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Financial Globalization and Bank Lending: The Limits of Domestic Monetary Policy?

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Abstract

We empirically analyze how bank lending reacts to monetary policy in the presence of global financial flows. Employing a unique and novel dataset of the funding modes and currency composition of the full population of Norwegian banks in structurally identified regressions, we show that the efficiency of the bank lending channel is affected when banks can shift to international funding and thus insulate their costs of funding from domestic monetary policy. We isolate the effect of global factors from domestic monetary policy by focusing on the deviation of exchange rates from the prediction of (uncovered and covered) interest rate parity. The Norwegian banking sector represents an ideal laboratory since the exogenous

exchange rate dynamics allows for a convincing identification of the relation between lending and global factors.

Keywords: monetary policy, foreign funding channel, bank lending channel, exchange rate dynamics

JEL classification: E52, F36, G21

1 Introduction

How does bank lending react to monetary policy in the presence of global financial flows? The conventional wisdom, the so-called "bank lending channel", states that tightening domestic monetary policy raises banks' funding cost in the domestic money market, which leads to a contraction in banks' credit supply, and vice versa (see, for example, Kashyap and Stein, 2000). However, if banks actively fund themselves in international money market, the traditional bank lending channel may be less effective, or even break down.

In this paper, we present a first step that empirically analyzes how international funding allows banks to cushion domestic monetary policy shocks, using a novel and unique dataset that includes the currency composition of all balance sheets of the full population of Norwegian banks in the past 20 years or more. First, using standard approaches for identifying bank lending channel, we show that domestic monetary policy generates very limited explanatory power in explaining bank lending in Norway. This is particularly the case after the central bank, Norges Bank, shifted its monetary policy regime from exchange rate stabilization to flexible inflation targeting in 2001. Our conjecture is that the failure to document a classical bank lending channel for Norway post-2001 is due to the omission of potential changes in the costs of funding of Norwegian banks in international money markets. To approximate the component of international funding costs which are not driven by domestic monetary policy, we compute the deviation of the Norwegian krone exchange rate from the uncovered interest rate parity (UIP) and include this deviation as an additional control variable in our bank lending channel model. Once this additional control is included, we are able to restore the validity of the lending channel. That is, access to global funding may become favorable for banks if the differentials between the domestic and international money market interest rates are not completely neutralized by the changes in the exchange rate to the degree predicted by interest rate parities, and this in turn affects bank lending. This echoes a similar mechanism suggested by Bruno and Shin (2015a), and our paper provides the first micro-level evidence. Furthermore, to account for the fact that some of the foreign currency positions of Norwegian banks are hedged we also rerun the

regression using the deviation from covered interest rate parity (CIP) instead of UIP deviations as an alternative proxy for the costs of foreign currency funding. The results remain qualitatively unchanged.

We then explore the channels through which international funding affects the lending of Norwegian banks. We find that the impact of international funding is asymmetric: whenever domestic interest rates are rising, lending is not contingent on these, while loosening monetary policy in the form of falling interest rates does increase the capability of banks to lend; when the costs of funding signaled by the UIP deviation are favorable, bank lending only follows the UIP deviation but not domestic monetary policy, while domestic monetary policy affects bank lending when such costs of funding are not favorable. That is, banks actively arbitrage between global and domestic funding, whose costs are reflected by UIP deviations and central bank policy rates, respectively. Furthermore, international funding does not only affect the lending of big banks, which actively fund themselves in international money market, but also small and regional banks, which have little, if any, access to international funding. Digging deeper into the anatomy of these empirical relations, we find that they are driven by the fact that the larger banks, which typically have a substantial share of foreign currency funding, exploit preferential funding conditions in times of positive UIP deviations and borrow more from abroad. This affects their liquidity supply in domestic currency to the smaller banks in the domestic money market: the lax funding conditions are partially passed through in form of interbank loans to smaller banks, which mainly fund in the domestic market, so that we observe a positive relation between UIP deviations and lending for the *full* sample of Norwegian banks.

Our findings contribute to several strands of the literature. First, we enrich the insights on the bank lending channel by adding further evidence on the cross-border spillovers of monetary policy. Existing literature often focuses on the impact of foreign monetary policy, especially for emerging countries where banks obtain foreign currency funding and issue loans in foreign currencies as well. Temesvary et al. (2015) find that global US banks respond to both domestic and host countries' (Hungarian) monetary policy through cross-border flows via external capital markets from the US to non-affiliates in the host countries, and such "global bank lending channel" generates a spillover effect of US monetary policy to foreign economies. Morais et al. (2015) show that foreign banks transmit foreign monetary policy to Mexico by increasing the loan supply to local borrowers when foreign monetary policy is soft. Krogstrup and Tille (2015) study the role of the Swiss franc in both bank lending and funding across European countries. They find that CHF funding depends on exchange rate and CHF lending in emerging countries, while risk aversion and funding costs matter more in the euro area. Studying the case of Turkey, Baskaya et al. (2017) show that global funding conditions are transmitted to emerging economies. And last but not least, Bräuning and Ivashina (2017) show that even when cross-border positions are hedged in terms of domestic currency, bank lending is still subject to spillover effects which are enforced by the shift of supply in hedging transactions. By

contrast, our paper focuses on the efficiency of domestic monetary policy in a typical advanced open economy, where banks have access to both domestic and foreign currency funding, while issuing loans mostly in domestic currency. As we find, banks actively arbitrage between domestic and international money markets, and while domestic monetary policy has limited impact on the latter, the efficiency of domestic monetary policy on bank lending channel may be eroded. This is a new complement to the spillover literature.

Second, we contribute to the strand of research on the role of bank heterogeneity in the identification of the lending channel. In their seminal work based on US micro-level data, Kashyap and Stein (2000) find that the impact of monetary policy on lending behavior is quite heterogeneous among banks, and it depends on their liquid asset positions: lending from liquidity-constrained banks is more sensitive to funding shocks. Later, research interest has focused on the role of the internal capital market of big banks: Campello (2002) shows that the internal capital market within a financial conglomerate relaxes credit constraints for its small bank affiliates, so that they react less to monetary policy compared with their independent peers. Ashcraft (2006) extends this line of argument by showing that banks affiliated with multi-bank holding companies enjoy better access to external funding, and can therefore better shield themselves from negative monetary shocks than stand-alone banks. In recent years, as banks have been increasing their access to the global financial market, the impact of the international funding channel on banks' lending behavior has started to attract attention in research. Using a US bank-level dataset, Cetorelli and Goldberg (2012a) show that US global banks raise funding by reallocating claims between headquarters and foreign subsidiaries, and such an internal capital market makes them better insulated from a contraction in domestic monetary policy. Baskaya et al. (2017) underline that the spillover of foreign monetary policy is mainly driven by large banks with access to international markets, with smaller banks are mostly unaffected by global funding conditions. In this paper, we go one step further and show that the impact of the international funding channel is not restricted to banks and their affiliates that have direct access to foreign currency funding. Through interbank lending in the domestic money market, the effect of foreign currency funding passes through from global banks to regional banks that have almost no access to the international money market.

By showing that the dynamics of exchange rates and global risk aversion affect domestic lending, our findings also echo recent concerns about the rising contribution of international financial factors to domestic credit cycles. Brunnermeier et al. (2012) argue that the procyclical nature of cross-border bank-intermediated credit flows has given rise to serious economic and financial instabilities. Avdjiev et al. (2015) criticize the "triple coincidence" assumption in the conventional paradigm for monetary economics, i.e., that the GDP boundary coincides with the monetary policy decision-making unit and currency area, for neglecting the effects of international currencies on domestic financial stability. Based on country-level

data, Bruno and Shin (2015b) show how US monetary policy spills over to cross-border bank capital flows through fluctuations in banks' risk-taking behavior, amplifying the leverage cycle in the foreign banking sector. On the aggregate level, Rey (2015) finds that the monetary policy of the US affects the leverage of global banks, which leads to co-movements of global asset prices and cross-border capital flows, and credit growth in the international financial system; this results in an "irreconcilable duo" – independent monetary policy is only possible if and only if the capital account is managed. Although our focus in this paper is not on banks' risk-taking behavior or financial stability, our findings imply that the existence of a global funding channel makes domestic monetary policy less effective, especially, for instance, when the central bank wants to tighten its monetary policy and put a brake on a domestic credit boom. This needs to be taken care of when macroprudential policies are designed to contain excessive volatilities over credit cycles.

The structure of our paper is as follows: Section 2 describes the institutional framework and the data. Section 3 replicates the approach of classical lending channel studies for the case of Norway and illustrates the failure of the traditional lending channel. Section 4 introduces the effect of global factors measured by the deviation of NOK exchange rates from UIP predictions and shows that this is a driving force of bank lending. Section 5 illustrates the working mechanism of foreign funding channel, and robustness checks are carried out in Section 6. Section 7 discusses the policy implications of our findings, and concludes.

2 Institutional Framework and Data

2.1 Norwegian Banking Sector: A Brief Introduction

As of 2015Q1, there are 105 savings banks and 28 commercial banks in Norway; among the commercial banks 14 are foreign owned banks, including two subsidiaries and 12 branches.[2] The entire Norwegian banking sector is characterized by high concentration – slightly above the EU average: the shares of the deposit market and lending market for the 10 largest banks are both around two thirds as of 2014 – the number has been fairly stable since 2000 (Ulltveit-Moe et al., 2013, together with our own update).

