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Uncertainty and International Banking

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Uncertainty and International Banking*

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Abstract

We develop a new measure of uncertainty derived from bank-level data. We apply the measure of firm-level uncertainty developed by Bloom and others (2012) to banking. Uncertainty is measured as the cross-sectional dispersion of shocks to banking-sector specific variables. We then analyze how uncertainty in banking affects lending by domestic and foreign-owned banks. We find that, first, higher uncertainty in banking has negative effects on bank lending. Second, the effect is heterogeneous across banks: Lending by banks which are better capitalized and have higher liquidity buffers tends to be affected less. Third, foreign-owned banks do not react differently to uncertainty in the host country compared to domestically-owned banks.

JEL-codes: G01, F34, G21

Keywords: International banking, uncertainty, financial intermediation

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1 Motivation

Since the outbreak of the financial crisis, many countries experienced stagnating or even declining levels of bank credit. Both demand and supply side effects are behind this decline (Cornett and others 2011). Banks have also withdrawn from international markets at a large scale. In this paper, we analyze the role of increased uncertainty in the banking sector for the decline in bank credit. We develop a new measure for uncertainty that exploits bank-level information, and we explore the impact of uncertainty in banking on the lending behavior of domestic and foreign-owned banks.

By analyzing the link between bank lending and uncertainty, this paper contributes to a large body of research documenting the impact of uncertainty on investment. In a recent survey, Bloom (2014) shows that uncertainty increases in recessions and that it has a negative impact on short-run hiring and investment in the manufacturing sector. Moreover, measures of uncertainty based on firm-level micro-data are strongly countercyclical and negatively affect economic growth. The reason might be that firms exercise an “option value of waiting”: The higher the degree of uncertainty, the more firms benefit from postponing investment projects, in particular if they are irreversible (Bloom, Bond, and Van Reenen 2007).

Similar to an investment by a nonfinancial firm, bank lending is a longer-term contractual arrangement. Consequently, it might be beneficial to postpone the loan decision in the presence of uncertainty. Uncertainty can affect banks' financial intermediation function through various channels. First, banks intermediate short-term funds into long-term loans. This exposes them to liquidity risk and maturity mismatch. In uncertain times, refinancing in interbank markets might become more difficult leading banks to restrain credit supply. Second, banks reduce information asymmetries and facilitate access to credit. In an environment characterized by higher uncertainty, credit risk increases and banks may restrict lending to information-sensitive borrowers. Third, the probability that banks are hit by large shocks increases in uncertain times such that investors demand a higher funding premium. Hence, banks might face tightened external financing constraints which restrict the ability to provide loans as shown by Valencia (2013).

Higher uncertainty in the banking sector can thus be considered to be a key factor behind the reluctance to lend domestically and the withdrawal of international banks from foreign markets. However, there are surprisingly few applications of the literature on firm-level uncertainty for banks. In this paper, we construct a measure of uncertainty

based on bank-level data and analyze its impact on bank lending of both domestic and foreign-owned banks. We use a dataset which builds on Bankscope and on information on foreign ownership of banks provided by Claessens and van Horen (2014). These data are used to generate measures of uncertainty in banking derived from bank-level data and to capture the degree of internationalization of banks.

With these data at hand, we ask three research questions. First, how can we measure uncertainty in banking and what have been patterns of uncertainty in banking during the crisis? Uncertainty is often measured through fluctuations (the volatility) of high-frequency time series such as stock prices. The advantage of this method is that it allows analyzing short-run changes in uncertainty. The disadvantage is that it is applicable to listed banks only. For Europe, smaller banks accounting for a significant fraction of the market are not covered. Not only are market data unavailable for these banks, relevant data are also available at a low (annual) frequency only. We thus use the dispersion of bank-level shocks to growth rates in total assets, short-term funding, productivity, and profitability as an alternative measure for uncertainty in banking. Descriptive statistics show that the dispersion of bank-level shocks has increased during the crisis, which we interpret as higher uncertainty. Moreover, the dispersion of bank-level shocks is not highly correlated with standard measures of uncertainty. This suggests that we measure a distinct feature of uncertainty.

