represent 90 per cent confidence intervals. Standard errors are clustered at bank and month level. The share of central bank credit in total liabilities prior TLTRO-II is used as an instrument for participation in TLTRO-II.
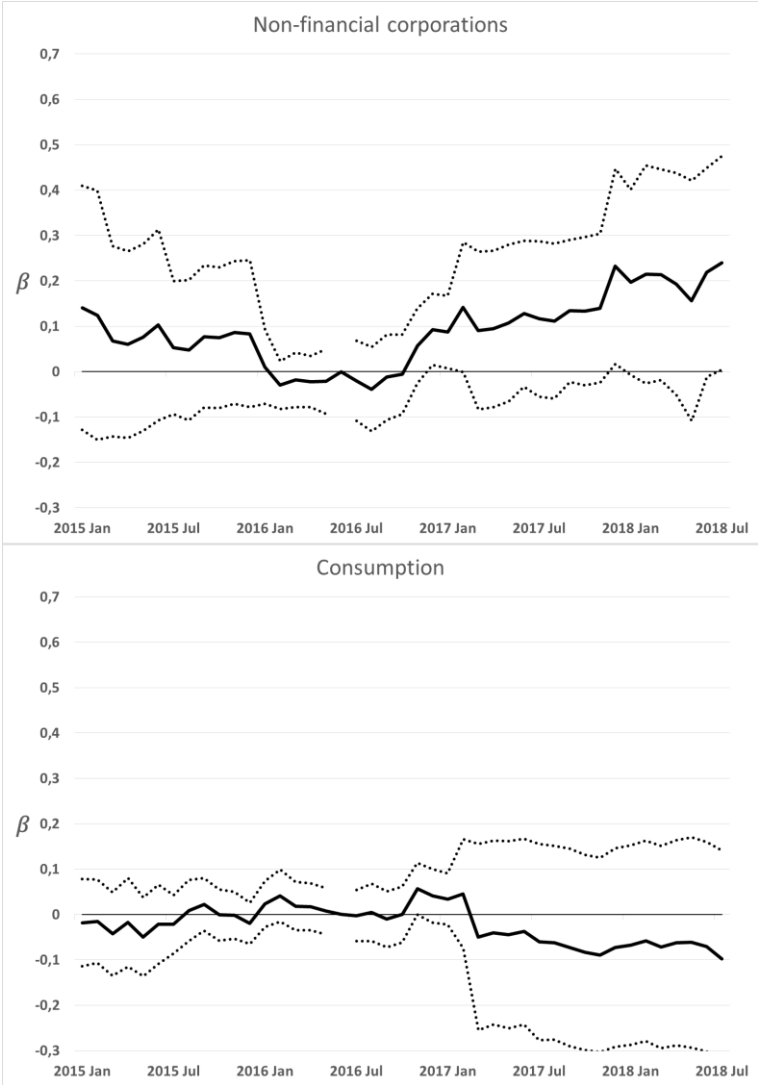
Figure 4. The estimated effects of the amount of TLTRO-II (parameters in vector β^*) on different types of credit.