Commercial banks are limited liability companies. Foreign commercial banks are either subsidiaries or branches of mostly Swedish and Danish banks. The main difference between subsidiaries and branches of foreign banks is that the subsidiaries are subject to Norwegian regulatory authorities, while the branches are subject to the regulatory authorities of their home countries. Notwithstanding this difference, both types

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[2] See Norges Bank Historical Monetary Statistics, available on http://www.norges-bank.no/en/Statistics/Historical-monetary-statistics/Money-credit-and-banking/, as well as Norwegian Savings Banks Association ("Sparebankforeningen"), available on http://www.sparebankforeningen.no.

of foreign bank institutions are obliged to submit the same set of reports concerning their balance sheet and income statements to the Norwegian statistical authorities.

Savings banks ("sparebank") were originally established by Norwegian municipalities, as independent entities without external owners, taking deposits and providing credit to local households and regional businesses. Nowadays the difference between savings banks and commercial banks are becoming smaller: since 1987, savings banks have been permitted to raise external equity by issuing primary capital certificates (PCCs), although PCCs do not give their holders ownership over the bank's entire equity capital. In 2002 savings banks were given the option of converting to limited liability savings banks.[3] There is full equality under the law between savings banks and commercial banks in terms of what business they may engage in.

What is new and noteworthy in the Norwegian banking sector are the mortgage companies ("kredittforetak"), currently 22 in total. They are subsidiaries of some of the commercial and savings banks, and were established after a legal change in 2007 and specializing in issuing covered bonds backed by domestic (over 95% are residential) mortgage loans. A small share of these covered bonds is eligible as collateral for Norges Bank's liquidity facilities, but the majority are sold in domestic and international markets. As of 2014Q4, total covered bonds outstanding in Norway amounted to EUR 104.524 billion (roughly 16% of total assets of the Norwegian banking sector, or, 25% of Norwegian GDP), and over 60% was denominated in foreign currencies.[4] Since a mortgage company's main function is the issuance of covered bonds to fund the mortgage business of its parent bank, we do not consider mortgage companies as separate entities in our estimations but rather match their foreign currency-denominated liabilities to those of the parent banks.[5]

2.2 Monetary Policy Regimes

Before 2001, stabilizing the exchange rate of the Norwegian krone was one of the major concerns. Monetary policy was then characterized by the central bank's frequent active intervention in the foreign exchange market, to maintain a fixed exchange rate vis-à-vis the currencies of major trading-partner countries.[6] However, as Norwegian economy became more and more exposed to the oil sector in 1980s, and in the absence of capital controls, fluctuations in oil prices could quickly influence wage and price expectations, the exchange rate and long-term interest rates, leading to excess volatilities in the macro-economy. To better

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[3] So far only one savings bank, Gjensidige NOR, has done the conversion. Later it merged with the largest commercial bank in Norway, DNB NOR Bank ASA.

[4] Our own calculation, based on Finance Norway statistics, available on https://www.fno.no/en/.

[5] All empirical results presented in this paper are robust to the use of the bank balance sheets without consolidation with the corresponding mortgage companies.

[6] "Two years with inflation targeting in Norway and Iceland", Danmarks Nationalbank, 2003, available on http://www.nationalbanken.dk/en/publications/Documents/2003/06/2003_MON2_two73.pdf.

anchor the real economy, starting from 2001, Norges Bank officially migrated to a flexible inflation targeting regime.[7] The Regulation on Monetary Policy of March 29, 2001, stipulates that "… Norges Bank's implementation of monetary policy shall, …, be oriented towards low and stable inflation. The operational target of monetary policy shall be annual consumer price inflation of approximately 2.5 per cent over time." It is also stated that "… the international value of the Norwegian krone is determined by the exchange rates in the foreign exchange market."[8] To emphasize the role of inflation targeting as a better anchor for the economy, in a letter to the Ministry of Finance on March 27, 2001, Norges Bank stated that "… the krone is floating, …, as do the exchange rates of other small and open economies. The best contribution monetary policy can make to stabilizing exchange rate expectations is to aim at the objective of low and stable inflation…" In fact, the central bank has stopped intervening in the foreign exchange market since January 1999,[9] even after the Norwegian krone heavily appreciated in the early 2000s due to a substantial government surplus. As we will argue in Section 3, the change in the monetary policy regime is related to the transmission of global factors to the Norwegian economy and modifies the interaction between these factors and the local monetary policy stance.

2.3 Data Description

Our data employs the monthly ORBOF reports (Report 10 and Report 11) submitted in the period between January 1994 and March 2015, which register the components of all Norwegian banks' – including commercial banks, savings banks, subsidiaries of foreign banks, branches of foreign banks, bank-affiliated mortgage companies – balance sheets and income statements. Since we aim at a consistent comparison with other lending channel empirical studies, which are frequently based on quarterly data, we use the respective end-of-quarter monthly report. The quarterly frequency also allows us a better match with the macroeconomic variables; further, it reduces the noise associated with very frequent loan volume observations.

Even though the data is available for earlier periods, we choose 1994Q1 as a starting point to avoid dealing with the substantial structural transformation of the Norwegian banking landscape during the 1988-1993

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[7] See more background information in Andreassen et al., "Norges Bank Watch 2001", available on http://www.bi.edu/cmeFiles/NBW2001.pdf.

[8] See "Guidelines for Monetary Policy", Norges Bank, available on http://www.norges-bank.no/en/Published/Submissions/2001/submission-2001-03-27html/.

[9] See "Monetary Policy in Norway", Norges Bank, available on http://www.norges-bank.no/en/about/Mandate-and-core-responsibilities/Monetary-policy-in-Norway/. It has been emphasized that "… *exchange market intervention, irrespective of whether currency is bought or sold, is not an appropriate instrument for influencing the krone over a longer period*."

so-called Nordic banking crisis, when numerous banks went bankrupt or were nationalized. The sample is an unbalanced panel of 185 banks.

The Norwegian bank-level data is unique in that it provides – for all categories reported in the balance sheet as well as for most of the profit and loss account items – information about the currency denomination, distinguishing between domestic currency and foreign currencies. This information allows us to track with very high precision the dynamics of foreign currency assets and liabilities, which is of crucial importance for the micro-level examination of how the efficiency of monetary policy is modified by the currency composition of bank assets and liabilities. The Norwegian banking sector is an ideal laboratory for studying the interactions between domestic monetary policy and global financial factors. First, Norwegian banks have the potential to explore global factor dynamics since they employ substantial shares of foreign currency funding. The share of foreign currency-denominated liabilities soared from about 10% of total bank liabilities in the mid-1990s to more than a quarter of total bank funding in 2015.[10] The speed of foreign currency funding growth has been particularly high after 2000, when the Norges Bank abandoned formal currency exchange interventions, thus leaving the Norwegian krone to freely react to international financial factors. The fact that the Norwegian krone market is highly liquid ensures that banks are able to access the FX market with rather low transaction cost. A second major advantage of the Norwegian data is that it allows us to employ oil price dynamics as an exogenous instrument for exchange rate fluctuations and thus achieve convincing identification. Third, the Norwegian example allows us to explore the role of global factors for bank lending in a high-income economy with free capital movement and very strong institutions, including strict bank regulation which requires banks to hedge most of their foreign currency positions. This advantage is particularly important given that most of the debate on the effect of global factors on local lending has so far focused on emerging periphery economies, where weak banking regulation and fragile institutions prevail. In addition, the Norwegian banking sector was not much affected by 2007-2009 global financial crisis and 2012 European debt crisis; monetary policy didn't reach the zero lower bound and no quantitative easing was carried out, so that there is less concern about the impact of unconventional domestic monetary policy in our sample.

We match the bank-level data to macroeconomic aggregate level variables such as GDP, real estate prices (which, as already mentioned, are mostly available with a quarterly frequency), as well as a battery of various domestic and international monetary policy and money market interest rates. The domestic interest rates are drawn from Norges Bank's monetary statistics, while the international interest rates stem from the

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[10] Including the foreign currency funding via bank-affiliated mortgage companies.

St. Louis Fed's FRED databank. We also merge to the dataset information concerning the levels and dynamics of the Norwegian krone's exchange rate relative to major foreign currencies.

3 Bank Lending Channel: The Baseline Results

3.1 Revisiting the Lending Channel

We start the empirical analysis by replicating the standard approach of analyzing the lending channel of monetary policy proposed by Kashyap and Stein (2000) and later modified by Cetorelli and Goldberg (2012a). Following the tradition of these studies, the estimation of the lending channel's efficiency is based on the assumption that a tightening of monetary policy represents a funding shock for banks which they cannot fully offset by issuing alternative liabilities so that the shock is transmitted to the asset side of the bank balance sheet. The transmission of the shock from the liabilities' to the assets' side is assumed to be contingent on the bank's endowment of liquid assets, as banks with a larger share of liquid assets can cushion the funding shock by liquidating these assets instead of cutting lending.

In econometric terms, the identification of the supply-driven effects of monetary policy on observable bank lending volumes (as described by the bank lending channel view) is achieved by showing that the sensitivity of lending to liquid assets endowment varies with the monetary policy stance. More specifically, by showing that lending of banks with a lower liquidity endowment reacts more strongly to a tightening of monetary policy than the lending of more liquid banks, we may conclude that monetary policy affects observable lending volumes by shifting not only the demand for loans but also the supply of these.

The estimation is based on a two-stage procedure (Kashyap and Stein, 2000; Cetorelli and Goldberg, 2012a).