Second, how does uncertainty affect bank lending? We closely follow previous literature analyzing the impact of funding shocks on banks' investment patterns. Cornett and others (2011) have developed an empirical model which can be used to analyze the impact of funding shocks on the lending behavior of banks.¹ They find that, during liquidity crises, banks with a relatively large share of illiquid assets reduce lending more. Valencia (2013) analyzes the relationship between loan supply and uncertainty for a sample of US commercial banks and the period 1984-2010. He shows that banks with relatively low levels of capitalization decrease lending more if uncertainty increases. Uncertainty is thereby measured as the dispersion of professional forecasts or stock market volatility. We instead develop a cross-sectional measure of uncertainty derived from bank-level data. We find that higher uncertainty in banking has negative effects on bank lending. The effect is heterogeneous across banks: Lending by banks which are better capitalized and which have higher liquidity buffers is affected less. These results are essentially in line with those by Valencia (2013).

¹ For research on the transmission of shocks across countries through internationally active banks, see the work by Cetorelli and Goldberg (2011, 2012).

Third, does the internationalization of banks have an impact on their response to higher uncertainty? Previous literature shows that internationally active or foreign-owned banks decreased their loan supply more than domestic and locally funded banks (De Haas and van Lelyveld 2014, Ongena, Peydro and van Horen 2013). This retrenchment of international lending can be attributed to a flight home effect (Giannetti and Laeven 2012), and it depends on the geographical distance of the foreign market (De Haas and van Horen 2013). We contribute to this literature by asking whether the ownership structure of banks matters for the response of individual banks to uncertainty. We do not find conclusive evidence that foreign-owned banks are affected less by uncertainty in banking in the host countries than domestically-owned banks.

In the following second part, we present a stylized model to illustrate the concept of uncertainty. In part three, we describe the data that we use and discuss how we measure uncertainty in banking. In part four, we show the evolution of uncertainty in banking across countries and time, and we relate uncertainty in banking derived from bank-level data to alternative measures of uncertainty. In part five, we present our empirical results linking bank lending of domestic and foreign-owned banks to uncertainty. In part six, we conclude.

2 A stylized model

To illustrate the concept of uncertainty which underlies this paper, we present a stylized model. Based on the model by Shin (2012), we can assess the impact of higher uncertainty in banking on banks' loan supply. Assume that at time t , the balance sheet of the bank looks as follows:

Assets		Liabilities	
Loans	l_t	Deposits	d_t
Liquid Assets/Cash	c_t	Equity	e_t

The bank makes loans l_t at time t and receives a return (=loan rate) at time $t+1$ of \tilde{r}_{t+1} . The loan rate \tilde{r}_{t+1} is risky as borrowers might not pay back the full loan but larger than zero in expectation ($E[\tilde{r}_{t+1}] > 0$). The deposit rate and the return on liquid assets are assumed to be risk free and equal to zero.

The value of equity at time $t+1$ is then given by:

$$e_{t+1} = l_t(1 + \tilde{r}_{t+1}) + c_t - d_t = e_t + \tilde{r}_{t+1}l_t \quad (1)$$

The bank defaults in $t+1$ if the value of the equity is negative ($e_{t+1} < 0$), i.e. if the return on loans is smaller than the amount of equity per unit of loans available to cover potential losses:

$$\tilde{r}_{t+1} < -\frac{e_t}{l_t} \quad (2)$$

2.1 The VaR constraint

We assume that the bank is risk-neutral but operates under a value at risk (VaR) constraint which is given by:

$$\text{Prob}\left(\tilde{r}_{t+1} < -\frac{e_t}{l_t}\right) \leq 1 - \alpha \quad (3)$$

The value at risk is defined as the loss not to be exceeded with probability $1 - \alpha$, i.e. $\text{VaR}_\alpha = e_t / l_t$. We can think of the VaR constraint as reflecting how the bank manages its risk, or, alternatively, a minimum capital requirement imposed by the regulator. The VaR constraint can also be defined as a deviation from the mean measured in terms of standard deviations σ_t , which is assumed to be known at time t , i.e.

$$\text{Prob}(\tilde{r}_{t+1} < \mu - \phi\sigma_t) \leq 1 - \alpha \quad (4)$$

where ϕ is some constant.