The dashed lines represent 90 per cent confidence intervals. Standard errors are clustered at bank and month level. On left, the (log) amount of central bank credit prior TLTRO-II is used as an instrument for the (log) total borrowing in TLTRO-II. On right, the (log) amount of eligible loans in January 2016 is used as an instrument for the (log) total borrowing in TLTRO-II.
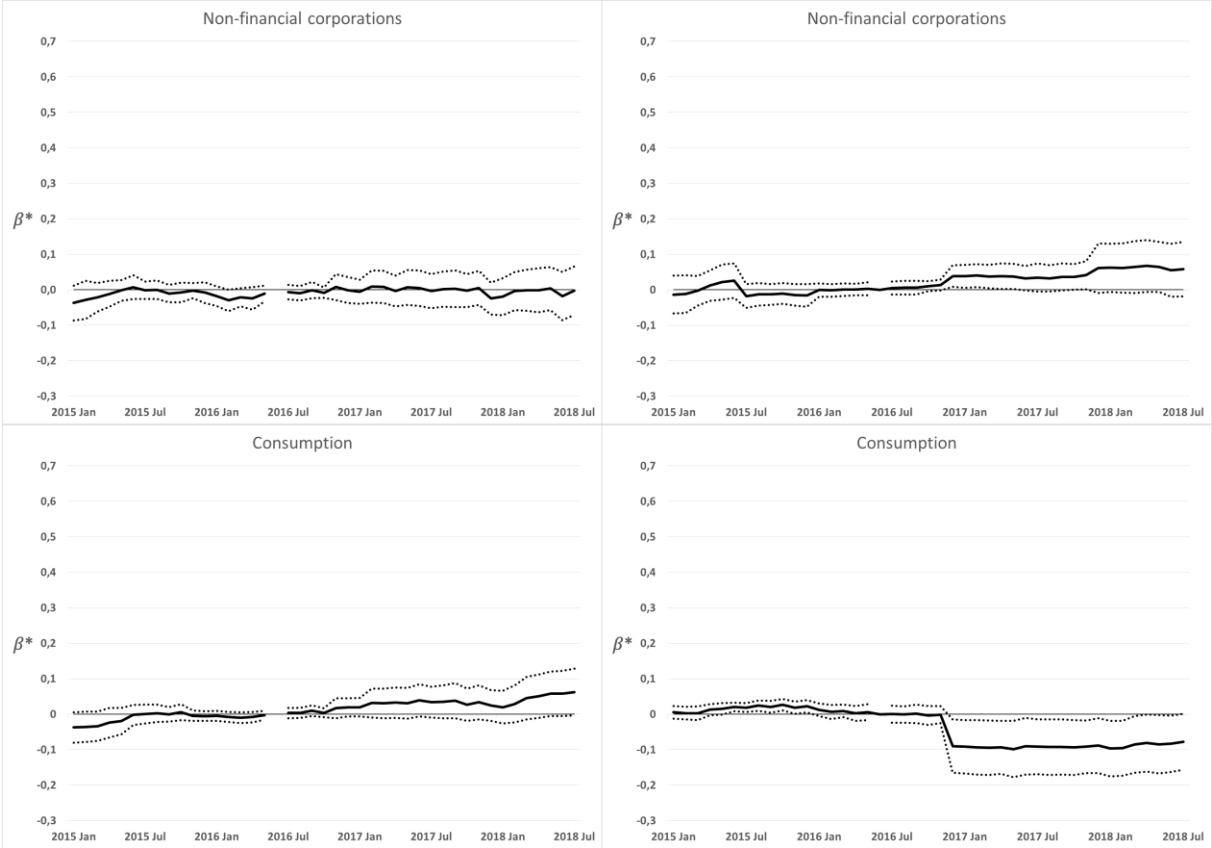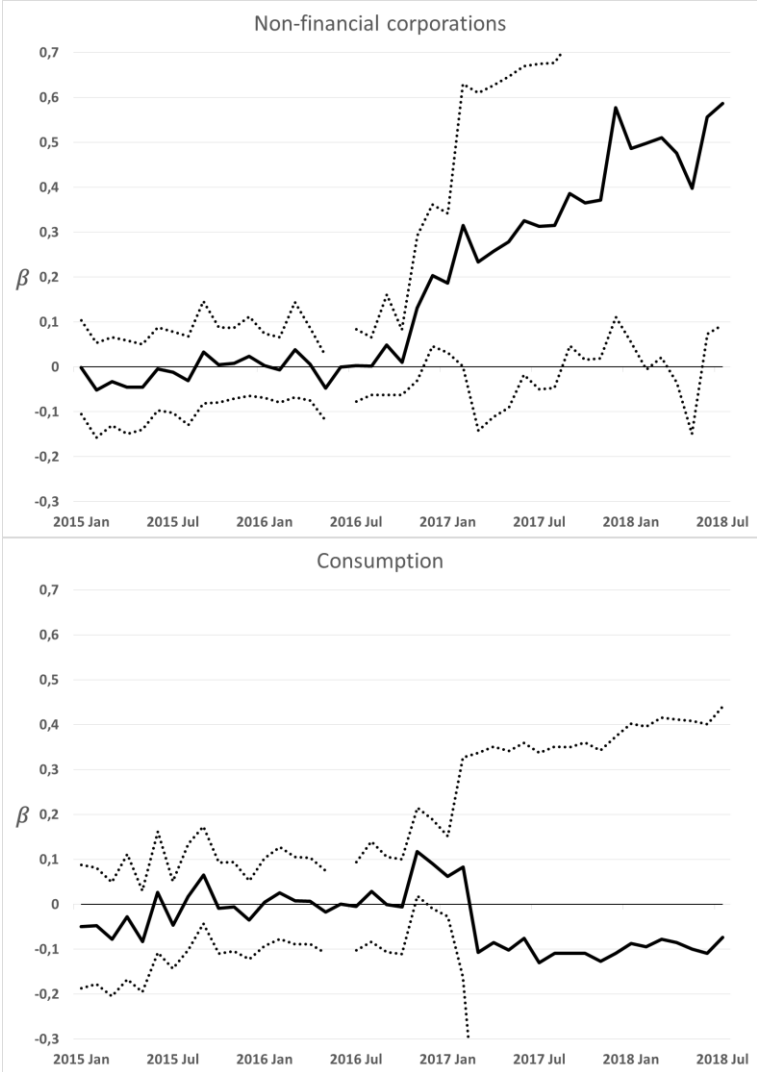
Figure 5. The estimated effects of TLTRO-II in crisis countries on different types of credit.