The first stage is described in Equation (1):

$$\Delta \ln loans_{i,t} = \sum_{j=1}^{4} \alpha_{t,j} \Delta \ln loans_{i,t-j} + \beta_t X_{i,t-1} + \sigma_t Controls_{i,t-1} + \varepsilon_{i,t} \qquad (1)$$

in which $loans_{i,t}$ is the total lending of bank i in quarter t. The liquidity measure of bank i, $X_{i,t-1}$, is defined as the logarithm of the ratio of a bank's liquid assets to total assets. The vector $Controls_{i,t-1}$ includes the bank-specific control variables such as the bank's capitalization ratio, its balance sheet size, deposit growth rate, the type of bank, etc. (a full list of all variables and their definition is presented in Table 1),[11] and $\varepsilon_{i,t}$ is the error term. We also include a vector of macro-level control variables, such as GDP growth rate, house prices, etc., to capture the impacts of business cycles. To avoid the typical simultaneity

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[11] Results are qualitatively unchanged if we include throughout all regression specifications controls for the type of bank (e.g. savings, commercial, or foreign).

issues related to the fact that banks jointly determine asset and liability positions on their balance sheet, these control variables enter the regressions with one-quarter lags.

We run the cross-sectional model (1) quarter by quarter to generate a time series of the coefficients β_t, which represents the time-variant sensitivity of bank lending to the liquid assets of the bank. In the second stage, the relation between the time series of β_t and monetary policy interest rates is examined based on the following model (2):

$$\beta_t = \gamma_0 + \sum_{j=1}^{n} \gamma_j r_{t-j} + \mu_t \qquad\qquad (2)$$

in which we regress β_t on monetary policy rates r_{t-j} in the preceding j periods, with μ_t being the error term. Using the Akaike Information Criterion, we define the number of quarters n to be included in the series of lagged monetary policy rates as six.[12] Following Cetorelli and Goldberg (2012a) we consider possible autocorrelation and correct standard errors using the Newey-West variance estimator.

The definition as well as summary statistics of all variables included in both stages of the estimation are presented in Table 1.

Table 1: Variable definition and summary statistics

This table reports the variable definitions as well as the number of observations, the mean and the median values, the standard deviation and the 1st and the 99th percentile for each of the variables employed in the analysis.

		N	Mean	Median	Std. Dev.	1 Pctile	99 Pctile
Panel A: Bank-level variables							
LOAN GROWTH	Log growth rate of total loans and leases between quarter t and quarter $t-1$	13026	0.028	0.022	0.189	-0.122	0.329
LIQUID ASSETS TO ASSETS	Ratio of liquid assets to total assets	13086	0.106	0.081	0.106	0.010	0.581
CAPITALIZATION	Ratio of total shareholders' equity to total assets	13086	0.051	0.050	0.097	-0.001	0.129
DEPOSIT GROWTH	Log growth rate of total deposits between quarter t and quarter $t-1$	12963	0.026	0.018	0.189	-0.169	0.372
DEPOSITS	Ratio of total deposits to total assets	13000	0.684	0.710	0.160	0.046	0.905

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[12] Cetorelli and Golbderg (2012a) fix this number to 8. We have rerun all models using the 8 quarter specifications, the results are qualitatively the same.

		N	Mean	Median	SD	Min	Max
WRITE OFFS	Ratio of total write offs to total assets (write-off enter the ORBOF report with a negative sign)	12228	-0.007	-0.005	0.010	-0.037	-0.000
FOREIGN CURRENCY LIABILITIES	Ratio of liabilities denominated in foreign currency to total liabilities	13086	0.023	0.000	0.084	0.000	0.427
C&I LOANS	Ratio of C&I loans to total loans and leases	13061	0.980	0.983	0.016	0.925	1.000
SIZE	Logarithm of total assets (in thousand NOK) adjusted for CPI	13087	14.537	14.286	1.648	10.798	19.226

Panel B: Interest rates and international finance controls

		N	Mean	Median	SD	Min	Max
KEY POLICY RATE	Interest rate paid by the Norges bank on commercial bank reserves	21040	3.875	3.875	2.022	1.250	8.000
NIBOR	Norwegian Interbank offered rate with 3 months maturity	21040	4.329	4.081	2.050	1.384	8.793
UIP DEVIATION	Log growth rate deviation from UIP, defined in Section 4.1	21040	0.077	-0.047	0.596	-3.119	1.918
OIL PRICE	Change in barrel price of Brent oil in USD	21040	0.404	0.920	12.130	-57.70	34.929
VIX	VIX index as published at FRED (St. Louis Fed)	21040	20.249	17.93	9.113	11.11	68.51
BBB BOND SPREAD	Spread between the yield of BBB and AAA rated bonds as published at FRED (St. Louis Fed)	21040	2.076	1.895	1.158	0.750	7.720

Panel C: Macroeconomic Controls

		N	Mean	Median	SD	Min	Max
GDP GROWTH	Annualized growth rate of GDP (quarterly data) in %	21040	2.625	2.505	2.255	-1.623	9.126
HOUSE PRICE GROWTH	Annual growth rate of house prices (per sqm)	21040	0.015	0.000	0.037	-0.077	0.127

Cetorelli and Goldberg (2012a) point to a further potential identification issue related to the fact that bank liquid asset holdings may react to macroeconomic conditions and that this reaction to macroeconomic condition might be different for banks with different funding modes. They propose an additional

identification step in which the observable liquid assets ratio is instrumented by the residual of a regression of liquid-assets-to-total asset ratio on the ratio of commercial and industrial lending to total lending and the ratio of non-performing loans to total loans. This residual is strongly correlated with the observable bank liquidity position but avoids the endogeneity of liquidity with respect to macroeconomic conditions since these are already controlled for by the characteristics of bank lending.

If the conventional transmission mechanism of monetary policy were to work, bank lending should become more sensitive to bank liquidity when monetary policy is tightened, and less so when monetary policy is loosened; therefore, the sum of the coefficients of monetary policy rates γ_j should be positive and significant.

Table 2: Lending channel in Norway 1994-2015

This table reports the results of the estimation of the regression of the sensitivity of bank loan growth to bank liquidity (β) on monetary policy interest rates, which are measured for the results presented in the upper panel by the rate on bank deposits with the central bank (key policy rate) and for the results presented in the lower panel by the NIBOR (Norwegian Interbank Offered Rate). Column (1) uses the βs which are computed from a regression of bank loan growth on the liquid assets-to-assets ratio, while column (2) is based on instrumenting the liquid assets-to-assets ratio. The reported figures in the columns are from the sum of the estimated coefficients on the six lags of each respective monetary policy rate. *, ** and *** indicate significance at the 10%, 5% and 1 % level, respectively.

	β_j (estimated using the liquid assets-to-asset ratio)	β_j (estimated using the residual of liquid assets-to-asset ratio regression)
	(1)	(2)
$\sum \gamma_j$ (Key policy rate)	-0.0030*	-0.00541***
	(0.00066)	(0.00072)
$\sum \gamma_j$ (NIBOR)	-0.0016*	-0.0031*
	(0.00067)	(0.00073)
Number of observations	20777	20777
Adjusted R^2	0.02	0.08

The outcome of the two-step regression is reported in Table 2 (the intermediate estimates of β_t is reported in Appendix A, and the second-stage estimates for all lagged variables are reported in Appendix B). This table contains two rows of results. The upper row presents the results in the case when the monetary policy rate is measured by the key policy rate of the Norges Bank which is defined as rate paid by central bank on commercial bank reserves. The second row reports the results of the estimation in the case where the money market interest rate NIBOR (Norwegian Interbank Offered Rate) is used as a proxy for the monetary policy

stance. The table also reports two columns for each of the rows – one using the standard Kashyap and Stein (2000) specification and one using the approach of instrumenting the liquidity ratio proposed by Cetorelli and Goldberg (2012a).

In all regression specifications reported in this table, the sum of the coefficients of the interest rates is negative and (mostly weakly) statistically significant. The negative sign implies that the sensitivity of lending to the liquidity position of a bank is lower in times of tighter monetary policy. This result, therefore, implies that the conventional transmission mechanism of monetary policy is not supported by our sample.

3.2 The Transmission Mechanism and the Shift in Monetary Policy Regimes

The fact that we are not able to document a lending channel for the Norwegian credit market might be surprising at a first glance, as almost uniformly most published studies using micro-level data typically do find lending channel effects at least for some subcategories of banks (Campello, 2002, Ashcraft, 2006, Cetorelli and Goldberg, 2012a). Nevertheless, the missing efficiency of monetary policy with respect to lending dynamics is not surprising once recent findings of the international finance literature, which point to the potential interaction between domestic and foreign monetary policy, are taken into consideration. As suggested by Rey (2015), in the absence of capital controls, the monetary policy of the core economies may affect credit dynamics in non-central countries, which in turn points to limits of domestic monetary policy. Rey (2015) illustrates this relation by documenting the existence of global financial cycles which strongly negatively correlate with risk aversion and uncertainty typically approximated by the VIX index. Bruno and Shin (2015a), who document the cross-border effects of loose monetary policy in core economies, further develop this argument. These authors link the cross-border transmission of monetary policy to the failure of uncovered interest rate parity: exchange rates fail to offset the interest rate differential between core and non-core economies. Hofmann et al. (2016) further show that the appreciation of local currency is associated with a decline in the risk spread of the respective economies. This argument implies that exchange rate appreciation has an effect on the costs of funding of banks in non-core economies even when the foreign currency positions are hedged. These exchange rate-driven changes in the costs of funding can therefore interact with domestic monetary policy, thus potentially explaining the counterintuitive relation between domestic interest rates and lending volumes illustrated in Table 2.

The theoretical arguments in the above strand of the literature are based on the assumption that exchange rates reflect the variation in the risk premium; thus, deviations from the uncovered interest rate parity emerge as a proxy for the shifts in the supply of funds to a non-core economy, reflecting the dynamics of the risk premium. A central bank can eliminate the link between the risk premium and exchange rates by active intervention in the foreign exchange market. Moreover, the currency market intervention can provide

a central bank with better control of the interaction between international financial factors and domestic monetary policy. The recent history of central bank operations in Norway presents us with a good setup to study the effect of the interaction between international factors and monetary policy. To this end, we examine a regime change which was introduced in 2001: Norges Bank changed its monetary policy regime from exchange rate stabilization to inflation targeting.