We assume that the bank maximizes its shareholder value e_{t+1} at time $t+1$. In the absence of the VaR constraint, the risk-neutral bank would give out as many loans as possible. The reason for this is that the expected return is larger than zero. In principle, the size of the balance sheet would thus be indeterminate. However, the VaR constraint under which the bank operates determines the size of the loan portfolio. This can be seen by combining equations (3) and (4):

$$l_t = \frac{e_t}{\phi\sigma_t - \mu} \quad (5)$$

2.2 Uncertainty in banking and loan rates

We assume that loan rates of bank i follow a stochastic process with time-varying volatility:

$$\tilde{r}_{it+1} = \mu_i + \sigma_i \varepsilon_{it+1} \quad (6)$$

where $E[\varepsilon_{it}] = 0$ and $\varepsilon_{it} \sim N(0,1)$ which implies that the mean of the loan rate conditional on time t information (I_{it}) is constant, so $E[\tilde{r}_{it+1} | I_{it}] = \mu_i$. While the assumption of μ_i being constant might appear too restrictive, its interpretation can easily be generalized to the

predicted value of the loan rate at time t without making a specific assumption on the underlying prediction model. Therefore, we can simply refer to μ_i as the predicted part of the loan rate and to $\sigma_i \varepsilon_{it+1}$ as the unpredicted part for each bank i .

The volatility of the bank-specific shock ε_{it+1} to the loan rate is time-varying. Regarding the timing convention, we follow Bloom et al. (2012) and assume that banks know in advance about any potential change in business conditions, which would be reflected in a change in the distribution of shocks and thus the volatility σ_i . A higher σ_i can be interpreted as higher uncertainty because it widens the distribution of \tilde{r}_{it+1} . Hence, it constitutes a measure of *uncertainty in banking*. More specifically, we assume that in t , the bank can condition its portfolio decision on the level of uncertainty σ_i . While the bank knows that the distribution of shocks has widened, the bank does not learn about the realization of the loan rate \tilde{r}_{it+1} before $t+1$.

In the following, we show how higher uncertainty in banking lowers the volume of loans relative to total assets of a bank. Instead banks hold more liquid assets as they yield a safe return of zero.

2.3 Uncertainty in banking and loan supply

Starting from the optimal size of loans on the asset side given by equation (5) which is assumed to hold in all periods, we can derive the change in loans from $t-1$ to t relative to total assets at time $t-1$ ($ta_{t-1} = e_{t-1} + d_{t-1}$). This will constitute the dependent variable in the empirical analysis below:²

$$\frac{\Delta l_t}{ta_{t-1}} = \frac{l_t - l_{t-1}}{ta_{t-1}} = \frac{e_{t-1}}{ta_{t-1}} \left(1 + \frac{\tilde{r}_t}{\varphi \sigma_{t-1} - \mu} \right) - \frac{e_{t-1}}{ta_{t-1}} \quad (7)$$

We assume that at time t , the bank learns about changes in uncertainty in banking and can incorporate this information into its loan supply decision. The effect of higher uncertainty on the change in loans relative to total assets in $t-1$ is given by the first partial derivative of equation (7) with respect to uncertainty in banking σ_i :

$$\frac{\partial \left(\frac{\Delta l_t}{ta_{t-1}} \right)}{\partial \sigma_i} = \frac{-\varphi e_{t-1} \left(1 + \frac{\tilde{r}_t}{\varphi \sigma_{t-1} - \mu} \right)}{(\varphi \sigma_{t-1} - \mu)^2} < 0 \quad (8)$$

² We skip the bank index i in the following.

The result implies that the bank reduces the volume of loans on its balance sheet, i.e. it supplies less loans, if uncertainty in banking increases. The inequality holds as long as $\tilde{r}_t > \mu - \varphi\sigma_{t-1}$, which implies that the bank is solvent in t (see equation (2)).