The treatment group consists of the banks that participated in TLTRO-II and are located in Spain, Italy, Greece or Portugal. The dashed lines represent 90 per cent confidence intervals. Standard errors are clustered at bank and month level. The share of central bank credit in total liabilities prior TLTRO-II is used as an instrument for participation in TLTRO-II.

Figure 6. The effect of TLTRO-II on sovereign bond holdings.

The endogenous variable is (log) government bond holdings. The treatment group consists of the banks that participated in TLTRO-II and are located in Spain, Italy, Greece or Portugal. The dashed lines represent 90 per cent confidence intervals. Standard errors are clustered at bank and month level. The share of central bank credit in total liabilities prior TLTRO-II is used as an instrument for participation in TLTRO-II.
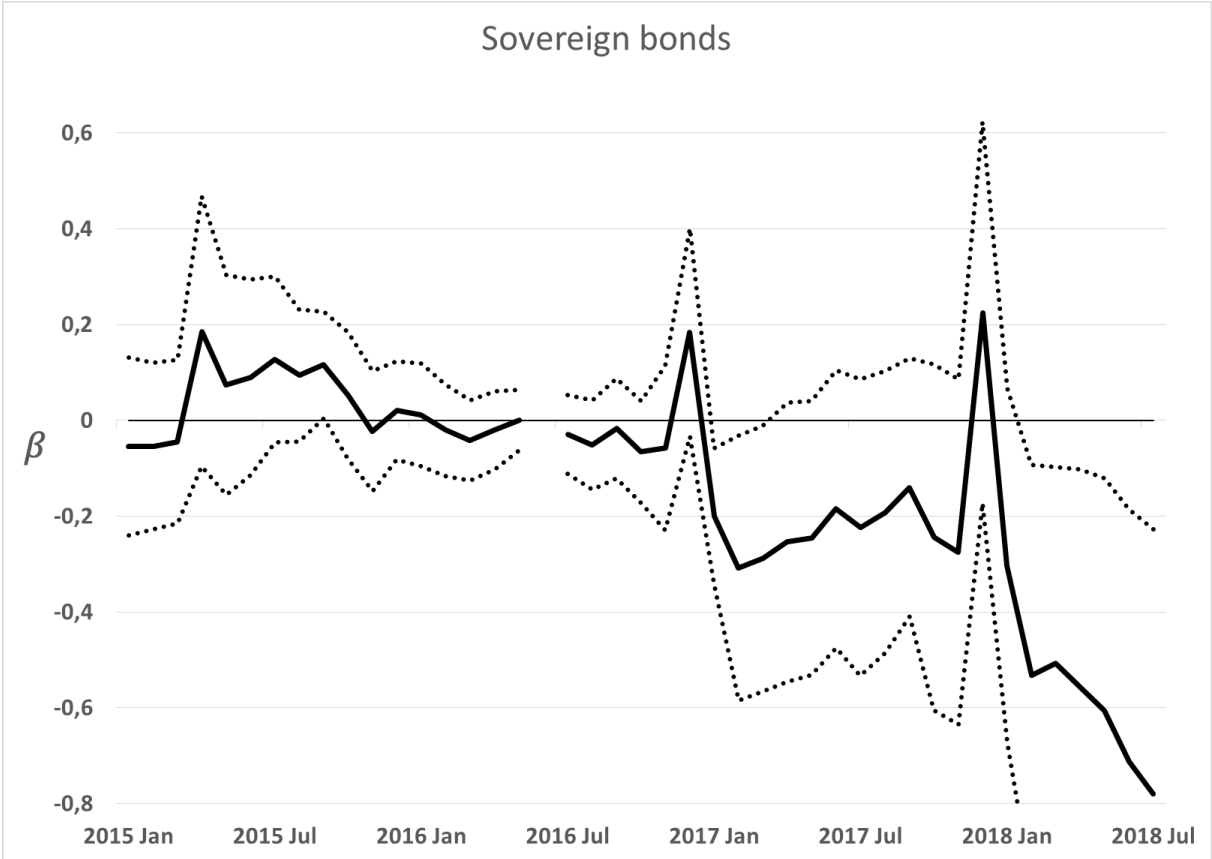
Figure 7. Results from propensity score matching.