To examine whether the transmission mechanism of monetary policy changes around the introduction of the new monetary policy regime, we split the sample into two sub-samples, pre-2001 and post-2001 (which we define to begin with the first quarter of 2001), and redo the same two-stage regressions. We find that the conventional transmission mechanism works in pre-2001 sub-sample, with the sum of the coefficients γ_js being both positive and significant. However, the mechanism stops working in the post-2001 sub-sample, with the sum of the coefficients γ_js being either of wrong sign or insignificant, as Table 3 shows.

Table 3: Monetary policy pre- and post-2001

This table reports the results of the estimation of the regression of the sensitivity of bank loan growth to bank liquidity (β) on monetary policy interest rates, which are measured for the results presented in the upper lines by the rate on bank deposits with the central bank (key policy rate) and for the results presented in the lower lines by the NIBOR (Norwegian Interbank Offered Rate). Column (1) uses the βs which are computed from a regression of bank loan growth on liquid assets-to-assets ratio, while column (2) is based on instrumenting the liquid assets-to-assets ratio. The reported figures in the columns are from the sum of the estimated coefficients on the six lags of each respective monetary policy rate. Panel A reports the results in the case when the estimation sample is restricted to the period 1994-2000, while Panel B reports the 2001-2015 results. *, ** and *** indicate significance at the 10%, 5% and 1 % level, respectively.

	β_j (estimated using the liquid assets-to-asset ratio)	β_j (estimated using the residual of liquid assets-to-asset ratio regression)
Panel A: Pre-2001		
$\sum \gamma_j$ (Key policy rate)	0.0145***	0.0149***
	(0.0032)	(0.0034)
Number of observations	5786	5786
Adjusted R^2	0.10	0.39
$\sum \gamma_j$ (NIBOR)	0.0482*	0.0438*
	(0.0025)	(0.0031)
Number of observations	5786	5786
Adjusted R^2	0.11	0.42
Panel B: Post-2001		

$\sum \gamma_j$ (Key policy rate)	-0.0042***	-0.0049***
	(0.00091)	(0.00083)
Number of observations	12887	12887
Adjusted R^2	0.08	0.26
$\sum \gamma_j$ (NIBOR)	-0.0091*	0.0010
	(0.0010)	(0.0008)
Number of observations	12887	12887
Adjusted R^2	0.10	0.35

In addition, in unreported tests, we also split the sample into different sub-periods in order to establish whether 2001 is indeed the year when the regime changed. We consistently find that for any periods prior to 2001 the conventional lending channel is at work, while it is not valid for periods starting after 2000. A Chow-test also indicates a structural break in 2000. Given the fact that substantial advances in information technology also improved the international integration of financial markets – thus increasing the international exposures of banks not only in Norway but basically around the globe – we do not argue that the change in the monetary policy regime is the sole driving force of the shift in the lending channel's efficiency. We rather think of the abolition of the foreign exchange interventions by the Norges Bank as the step that enables significant deviations from UIP and thus allows for a stronger effect of global factors on banks' funding costs.

Furthermore, within the post-2001 subsample we find strong asymmetry in banks' reaction to looser and tighter monetary policy. As is shown in Table 4, when there is a positive change in NIBOR, i.e., when monetary policy becomes tighter (defined as a rise in NIBOR during the past 4 quarters, or, $r_{t-1} - r_{t-4} > 0$), bank lending reacts to monetary policy in a "wrong" way as $\sum \gamma_j$ is negative; however, when there is a negative change in NIBOR or when monetary policy becomes looser (defined as $r_{t-1} - r_{t-4} < 0$), bank lending responds to monetary policy "correctly" as $\sum \gamma_j$ is positive and significant accompanied by a substantial rise in adjusted R^2, implying that bank lending reacts to loosening domestic monetary policy but not a tightening one. This asymmetry suggests that banks may take advantage of cheap funding from the domestic money market when domestic monetary policy is loosened, while avoiding increasing funding cost under tightening domestic monetary policy by shifting funding towards international money markets, where domestic monetary policy has a much lower impact. We investigate such conjecture in the next section.

Table 4: *Asymmetric reaction to looser and tighter monetary policy*

This table reports the results of the estimation for the post-2001 period of the regression of the sensitivity of bank loan growth to bank liquidity (β) on the NIBOR as a proxy for the monetary policy interest rate. $\sum \gamma_j$ represents the sum of the coefficients of NIBOR's six lags. *, ** and *** indicate significance at the 10%, 5% and 1 % level, respectively.

Post-2001	Positive NIBOR changes	Negative NIBOR changes
$\sum \gamma_j$	-0.0019* (0.001)	0.0119*** (0.001)
Adjusted R^2	0.06	0.73
Number of observations	5523	3419

4 What Drives Bank Lending if the Conventional Lending Channel Fails?

The results presented in Section 3 show that the efficiency of the lending channel in the transmission of domestic monetary policy is substantially reduced in the post-2001 period. In this section, we turn to exploring whether global factors contributed to the curtailed impact of domestic monetary policy. More specifically, we focus on exploring whether banks employ the interest differentials between Norway and the core economies (especially the US and the euro area) to insulate from tightening of the stance of domestic Norwegian monetary policy. If the uncovered interest rate parity holds, exploring these differentials would not affect banks' costs of funding, since any interest rate differentials will be neutralized by exchange rate dynamics. However, if UIP fails, dollar (or euro) based investors may generate higher returns by investing in Norwegian krone. Deviations from UIP can therefore affect the costs of funding of Norwegian banks in a way that is not directly related to domestic monetary policy.

4.1 Deviations from UIP and the Foreign Funding Channel

As argued by Rey (2015) and Bruno and Shin (2015a), the deviations from UIP can be driven by the changes in risk aversion and financial market volatility. Indeed, the case of Norway post-2001 describes a setup characterized by the free movement of capital plus no exchange rate interventions which is consistent with the framework of these models. Positive UIP deviations indicate a positive return of investment in Norwegian krone by dollar (or euro) based investors, therefore they de facto represent a positive shift of the supply of funds to Norwegian investors (including banks). While studies using emerging economies data relate these deviations to the decline of risk aversion and to periods of low volatility (as in Rey, 2015), the Norwegian example in the post 2000 period allows us to look at the flip side of the phenomenon where in periods of high volatility and high risk aversion, capital flows to Norway since the strong institutional

quality of this country makes it a reasonable safe haven, thus pushing exchange rates in a direction deviating from the UIP predictions.[13] This is particularly the case during periods when the perception of the strength of the Norwegian economy was also reinforced by high and rising oil prices.

In order to examine the effect of the shift in the cost of foreign currency funding of Norwegian banks, we construct a simple measure of deviation from UIP in the following way:

$$UIP_{dev,t} = \frac{implied\ NOK/USD_{t+1} - NOK/USD_{t+1}}{NOK/USD_t} \qquad (3)$$

in which NOK/USD_{t+1} represents the observable NOK/USD exchange rate in period $t+1$, while the implied NOK/USD exchange rate is the exchange rate that can be expected if the UIP holds. This implied NOK/USD exchange rate is calculated through

$$implied\ NOK/USD_{t+1} = NOK/USD_t \frac{1+r_t}{1+r_t^*} \qquad (4)$$

where r_t and r_t^* are interest rates in Norway and the US, respectively, measured by three-month NIBOR and the USD LIBOR rates.[14] In this way, a positive UIP deviation, or, $UIP_{dev,t} > 0$ means that actual NOK/USD exchange rate is below what is suggested by UIP, implying an appreciation of the Norwegian krone.

Figure 1 presents the deviation from UIP over the entire horizon of our data sample. Indeed, the deviation (especially in a positive direction) became far wider and more volatile after 2001, when Norges Bank switched its monetary policy regime to inflation targeting and ceased intervening in the FX market. As we will show later, the peaks of the UIP deviations are mainly associated with oil price dynamics as well as with other global factors, such as global risk (as proxied by the VIX index).

If the deviation from UIP affects the costs of bank funding, then in econometric terms the examination of the effect of monetary policy on lending without considering the UIP deviation might lead to omitted variable bias. In a next set of regressions, we address this issue by re-estimating the model, now including the deviation from UIP as an additional explanatory variable.

With deviation from UIP, stage two regression (previously model (2)) becomes:

$$\beta_t = \gamma_0 + \sum_{m=1}^{2} \theta_m UIP_{dev,t-m} + \sum_{j=1}^{6} \gamma_j r_{t-j} + \mu_t \qquad (5)$$

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[13] The goal of our analysis is the interaction between global factors (correlated to UIP deviations) and monetary policy rather than the exploration of the sources of deviations from the UIP. That is why in this paper we do not focus on the sources of these deviations and their variation over time, for example, those related to the peso problem.

[14] Similarly, we can represent the deviations of the observable NOK/EUR from its UIP predictions using the three-month EURIBOR rate.

in which $UIP_{dev,t-m}$ denotes the deviation from UIP with m quarter lags. This number of lags is again determined by the Akaike Information Criteria, which points to two quarters as the optimal number of lags to be considered in the estimation. Figure 1 illustrates the stationarity of the UIP deviations which have also been established for the other variables in Equation (5) by earlier research, so we are not concerned about spurious effects in this time series model. Since as shown in Figure 1 substantial deviations from UIP are only observable in the post-2001 period and since only after the shift of monetary policy regime such deviations can be viewed as exogenous with respect to Norges Bank policy, we present this extended model version only for this later period.

Further, we are concerned about identification which could be potentially threatened if a positive deviation from UIP is generated by positive expectations about investment returns in Norway which simultaneously also affect the stance of Norwegian monetary policy. To deal with this issue, we adopt an identification strategy which instruments UIP dynamics by the dynamics of global oil prices (measured by the change in brent oil barrel price) as well as global risk (measured by the VIX index).