2.4 The role of the capital buffer

In the empirical analysis below, we investigate how the response of banks to uncertainty depends on their characteristics. One of these characteristics is the capital buffer that a bank holds. A bank might voluntarily choose to hold capital above the regulatory requirement to shield itself against unexpected losses. This is particularly important under the aspect of uncertainty. The reason is that from the perspective of the individual bank, uncertainty affects the probability to incur such an unexpected loss.

Within the logic of the model, a bank with a capital buffer is subject to a more stringent (but voluntarily chosen) VaR constraint at time $t-1$ which can be relaxed at time t ($\phi_{t-1} > \phi_t$). We show in the Appendix that a bank holding a capital buffer reduces the loan volume by less as long as it still gets a positive return on its loans ($r_t > 0$).

This model illustrates a specific mechanism how uncertainty in banking - modeled as an increase in the standard deviation - affects banks' behavior. We transfer this idea to our empirical analysis and measure uncertainty as the cross-sectional dispersion of bank-specific shocks. In reality, banks might be affected by uncertainty through a range of other channels. Therefore we vary the variable from which the measure of uncertainty in banking is derived. We also include other bank-level variables besides capital to control for heterogeneity in banks' business models and liquidity management.

3 Data and measurement issues

In this paper, we ask three questions: How can we measure uncertainty in banking? How does uncertainty in banking affect bank lending? And are domestic and foreign-owned banks affected differently? In this section, we discuss the data sources that we use and other issues related to measurement.

3.1 Bank-level data

Banks' balance sheet and income statement data are taken from Bankscope. Our sample is based on banks in 48 countries which belong to the OECD, the EU, and/or the G20. This ensures having a sufficiently homogenous set of industrialized countries while, at the same time, exploiting a sufficient degree of heterogeneity with regard to uncertainty

in banking. We keep only countries with more than 50 bank-year observations and banks with at least five consecutive observations. The sample period spans the years 1998-2012.

Our explanatory variables include balance sheet strength and banks' liquidity risk management as in previous papers in the field such as Cornett and others (2011). We construct these variables from Bankscope, and we winsorize them at the top and the bottom percentile. Liquidity is measured as the ratio of liquid assets to total assets (in %). Capitalization is measured as the Tier 1 regulatory capital relative to total assets (in %). We control for customer deposits relative to the total size of the balance sheet by including the deposits to assets ratio (in %). Additionally, we include the log of total assets (in thousands US-dollars). We also include the fraction of committed loans relative to the sum of committed loans and total assets (in %). For more information, see the data description in the Appendix. The corresponding summary statistics are provided in Table 1.

We use standard procedures to correct for outliers and implausible values. First, we exclude observations for which total assets are missing as well as the bottom percentile of total assets. Second, to account for mergers, we drop observations for which the annual change in assets is larger than 40% (Cornett and others 2011). Third, we drop observations if assets, equity, or loans are negative. We do the same if loans to assets, equity to assets, or non-performing loans ratios are larger than one. Fourth, a bank is kept in the sample if it is a bank holding company, a commercial bank, a cooperative bank, or a savings bank.

To measure the degree of internationalization of individual banks, we resort to data compiled by Claessens and van Horen (2014). These data provide information about the ownership status of a given bank. The dataset covers 5,324 banks in 137 countries for the period 1995-2009. Countries are included in the sample if they have more than five active banks in 2009. For advanced countries, only the largest 100 banks (based on their assets in the year 2008) are included. Despite these restrictions, 90 percent of a country's banking systems' assets are covered. As such, the database provides comprehensive information on banks' ownership status.

We exploit information on whether a bank is foreign or domestically-owned. In addition, if a bank is foreign-owned, we know the country of origin of the largest foreign shareholder. We can thus test whether the lending decision of a foreign-owned bank differs from a domestically-owned bank, and we can control for uncertainty in banking in the residence country of the largest foreign shareholder. We match these data to the bank-level data obtained from Bankscope.