The matching is done using nearest neighbor algorithm with replacement and 0.1 calliper. 7 banks are dropped from the treatment group and 40 from the control group. Thus, the final sample consists of 90 TLTRO banks and 50 other banks.
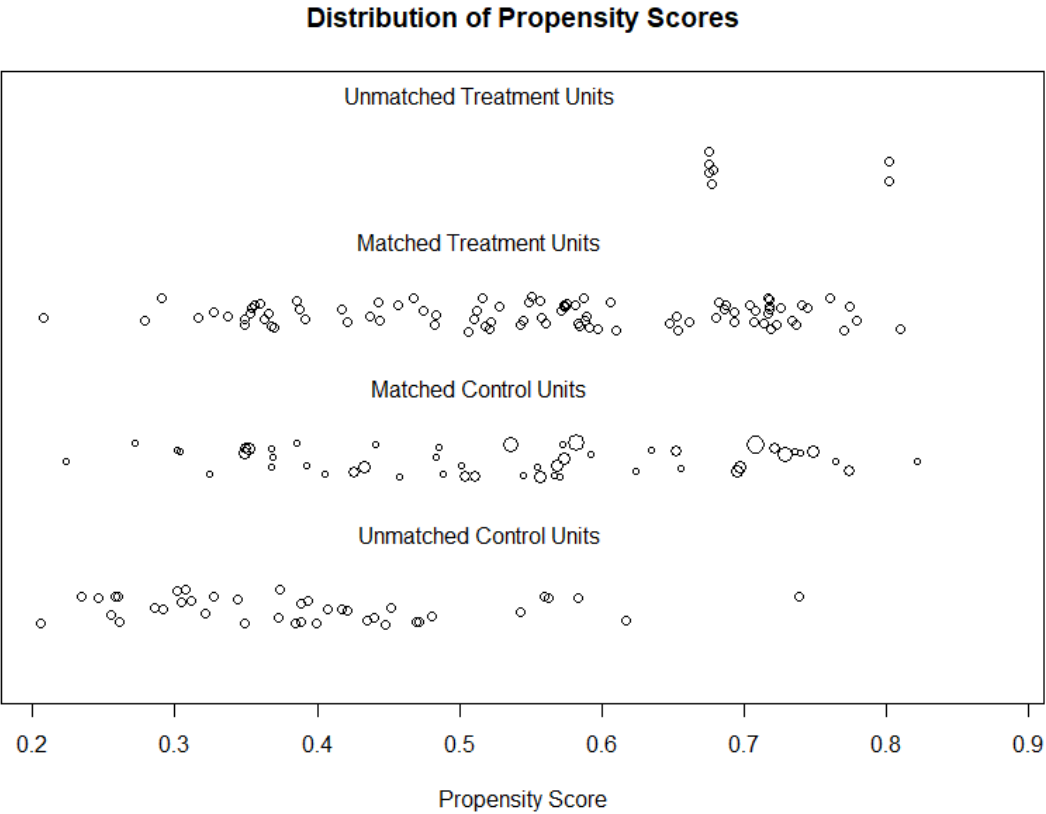

Distribution of Propensity Scores

Figure 8. Results after propensity score matching.