Figure 1: Deviations from uncovered interest rate parity, Norway 1994-2015
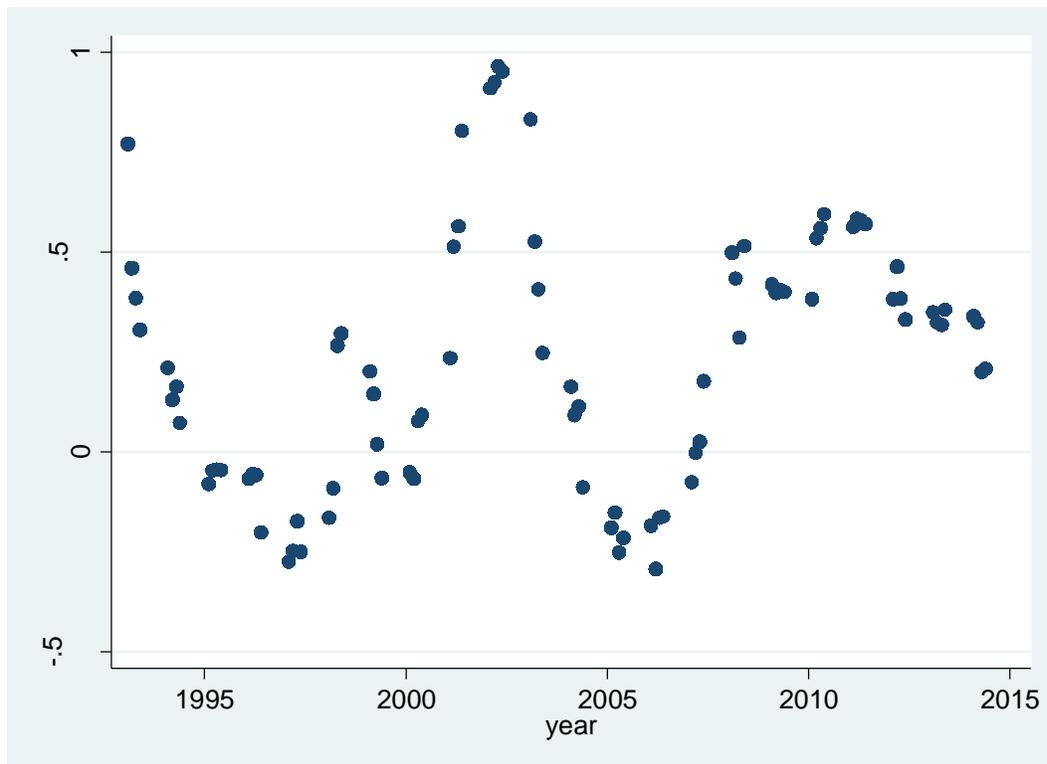
This graph illustrates the dynamics of the deviations from uncovered interest rate parity (UIP) for the period 1994-2015. These deviations are computed as the relative difference between the observed interest rate and the rate implied by the UIP as described in Equations (3) and (4).

Conceptually the oil price is a valid instrument for the UIP deviations, since on the one hand, observable spot NOK exchange rates strongly co-move with the oil price (given that the oil sector accounts for more than one-fourth of Norwegian GDP). On the other hand, because of the relatively small size of local oil reserves and the economy as a whole, Norway-specific factors are not sufficient to affect world oil prices, so the exogeneity of the instrument is guaranteed. Next, the use of the VIX index as an instrumental variable is motivated by the argument that capital inflows into periphery countries are strongly correlated with the volatility of global financial markets and the prevailing level of risk aversion (Rey, 2015, Hofmann et al., 2016). Given its strong institutions, Norway, however, represents the flip side of this argument: the higher global risk, the higher the inflow of capital into the country (see discussion of the first stage regression result).

The choice of instruments passes standard tests. Their strength is confirmed by an F-test statistic of the first-stage regression being roughly 19; while the exogeneity is formally confirmed by a Hansen overidentification test.[15]

For the sake of parsimony, we focus in this and the following exercises solely on models using the NIBOR as a proxy for domestic interest rates. This is without loss of generality, since we have already shown that results are not sensitive to the choice of domestic interest rates to be used in the model (key policy rate versus NIBOR). The results of the estimation are presented in Table 5.

Table 5: Monetary policy and global factors post-2001

This table reports the results of the estimation of the regression of the sensitivity of bank loan growth to bank liquidity (β) on the NIBOR as a proxy for the key policy rate and the deviations from the uncovered interest rate parity, which is instrumented by the oil price and the VIX. Panel A reports the main results of the second stage regression, where $\sum \gamma_j$ represents the sum of coefficients of the six lags of the NIBOR, while $\sum \theta_m$ represents the sum of coefficients of the two lags of the UIP deviation. Panel B reports the first stage regression for the two instrumented variables which are the two lags of the UIP deviation. R^2 is not reported for the instrumental variable regression because no decomposition of the variance of the dependent variable can be assigned to the endogenous dependent variables. *, ** and *** indicate significance at the 10%, 5% and 1 % level, respectively.

Panel A:

$\sum \theta_m$	$\sum \gamma_j$
-0.269***	0.0367*
(0.0122)	(0.0019)

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[15] We have also explored the empirical performance of a specification using the spread between US BBB-bond and AAA bond yields. This specification however overfits the model and the Hansen overidentification test marginally fails which is probably related to the high correlation between the VIX index and the BBB spread.

	Number of observations		8942		

Panel B:

First stage results

	UIP deviation $(t-1)$		UIP deviation $(t-2)$	
	coefficient	p-value	coefficient	p-value
3-month NIBOR				
L1.	0.101	0.000	0.168	0.000
L2.	-0.262	0.000	-0.051	0.027
L3.	-0.030	0.336	0.401	0.000
L4.	0.249	0.000	-0.634	0.000
L5.	-0.143	0.000	0.290	0.000
L6.	0.024	0.088	-0.096	0.000
Oil price				
L1.	0.008	0.000	0.006	0.000
L2.	0.004	0.000	0.011	0.000
VIX				
L1.	0.045	0.000	0.002	0.014
L2.	-0.023	0.000	0.022	0.000
Constant	-0.415	0.000	-0.739	0.000
Number of obs.		8942		8942
Adjusted R^2		0.142		0.437

Panel A of this table illustrates the sum of the coefficients θ_m (of the UIP deviations) and γ_j (of the interest rates) in the estimation of the model given by Equation (5) (the second-stage estimates for all lagged variables θ_m and γ_j are reported in Appendix C). The estimated sum of the coefficients points to two essential results. First, the lagged interest rates enter the regression with a positive statistically significant sum of coefficients. This result is illustrative of the fact that once we control for the effect of global factors, we find significant evidence on the validity of the bank lending channel. In other words, the failure to document bank lending channel effects in the models presented in Table 3 could be attributed to an omitted variable bias stemming from ignoring the interactions between domestic monetary policy and global factors.

Second, the negative and statistically strongly significant sum of the coefficients of the UIP deviation lags point to the effect of a global funding channel: when the exchange rate appreciates (an appreciation is given by a lower NOK/USD value which explains the negative sign of the θ_m coefficients) in deviation from the

UIP for reasons related to both oil price dynamics and global financial factors – Norwegian banks obtain favorable funding conditions, which allows them to increase lending stemming from reduced sensitivity to their liquidity position.

It is important to notice that the effect of UIP deviations is not only statistically but also economically strongly significant. According to the estimation results, a one standard deviation change in the UIP deviation – in our sample is roughly 0.6 – is associated with approximately 16% (0.16=0.269*0.6) change in the sensitivity β of bank lending to bank liquidity endowment.

Panel B of Table 5 presents the results of the first stage regressions for the two instrumented variables, which are the first and second lag of the UIP deviations. They show that, consistent with our arguments motivating the choice of instruments, the UIP deviation is positively related to oil price increase, as well as to an increase of the global financial risk as measured by the VIX index. Taken together these results suggest that both positive oil price dynamics and an increase in global financial risk generate an appreciation of the Norwegian krone, or, positive deviation from UIP. That is, this appreciation is linked to the safe haven status of Norway in times of positive oil price dynamics. This safe haven status results in an implicit negative risk premium on investments in Norwegian institutions. This drop in the local risk premium eases bank funding constraints and thus modifies the efficiency of monetary policy.

Digging deeper into the mechanics of the effects documented in Table 5, we split the post-2001 sample into periods when exchange rate dynamics were becoming more favorable for global funding (UIP deviation rose) and exchange rate dynamics were becoming less favorable for global funding (UIP deviation fell). While foreign funding always significantly affects bank lending (negative and significant $\sum \theta_m$ in both subsamples), the results shown in Table 6 point to banks' asymmetric reactions to domestic monetary policy under positive versus negative exchange rate dynamics: when global funding conditions get more favorable, bank lending does not react to domestic monetary policy (insignificant $\sum \gamma_j$), suggesting that banks rely more on international money market; in contrast, when global funding conditions became less favorable, bank lending is sensitive to domestic monetary policy (positive and significant $\sum \gamma_j$), implying that banks turn to the domestic money market when international sources of funding become less favorable.

Table 6: Asymmetric reaction to favorable and unfavorable exchange rate dynamics

This table reports the results of the estimation of the regression of the sensitivity of bank loan growth to bank liquidity (β) on the NIBOR as a proxy for the monetary policy interest rate and the deviations from the uncovered interest rate parity, which is instrumented by the oil price and the VIX for periods with positive and with negative changes of the UIP deviation. $\sum \gamma_j$ represents the sum of the six lags of the NIBOR, while $\sum \theta_m$ represents the sum of the two lags of the UIP deviation. R^2 is not reported for the instrumental variable regression because no decomposition of the variance of the dependent variable can be assigned to the endogenous dependent variables. *, ** and *** indicate significance at the 10%, 5% and 1 % level, respectively.