3.2 Measuring uncertainty in banking

3.2.1 Cross-sectional dispersion as a measure of uncertainty

To measure the impact of uncertainty on bank lending, we conceptualize the term uncertainty as follows. Times of uncertainty are times during which future outcomes become less predictable. For instance, the ability of individual banks to forecast future performance of borrowers or the availability of funding might decline in the presence of higher uncertainty. One reason for which predictability decreases can be that the underlying distribution of shocks to the outcome variable widens. In the theoretical model, this was reflected by a widening of the distribution of shocks to the loan rate. Alternatively, one could imagine a widening of the distribution of the repayment performance of firms. This suggests measuring uncertainty in banking as the dispersion of bank-level shocks.

Empirical measures of uncertainty include (implied) stock market volatilities as well as dispersion measures based on firm-level sales growth or productivity shocks. Often, uncertainty is measured using (lagged) stock price volatility as a measure of historic volatility (Bloom 2007). This approach is based on high-frequency market data. Similarly, measures of implied volatility draw on market data such as prices of stock options (Stein and Stone 2012). Given that stock market based uncertainty measures have been used in many previous studies, results are easily comparable.

However, for many applications of interest, such high-frequency market data are not available for all firms. This is the case in banking, which we study here. Reliable market data on banks' share prices are difficult to obtain for many emerging markets and developing countries. Even for key developed market economies such as Germany, stock market data would restrict the sample to a very small set of listed banks.

For this reason, we need a measure of uncertainty which can be computed based on lower frequency balance sheet or profitability data. Jurado, Ludvigson, and Ng (2013) argue that a meaningful measure of uncertainty needs to relate to the unpredicted component of a variable. We thus do not use balance sheet or profitability data as such but extract the unexplained components of bank-level variables. This is similar to De Veirman and Levin (2014) who derive firm-specific volatility measures from residuals of sales or earnings growth regressions of US firms.

Consequently, we compute the cross-sectional dispersion across these unexplained components across all banks in a given country and year. This implies that the dispersion increases if the distribution of these unexplained components widens: on average across

all banks, the future becomes less predictable. An increase in the cross-sectional dispersion of shocks can thus be interpreted as a higher degree of uncertainty in banking. This is in line with the approach and findings of Bloom and others (2012). They show that the cross-sectional dispersion derived from firm-level data can be a useful approximation for uncertainty, and that it can be used to explain variations in business cycle movements across time and space.

3.2.2 *Application to banking*

Bloom and others (2012) compute the cross-sectional dispersion of productivity shocks based on a sample of US manufacturing firms. To the best of our knowledge, the concept to use the cross-sectional dispersion to measure uncertainty has not yet been applied to banking.

In banking, productivity is more difficult to define compared to manufacturing because the distinction between inputs and outputs is less clear (Degryse, Kim, and Ongena 2009). Deposits, for example, may be considered as being an input into the “production” of loans, but overdraft deposits might also turn into loans. Also, banks have to balance the optimal use of inputs and outputs to generate sufficient returns while also managing the risk of their operations. The resulting heterogeneity in business models needs to be taken into account. We thus do not constrain our analysis to bank productivity but calculate four annual cross-sectional dispersion measures:

- Dispersion of shocks to total asset growth: We use the dispersion of shocks to total asset growth as a proxy for asset-side shocks affecting banks. These asset-side shocks can be related to loan demand shocks but they can also capture other factors affecting the volume of banks' assets.
- Dispersion of shocks to short-term funding growth: In uncertain times, access to funding might differ significantly across banks. Banks which heavily rely on customer deposits may be affected less by a funding shock than banks relying on wholesale funding. As a result, the dispersion of shocks to short-term funding across banks widens. We measure short-term funding as deposits from banks, repos and cash collateral, other deposits, and short-term borrowings.
- Dispersion of shocks to productivity growth: We estimate bank productivity using an empirical methodology in the spirit of Levinsohn and Petrin (2003) and applied to banks by Nakane and Weintraub (2005) or Buch, Koch, and Koetter (2009): $\ln y_{it} = \beta_0 + \beta_l x_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + \eta_{it}$. Bank output is given by y_{it} , x_{it} denotes the free input variables, k_{it} the fixed input and m_{it} the intermediate input. The error