The dashed lines represent 90 per cent confidence intervals. Standard errors are clustered at bank and month level. The share of central bank credit in total liabilities prior TLTRO-II is used as an instrument for participation in TLTRO-II.
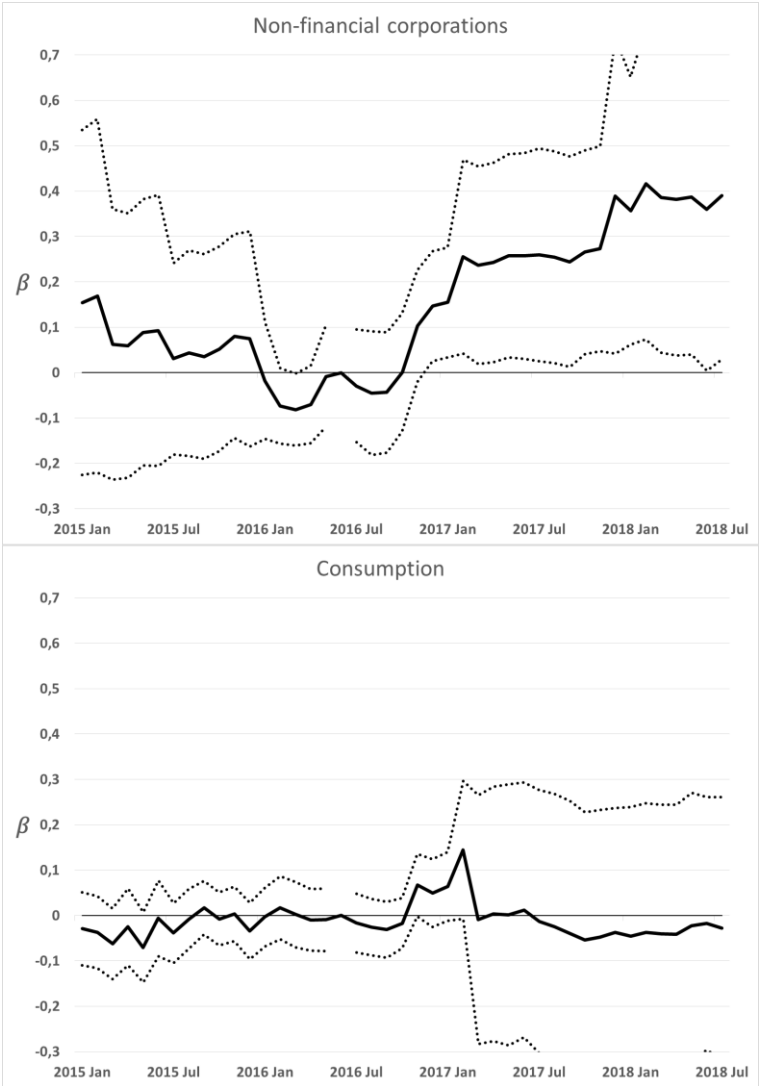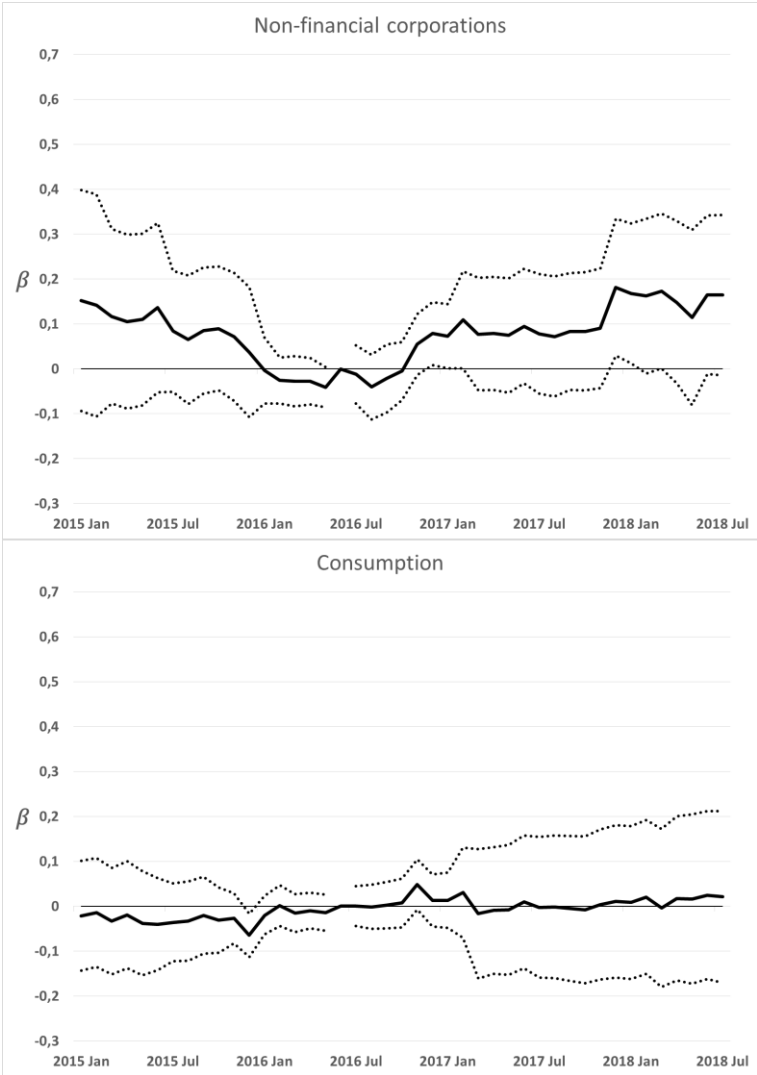
Figure 9. Results after using loans for house purchase as a proxy for credit demand.

The dashed lines represent 90 per cent confidence intervals. Standard errors are clustered at bank and month level. The share of central bank credit in total liabilities prior TLTRO-II is used as an instrument for participation in TLTRO-II.

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