Post-2001	Positive changes in UIP deviation	Negative changes in UIP deviation
$\sum \theta_m$	-0.080***	-0.187***
	(0.014)	(0.022)
$\sum \gamma_j$	-0.001	0.030***
	(0.003)	(0.003)
Number of observations	4734	4208

4.2 Currency Hedging, Deviations from CIP, and Global Funding Supply

In sum, the evidence presented in the past section underlines deviations from UIP as important determinants of Norwegian bank lending. The economic and the statistical significance of the effect of UIP deviation might be surprising at a first glance, given the fact that Norwegian regulation requires banks to hedge some of their foreign currency exposure by means of swap or forward contracts (as stipulated by Chapter IV of Act No. 40 of 10 June 1988 (Financial Institutions Act) for all financial institutions, as well as Regulation No. 550 of 25 May 2007 for mortgage companies, see Molland, 2014). In practice, banks need to exchange foreign currency for Norwegian krone after they borrow in foreign currencies, and they need to make sure that sufficient foreign currency is available when the loan matures. Typically, banks enter foreign currency swaps if the funding is short-term, or cross-currency basis swaps if the funding is long-term.

However, even if foreign currency liabilities are hedged, exchange rate dynamics can still be relevant to the banks' costs of funding. This is the case on the one hand (as already mentioned), since deviations from UIP reflect a shift in the supply of international funds to Norway, which then shifts the costs of funding of Norwegian banks. On the other hand, even if positions are hedged at the maturity of the liabilities' contracts, the maturity mismatch between assets and liabilities generates a liquidity risk in that a bank has to revolve the foreign currency liability to match the maturity of the assets. The conditions under which the corresponding liabilities revolve will depend on exchange rate dynamics no matter whether or not the initial foreign currency exposure is hedged. Further, as shown by Bräuning and Ivashina (2017) the inflow of substantial amount of capital into a country and the corresponding need for hedging the exchange rate positions shift the demand-supply equilibrium in the markets for hedging instruments, thus also affecting the costs of the hedge.

Taking the debate further, we also find that global factors matter for bank lending even if we focus on completely hedged positions. More specifically, we follow the approach of Hofmann et al. (2016) for analyzing the risk shifting effects of currency appreciation and focus on exploring how deviation from

covered interest rate parity (CIP) affects the efficiency of the lending channel. To this end, we construct the local currency risk-spread measure proposed by Du and Schreger (2016) as a proxy for the deviations from CIP. This measure is defined as the spread of the yield of local currency (in our case NOK) government bond achievable by a dollar-based investor over the yield of a US Treasury security with the same maturity. While CIP deviations cannot be identified using NIBOR/LIBOR differential since the NIBOR rate is by definition quoted as the LIBOR rate plus the forward premium, the Du-Schreger measure, which is government bond yield-based, does identify some non-negligible deviations from CIP.

In order to explore the role of global factors on the hedged banks' foreign currency positions, we rerun the regression specifications using the Du-Schreger measure instead of the deviations from UIP, i.e., the second step is specified as

$$\beta_t = \gamma_0 + \sum_{n=1}^{2} \delta_n CIP_{dev,t-n} + \sum_{j=1}^{6} \gamma_j r_{t-j} + \mu_t \qquad (6)$$

Again, we improve the identification by controlling for the fact that both the Du-Schreger measure and bank lending might be driven by unobservable characteristics of the state of the Norwegian economy. To this end we use the VIX index as an instrument for the Du-Schreger measure. Unlike the case of the UIP deviation, we focus only on the VIX index and not on oil price dynamics as an instrument. This choice is driven by the fact that while UIP deviations are affected by the unexpected exchange rate shocks related to oil price dynamics, CIP deviations can by construction be unrelated to such unexpected shocks. Further, statistically we find that only VIX but not the oil price is related to CIP deviations as measured by the Du-Schreger parameter.

Table 7: Du-Schreger's local currency risk measure and the lending channel

This table reports the results of the estimation of the regression of the sensitivity of bank loan growth to bank liquidity (β) on the NIBOR as a proxy for the monetary policy interest rate and the deviations from covered interest rate parity approximated by the Du-Schreger measure and is instrumented by the oil price and the VIX for periods with positive and such with negative changes of the NIBOR. $\sum \gamma_j$ represents the sum of the six lags of the NIBOR, while $\sum \delta_n$ represents the sum of the two lags of the CIP deviation. R^2 is not reported for the instrumental variable regression because no decomposition of the variance of the dependent variable can be assigned to the endogenous dependent variables. *, ** and *** indicate significance at the 10%, 5% and 1 % level, respectively.

	Du-Schreger CIP deviation 5 years	Du-Schreger CIP deviation 3 months
	(1)	(2)
$\sum \delta_n$	-0.693***	-2.083***
	(0.039)	(0.484)

$\sum \gamma_j$	0.094***	0.166**
	(0.009)	(0.073)
Number of observations	7627	8416

The results of the estimations are presented in Table 7, which contains two columns. The results reported in the first column reflect the estimation results when the Du-Schreger measure is computed as the spread of the yield between government bonds with a maturity of 5 years. The period covered in the estimation is 2001-2015Q1. The second column reports the results of a specification based on the Du-Schreger measure computed for short-term (three-month) government bonds. Since short-term Norwegian bond were only issued starting from 2003, this specification is run for the 2003-2015Q1 sample.

For both specifications, the results are again consistent with a strong role of global factors in shaping domestic Norwegian lending. More specifically, we find that even when we control for the hedging of foreign currency positions, the volatility-implied deviations of CIP are still significantly related to the Norwegian banks' ability to insulate themselves from domestic monetary policy shocks. This is particularly the case when we focus on the deviations from CIP derived from short-term interest rate differentials (column (2) of Table 7) signaling particularly strong opportunities for banks to insulate from domestic monetary policy in times when covered interest rate differentials exist even in the shortrun.

5 The Working Mechanism of Foreign Funding Channel

Our results in Section 4 suggest that international financial conditions play a key role in determining bank lending in Norway. We find that for the full sample of banks the appreciation of the Norwegian krone in deviation from the UIP is associated with higher lending growth. We also find that once this effect is controlled for, bank lending is also contingent on domestic monetary policy.

In a next set of regressions, we present further tests which aim at providing the mechanism about the channels which generate this effect. We start by exploring whether the effect of the UIP deviation is mainly driven by those banks which have access to foreign currency funding. For this purpose, we split the sample of banks quarter-by-quarter in two subsamples: one for those from banks that actively use foreign currency funding (call them "international" banks), and the other one for banks that do not (call them "non-international" banks). Note that the difference between the two groups of banks is not their differential reaction to potential benefits of using foreign currency funding but rather ex ante institutional characteristics of the banks. So, the first subsample mainly consists of large, international banks that have access to international money market through their foreign branches as well as large domestic savings banks that

actively participate international money market, while the second subsample encompasses small, regional and stand-alone banks that mainly fund themselves domestically.[16] Table 8 illustrates the results of the re-estimation of the model reported in Table 4 for the two subsamples. Comparing the results for these two subgroups of banks, we find two major differences.

First, for the group of banks using foreign currency funding, the effect of monetary policy on the sensitivity of lending to liquidity is negative, implying that conventional bank lending channel of monetary transmission mechanism does not work for these banks. The opposite is true for the banks with no foreign currency liabilities whose lending is subject to the conventional lending channel relation.

Table 8: Monetary policy and global factors for banks with and banks without access to foreign currency funding

This table reports the results of estimating the regression of the sensitivity of bank loan growth to bank liquidity (β) on the NIBOR as a proxy for the monetary policy interest rate and the deviations from the uncovered interest rate parity, which is instrumented by the oil price and the VIX for banks with foreign currency funding and for banks with no foreign currency funding. R^2 is not reported for the instrumental variable regression because no decomposition of the variance of the dependent variable can be assigned to the endogenous dependent variables.

	"international" banks (1)	"non-international" banks (2)
$\sum \theta_m$	-0.902***	-0.125***
	(0.200)	(0.012)
$\sum \gamma_j$	-0.053*	0.008***
	(0.032)	(0.002)
Number of observations	952	7990

The second difference consists of the different economic effects of the UIP deviations on the sensitivity of lending to liquid assets across the two subsamples. While for *both* groups of banks the effect of UIP deviations is statistically significant and negative, the magnitude of the sum of the θ_m coefficients is substantially higher for banks relying on foreign currency funding.[17] This result implies that UIP deviations shift the lending behavior of both types of banks, but the effect is much stronger for banks which actively

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[16] In unreported tests, we illustrate the robustness of the finding by similarly showing that banks which use substantial amounts of foreign currency funding (e.g. at least 10% of total liabilities are denominated in foreign currency) have a stronger adjustment of lending to changes in UIP deviations than banks with minor or non-existent use of foreign currency funding. Similarly, lending by banks which use substantial amounts of foreign currency funding are not sensitive to domestic monetary policy rate dynamics.

[17] A t-test confirms that difference between the sum of the estimated coefficients is statistically significant at 1%.

use foreign currency funding. The finding that global factors affect not only the behavior of banks with substantial global exposures, but also of such with purely domestic positions mostly denominated in domestic currency substantially contributes to the literature on the spill-over effects of monetary policy. We basically show that the relevance of the interaction between domestic and foreign monetary policy is not restricted to global banks only, which have been almost the sole focus of existing microeconometric research (Cetorelli and Goldberg, 2012a, b, Bräuning and Ivashina, 2017, Timesvary et al., 2015, Baskaya et al., 2017).