consists of an unobserved productivity term ω_{it} and a random term η_{it} . The approach accounts for simultaneity between productivity and the factor input choices of banks. This is achieved by introducing the intermediate input which correlates with productivity. Productivity shocks thus primarily account for supply-side factors. The output of banks is defined as the total lending volume. We choose two free input variables. The first is total long-term funding. The second accounts for bank staff and is proxied by personnel expenses. Banks have to maintain branches or subsidiaries to provide loans. These cannot be adjusted rapidly and we capture the fixed input by fixed assets. For the intermediate input good, we choose total equity.

- Dispersion of shocks to profitability (RoA): During crisis times, adverse shocks become more likely. This can cause the distribution of profitability shocks to widen. These shocks can, for instance, be related to an increase in credit risk. Profitability is proxied by returns on assets (RoA) defined as the ratio of operating profits to total assets (in %).

Uncertainty in banking is then measured as the cross-sectional dispersion of shocks for each of these four variables. To compute the cross-sectional dispersion of shocks, we proceed in two steps.

In a first step, we derive bank-year specific shocks for each of these four variables from the following regression model:

$$\log(X_{ijt}) - \log(X_{ijt-1}) = \Delta \log(X_{ijt}) = \alpha_i + \alpha_{jt} + \varepsilon_{ijt} \quad (11)$$

where $\Delta \log(X_{ijt})$ is the growth rate of bank i 's assets (short-term funding or productivity) in percent at time t in country j and α_i are bank fixed effects.^{3,4} We control for

heterogeneous effects of common factors at the country level by including time varying country fixed effects α_{jt} . The residuals ε_{ijt} are used to calculate the cross-sectional dispersion measures. By focusing on shocks rather than the variables as such, we relate uncertainty to the unexplained components. This is in line with Jurado, Ludvigson, and Ng (2013) who argue that any measure of uncertainty should be based on the variation in the unforecastable component of the outcome variable. If banks forecast according to equation (11), the regression residual captures the individual forecast error in each year.

In a second step, we calculate uncertainty in banking as the cross-sectional dispersion across all bank specific shocks ε_{ijt} per country and year. We compute the cross-sectional

³ Results remain unaffected if we estimate equation (11) separately for all banks in one country.

⁴ Because return on assets (RoA) is a flow variable, we estimate this equation for the levels of RoA.

dispersion as the standard deviation (SD). This gives the measure for uncertainty in banking derived from bank-level data, which we call $UncBank_{jt}$ for country j at time t :

$$UncBank_{jt} = SD(\varepsilon_{ijt}) \quad (12)$$

This can be seen as the empirical counterpart of the time-varying volatility σ_t capturing uncertainty in banking in the theoretical part. It is a conditional dispersion measure as we do not use the variables as such but the estimated errors of regression (11).

The corresponding summary statistics of the dispersion measures are provided in Table 2. Note that the values cannot be easily compared across the different measures. The reason is that the summary statistics of the standard deviations depend on the definition and the levels of the underlying variable. For comparability across time, we describe the pattern of the standardized measures for uncertainty in banking in Section 4.1 (Figure 1).

3.3 *Alternative uncertainty measures*

To compare our measures of uncertainty in banking derived from bank-level data to other uncertainty measures, we use the following macroeconomic variables:

First, we calculate bank volatility based on weekly bank stock price indices taken from Datastream. To capture uncertainty in financial markets as a whole, we construct a measure for stock market volatility using monthly stock price indices from Datastream. In contrast to bank-level data based measures of uncertainty, which are calculated for cross-sections, these variables are time-series measures of uncertainty.

Second, uncertainty in the broader economy is covered by the following four measures: Political uncertainty in the economy is proxied by the economic policy uncertainty index for the US (Baker, Bloom, and Davis 2013). To control for business cycle fluctuations, we include GDP growth which is taken from the IMF World Economic Outlook. In addition, disagreements in forecasts tend to widen during recessions and can serve as a measure for uncertainty (Bloom 2014). Finally, we use the dispersion in firm returns obtained from Bloom (2014).