The finding that even bank lending from the second group, i.e., banks not relying on foreign currency funding, reacts to UIP deviation implies that foreign funding channel passes through the international banks to the domestic interbank market, where banks borrow from each other in NOK. Again, this result is in sharp contrast to the results of studies on the spill-over effect of monetary policy to emerging economies and suggests that the Norwegian interbank market achieves a more efficient allocation of capital relative to emerging markets' interbank markets. To examine how foreign funding channel affects the population of all Norwegian banks we first document the positive correlation between the growth in the aggregate volume of banks' total foreign currency funding (fcf_t) and (lagged) UIP deviations by estimating the following simple model:

$$\Delta \ln fcf_t = \alpha_0 + \sum_{n=0}^{k} \eta_n UIP_{dev,t-n} + \varphi_t \qquad (7)$$

Table 9: The response of total foreign currency funding to UIP deviations

This table reports the results of estimating the regression of the growth rate of banks' total foreign currency funding on (1) simultaneous UIP deviation, or (2) simultaneous and lagged UIP deviations.

	Simultaneous UIP deviation ($k = 0$)	Simultaneous and lagged UIP deviations ($k = 1$)
$\sum \eta_n$	0.057*** (0.016)	0.060*** (0.016)
Adjusted R^2	0.128	0.112
Number of observations	84	84

The estimated correlations are reported in Table 9. They illustrate that for both UIP deviations with and without lag a strong positive link between banks' foreign currency funding and global funding conditions.

This implies that international banks (those in group (1) from Table 8) increase borrowing from abroad when global borrowing conditions are favorable. Next, we explore how the Norwegian interbank market facilitates the pass-through of these favorable global condition from international banks to domestic non-international banks. For this purpose we examine how interbank liabilities of domestic non-international banks (those are the banks in the second group from Table 8) react to policy rates and UIP deviations:

$$\Delta \ln ib\_dep_{i,t} = \alpha_0 + \sum_{n=1}^{2} \eta_n UIP_{dev,t-n} + \sum_{k=1}^{2} \omega_k r_{t-k} + v_{i,t} \tag{8}$$

in which $ib\_dep_{i,t}$ denotes total interbank deposits of bank i in quarter t, and r_t denotes three-month NIBOR rate. Then we look at the response of total interbank deposits dominated in domestic currency and foreign currencies, respectively

$$\Delta \ln ib\_dep\_NOK_{i,t} = \alpha_0' + \sum_{n=1}^{2} \eta_n' UIP_{dev,t-n} + \sum_{k=1}^{2} \omega_k' r_{t-k} + v_{i,t}', \tag{9}$$

$$\Delta \ln ib\_dep\_FX_{i,t} = \alpha_0'' + \sum_{n=1}^{2} \eta_n'' UIP_{dev,t-n} + \sum_{k=1}^{2} \omega_k'' r_{t-k} + v_{i,t}'', \tag{10}$$

in which $ib\_dep\_NOK_{i,t}$ and $ib\_dep\_FX_{i,t}$ denote total NOK and FX denominated interbank deposits, respectively. The results are reported in Table 10.

These results clearly show how foreign funding channel passes through to Norwegian banks not relying on foreign currency funding. They indicate that the volume of interbank deposits of the non-international banks does not react to monetary policy; instead, they react to UIP deviations, whose impact is positive and significant. This implies that these banks borrow more from other banks, whenever positive UIP deviations alleviate the relative costs of global funding for Norwegian banks. The closer look at the currency denominations of the interbank liabilities shows that the changes happen to the interbank deposits in NOK, not in foreign currencies, meaning that foreign funding channel works through NOK loans from the international banks to the less international ones. So, the more domestically oriented banks can also benefit from the UIP deviations by receiving additional interbank funding denominated in NOK.

Table 10: Interbank deposits of banks with no foreign currency liabilities

This table reports the results of the estimation of regressions of the logarithmic change in the volumes of interbank deposits on the lag values of UIP deviations and NIBOR. $\sum \eta_n$ and $\sum \omega_n$ represent the sum of the coefficients of the two lags of UIP deviations and NIBOR, respectively. Column (1) considers all interbank deposits independently from the currency which they are denominated in, column (2) is based only on interbank deposits denominated in NOK, while column (3) is based on only interbank deposits denominated in foreign currency (FX).

	Total interbank deposits	NOK interbank deposits	FX interbank deposits
	(1)	(2)	(3)

$\sum \eta_n$	0.2390* (0.0721)	0.2244* (0.0741)	0.0036 (0.1542)
$\sum \omega_k$	-0.0138 (0.0175)	-0.0132 (0.0180)	0.0396 (0.0358)
Number of observations	5037	5037	667
Adjusted R^2	0.04	0.01	0.04

We further underline the role of the domestic interbank market for the pass-through of the foreign funding channel to non-international banks by comparing the relative importance of domestic monetary policy and UIP deviations for the lending dynamics of non-international banks with high reliance on interbank funds to that of non-international banks, which are mostly funded via retail deposits. For this purpose, we look at the distribution for all non-international banks of the share of interbank liabilities in total liabilities and identify the highest (banks relying heavily of interbank funding) and the lowest quantile (mostly retail-funded banks) of this distribution. We then rerun the two-step regression specified by equations (1) and (5) for the identified subgroups of banks relying heavily of interbank funding and mostly retail-funded banks (highest and lowest quartile, respectively). The results, which are reported in Table 11 show that banks relying most on interbank funding react to UIP deviations while banks relying least on interbank funding do not ($\sum \theta_m$ gives the wrong sign). Both groups, as domestic banks, also react to domestic monetary policy as Table 8 shows, while banks in the highest 25% quantile react more strongly and lead to a higher value of $\sum \gamma_j$. This reflects the fact that banks which rely least on interbank funding are mostly small regional banks which have substantial monopolistic position in local deposit market, which allows them to partially decouple their retail funding from monetary policy shocks, hence their credit supply responds less to domestic monetary policy.

Table 11: Monetary policy and global factors for banks relying more and banks relying less on funding from domestic interbank market

This table reports the results of estimating the regression of the sensitivity of bank loan growth to bank liquidity (β) on the NIBOR as a proxy for the monetary policy interest rate and the deviations from the uncovered interest rate parity, which is instrumented by the oil price and the VIX for banks relying more and for banks relying less on funding from domestic interbank market. R^2 is not reported for the instrumental variable regression because no decomposition of the variance of the dependent variable can be assigned to the endogenous dependent variables. The number of

observations for the banks in the lowest quartile of interbank liabilities is substantially lower due the more imbalanced nature of the data for these very small banks.

	Non-international banks in highest 25% quantile of interbank liabilities	Non-international banks in lowest 25% quantile of interbank liabilities
	(1)	(2)
$\sum \theta_m$	-0.426***	0.562***
	(0.020)	(0.093)
$\sum \gamma_j$	0.038***	0.025***
	(0.003)	(0.010)
Number of observations	2240	418

In sum, we find that even though the banks with more international funding are those which are best insulated from domestic monetary policy, the dynamics of the Norwegian interbank market exposures suggests that these bank pass through some of their international funding advantages to banks with more domestic scopes of operations by channeling funds to these banks via the interbank market when international funding conditions are beneficial.

6 Robustness Checks

In this section, we conduct several robustness checks for the previous results. First, as Christiano et. al. (1999) argue, there is little consensus on the measurement for monetary policy shocks. Here we do not attempt to propose one perfect measurement, but rather we take four alternative monetary policy indicators that are typically used in the literature to replace the one in regression (2): (i) the key policy rate; (ii) changes in three-month NIBOR; (iii) percentage changes in 3-month NIBOR; (iv) interbank overnight lending rate.

Next, we also control for the changes in Federal Reserve's monetary policy by including the quarterly amount of asset purchases during quantitative easing (QE) by the Fed as an additional control variable in the second stage regression. And last but not least, we show that the results are robust to using the estimated UIP deviation of the NOK to the EUR rather than to the USD. This is to address the concern that a substantial share of foreign currency funding might be denominated in EUR rather than in USD.

The results of all robustness specifications are reported in Table 12. For each of the alternative specifications, the variables enter the regression with statistically significant coefficient of the expected signs and the results here are consistent with those reported in Table 4.

This table reports the results of the estimation of the regression of the sensitivity of bank loan growth to bank liquidity (β) on the NIBOR as a proxy for the policy rate and the deviations from the uncovered interest rate parity, which is instrumented by the oil price and the VIX. It replicates the results presented in Table 4 for different specifications of the monetary policy rate (columns (1)-(4)), as well as controlling for the quantitative easing period (column (5)) and using the UIP deviation of the NOK/EUR exchange rate instead of NOK/USD. R^2 not reported for the instrumental variable regression because no decomposition of the variance of the dependent variable can be assigned to the endogenous dependent variables.

	Key policy rate	Change in NIBOR	Percentage change in NIBOR	Overnight rate	Quantitative easing	NOK/EUR UIP deviations
	(1)	(2)	(3)	(4)	(5)	(6)
$\sum \theta_m$	-0.215*	-0.258*	-0.251*	-0.175*	-0.269*	-0.182*
	(0.011)	(0.011)	(0.012)	(0.007)	(0.012)	(0.006)
$\sum \gamma_j$	0.018*	0.464*	0.606*	0.016*	0.036*	0.042*
	(0.002)	(0.172)	(0.029)	(0.001)	(0.019)	(0.002)
Number of observations	8942	8942	8942	8942	8942	8942

7 Concluding Remarks

In this paper, we provide the first micro level evidence on the limits of the efficiency of the conventional bank lending channel in the transmission mechanism of domestic monetary policy when banks have access to global funding sources. Using Norwegian data, we show that global funding conditions modify the efficiency of domestic monetary policy. More specifically, we show that exchange rate dynamics that deviate from the UIP can generate beneficial global funding conditions for Norwegian banks, raise their incentives to use foreign currency funding and insulate banks from domestic monetary policy tightening.

Examining the mechanism of transmission of global factors, we find that, while large Norwegian banks borrow substantially in foreign currency, they issue NOK-dominated interbank loans to smaller domestic banks. The volume of these interbank positions is positively related to the deviations from interest rate parities.

As is seen in our results, when the Norwegian krone is appreciating and the global risk aversion is high, the negative risk premium attracts capital inflows which lead to growth in bank lending, and the same results

still hold after we take into account the fact that Norwegian banks hedge their foreign currency positions. These results are consistent with the so-called dilemma of global financial cycles (Rey, 2015) and can therefore be seen as the first micro level evidence for the limits of domestic monetary policy in affecting aggregate credit supply, when the capital account is not controlled (Rey, 2015, Hoffmann et al., 2016). In the sense that we focus on Norway – a high income economy with strong institutions, results are also complementary to Rey (2015), Hoffmann et al. (2016) and Baskaya et al (2917) who mainly explore emerging economies.

Furthermore, our results on the impact of foreign funding on domestic bank lending have deep financial stability policy implications. It has been argued that global banks can serve as a stabilizing mechanism for the banking system. For example, Cetorelli and Goldberg (2012b) show that during the liquidity drought in the Great Recession, locations of affiliates that are crucial for a global bank's revenue are prioritized in the internal liquidity allocation, making these affiliates better shielded from global funding shocks. Similar evidence is documented in Berg and Kirchenman (2015), who use data on all loan applications to a multi-national bank in Azerbaijan during the 2007-09 crisis.

The results presented in this paper, however, indicate that some important financial stability implications of global funding have so far been overlooked. After the current global financial crisis, many debates have been focusing on the role of global banks in spreading the crisis from one country to another, through their liquidity management and internal flow of funding (see Bank for International Settlements, 2010a, b), but our results suggest that it is equally important to understand the role of foreign funding in contributing to domestic credit cycles and excess risk-taking (not covered by this paper, however) in normal times, not only in crises. This brings several new challenges to both monetary policy and financial regulation.

The first challenge is related to the question of whether central banks need a new paradigm for monetary policy analysis. From our results, even if a central bank sticks to its mandate and focuses only on price stability, it is still unclear how much the effectiveness of monetary policy is affected by the foreign funding channel. In reality the rising availability of foreign funding may make banks' lending rates – or, the funding costs of firms and households, – react less to policy rates, and make the real activities react less to policy rates. There has so far been little relevant research establishing this relationship empirically.

The second challenge refers to the design of macroprudential policies to reduce booms and busts. As the "lean-against-the-wind" type of monetary policy may not be sufficient to contain credit cycles, the macroprudential regulation, such as Basel III framework that features countercyclical capital buffer and liquidity requirements, should be a good complement. However, in the current design of macroprudential

policies, there has been little distinction between domestic and foreign funding sources. Banks may still use foreign funding to arbitrage against domestic monetary policy that attempts to brake credit booms.

Third, how much should global banking be regulated? Needless to say, rising globalization in banking and foreign currency funding increase the likelihood of financial contagion and vulnerability of banks to foreign shocks, but before arguing for full capital controls, one has to keep in mind that the foreign funding channel also improves the diversity of banks' funding sources, facilitating international risk-sharing and cushioning the impact of domestic shocks. Therefore, regulators need to properly assess domestic banks' exposure to foreign risks and impose requirements for necessary buffers. Further, it is desirable to combine some degree of capital controls with macroprudential regulation, as proposed by Korinek and Sandri (2016) and, as an extension to their lender-of-last-resort responsibilities, central banks need more coordination to reduce cross-border spillovers of funding shocks, for instance, through currency swap agreements. After all, these financial stability policy concerns need to be addressed by the new global framework of banking regulation in the future.

Appendix

A. The intermediate estimates of β_t

Figure 2 presents the time series of β_t that is estimated from the first step regression (1).

Figure 2: Estimates of β_t
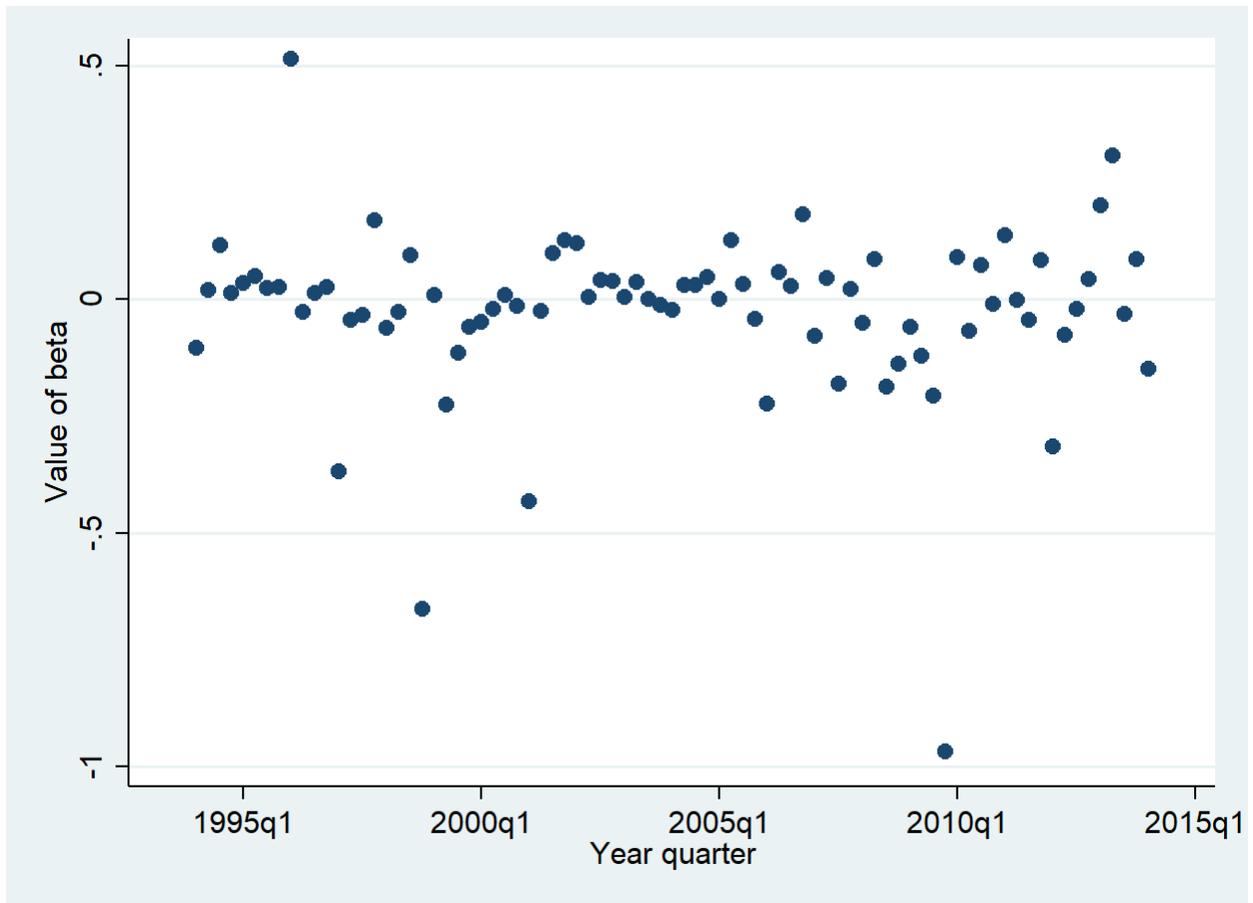
B. The second-stage estimates of lagged variables for Table 2

Key policy rate

	β_t (using the liquid assets-to-asset ratio)		β_t (using the residual of liquid assets-to-asset ratio regression)	
	coefficient	*p*-value	coefficient	*p*-value
L1.	-0.00178	0.366	-0.0669	0.000
L2.	0.0236	0.000	0.116	0.000
L3.	-0.0303	0.000	-0.0678	0.000
L4.	0.0190	0.000	0.0497	0.000
L5.	0.00346	0.305	-0.0851	0.000
L6.	-0.0171	0.000	0.0488	0.000
Constant	0.0331	0.000	-0.00528	0.096
Number of obs.		20777		20777
Adjusted R^2		0.0151		0.0795

Three-month NIBOR

	β_t (using the liquid assets-to-asset ratio)		β_t (using the residual of liquid assets-to-asset ratio regression)	
	coefficient	*p*-value	coefficient	*p*-value
L1.	0.00436	0.020	-0.0363	0.000
L2.	0.0950	0.003	0.0588	0.000
L3.	-0.0252	0.000	-0.0409	0.000
L4.	0.0444	0.000	0.0674	0.000
L5.	-0.0505	0.000	-0.125	0.000
L6.	0.0158	0.000	0.0726	0.000
Constant	0.0265	0.000	-0.0146	0.000
Number of obs.		20777		20777
Adjusted R^2		0.0182		0.0831

C. The second-stage estimates of lagged variables for Table 5

	β_t (IV regression using VIX)	
	coefficient	*p*-value
UIP deviation		
L1.	0.0300	0.003
L2.	-0.299	0.000
three-month		
NIBOR		
L1.	0.00395	0.564
L2.	0.0432	0.001
L3.	0.110	0.000
L4.	0.0821	0.000
L5.	-0.400	0.000
L6.	0.198	0.000
Constant	-0.140	0.000
Number of obs.		8942
Adjusted R^2		0.148

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