The alternative measures for uncertainty are depicted in Figure 2. Overall, they show a countercyclical pattern. We see increased levels of uncertainty during the recent financial crisis. In a similar vein, GDP growth has dropped sharply during the crisis, and disagreement among forecasters has increased. Most of the uncertainty measures have started to decline again at the end of the sample period. However, this does not hold true for the economic policy uncertainty index which remains at an elevated level.

4 Uncertainty in banking: descriptive statistics

4.1 Has uncertainty in banking changed over time?

In Figure 1, we plot the cross-sectional dispersion measures over time. For comparability, we have standardized these uncertainty measures.

Although countries inside and outside the Euro Area have been affected differently by the subprime and the sovereign debt crisis, the time trends for the Euro Area and the non-Euro Area are similar. Prior to the crisis, the dispersion of shocks to total assets, productivity, and profitability (RoA) has tended to decline. This trend has been interrupted by an increasing dispersion of shocks during the crisis but continued afterwards. The levels of uncertainty differ though between Euro Area and non-Euro Area countries. Euro Area countries tend to show a lower dispersion for all four uncertainty measures than non-Euro Area countries.

The patterns of the dispersion of shocks to short-term funding are quite different from this general picture: the dispersion has increased in the up-run to the crisis, and it has declined subsequently. Interpreting a higher standard deviation as a higher degree of uncertainty, this indicates that uncertainty in banking was transmitted through a wider dispersion of shocks to the funding side of banks' balance sheet. This is consistent with the interpretation of the financial crisis as a crisis of bank funding.

In sum, we find that cross-sectional dispersion measures based on bank balance sheet data, productivity, and profitability show different patterns. Nevertheless, the dispersion for all bank-level data based uncertainty measures is higher during the financial crisis. This suggests that these measures capture higher uncertainty during crisis times.

4.2 Do different measures of uncertainty measure the same?

Table 3 provides pairwise correlations of different measures of uncertainty. Although our four measures of uncertainty in banking are positively correlated, absolute values of the correlations are small. Hence, our measures pick up different features of uncertainty in the banking sector. One exception is the correlation among the dispersion of shocks to total assets and profitability (0.51).

The alternative uncertainty measures include, for example, bank volatility or stock market volatility. Correlations with the bank-level based dispersion measures tend to be small while three of our uncertainty measures correlate significantly with bank volatility. The uncertainty measure based on return on assets shows a significant correlation with most of the other proxies for uncertainty. The dispersion calculated from banks'

productivity shocks correlates positively with the dispersion in forecasts and firm return dispersion (Table 3).

Figure 3 compares the development of the common measures for uncertainty with the standardized dispersion measures derived from bank-level data. Measures based on high frequency data like bank volatility fluctuate more. In contrast, short-term fluctuations are smoothed out in the dispersion measures derived from annual bank-level data.

Correlations or simple time series plots do not allow accounting for common trends and country-specific shocks. Table 4 thus gives results of univariate panel regressions using the dispersion measures as the dependent and alternative uncertainty measures as the explanatory variables. These regressions include country- and year-fixed effects.⁵ All variables are positively and significantly correlated with bank volatility, except the cross-sectional uncertainty measure based on the dispersion of shocks to productivity. Hence, our *cross-sectional* measures for uncertainty in banking behave similarly to commonly used *time series* measures for uncertainty in the banking sector.

For the remaining alternative uncertainty measures, the picture is less clear-cut. The index of uncertainty with regard to economic policy is negatively correlated with the dispersion in asset shocks (Table 4a). Lower GDP growth or a higher dispersion of firm returns are associated with a higher uncertainty in banking measured as the dispersion of shocks to profitability as depicted in Table 4d. This is consistent with the previous results.

In sum, uncertainty in banking is, to a large extent, unrelated to alternative uncertainty measures and in particular to macroeconomic uncertainty. This is in contrast to what has been found for uncertainty measures based on microeconomic firm-level data (Bloom and others 2012), which are highly correlated with economic activity.⁶ The result suggests that our uncertainty measures based on bank-level data contain additional information on uncertainty in the banking sector. This is confirmed by their significant correlation with the volatility of stock returns in the banking sector.

⁵ In the case of economic policy uncertainty, which does not vary across countries, we control only for country fixed effects.

⁶ In contrast, a recent paper by De Veirman and Levin (2014) finds only limited evidence that firm-specific volatility is counter-cyclical.

5 How does uncertainty affect bank lending?

5.1 The empirical model

To analyze the effect of uncertainty in banking on bank lending, we start with the following benchmark model:

$$\begin{aligned} \frac{\Delta Loans_{ijt}}{Assets_{ijt-1}} = & v_i + v_t + \alpha_1 \Delta \log GDPDeflator_{jt} + \alpha_2 \Delta \log GDP_{jt} + \alpha_3 X_{ijt-1} + \alpha_4 UncBank_{jt} \\ & + \alpha_5 UncBank_{jt} * X_{ijt-1} + \varepsilon_{ijt} \end{aligned} \quad (13)$$

where $\Delta Loans_{ijt} / Assets_{ijt-1}$ denotes the difference in the loan volume relative to total assets in $t-1$ (in %). We control for time invariant bank characteristics and common time trends by including the fixed effects v_i and v_t . Uncertainty in banking is described by $UncBank_{jt}$, which is the cross-sectional dispersion across bank-specific shocks. Changes in the broader economy are captured by the change in the natural logarithm of the GDP deflator ($GDPDeflator_{jt}$) and real GDP (GDP_{jt}). X_{ijt-1} are time-varying bank characteristics capturing liquidity, capitalization, the share of customer deposits in total assets, size, and committed loan obligations. Lagging the bank characteristics accounts for simultaneity, it is not meant to address endogeneity.

When analyzing the impact of uncertainty on bank lending, we are facing two identification issues. The first identification issue relates to the endogeneity of uncertainty. Uncertainty might drive bank lending but the dynamics of lending might also affect uncertainty. This endogeneity concern is partly remedied because lending and uncertainty are measured at different levels: our dependent variable is bank-level lending while uncertainty is measured at the country level. Hence, if we assume that individual banks do not drive aggregate uncertainty, this should be a minor concern.

The second identification issue relates to demand and supply effects. Uncertainty affects banks – the suppliers of credit – as well as the firms who demand credit from banks. We disentangle demand and supply effects by making use of bank-level heterogeneity. The measure for uncertainty in banking is interacted with the bank-level explanatory variables $UncBank_{jt} * X_{ijt-1}$. This allows for different responses of banks to uncertainty depending on their balance sheet strength and liquidity management.

Assuming a differential response conditional on these bank-level variables allows identifying the supply side effect. A similar identification strategy has been applied by Cornett and others (2011) for the case of funding shocks or Valencia (2013) for aggregate uncertainty. This identification scheme is valid as long as borrowers are not

systematically similar in the respective balance sheet characteristic to the banks they borrow from.

We start from a baseline regression, including macroeconomic control variables (Table 5). To see whether the results differ when our measures for uncertainty or other proxies are used, we exchange them by e.g. stock market volatility or firm return dispersion (Table 6). We then replace the macroeconomic controls by country-year fixed effects (Table 7). These models have the advantage that all unobservable macroeconomic factors are absorbed. Yet, the effect of uncertainty in banking – which varies across countries and years only – cannot be identified. The focus is then on the interaction term of the bank-level data based uncertainty measure with bank characteristics. Based on this model, we perform robustness tests for different country samples and time periods (Tables 8-11). Finally, we control for the ownership status of banks (Tables 12-13).

5.2 *Baseline regressions including macroeconomic controls*

Table 5 shows the results for the baseline regressions including macroeconomic controls. Banks reduce loan supply as response to higher uncertainty in banking (*UncBank*). This holds for all cross-sectional uncertainty measures derived from bank-level data except the dispersion of shocks to short-term funding. A one unit increase in uncertainty in banking reduces bank lending on average from 1.3 percent in the case of the dispersion of shocks to profitability to 4.3 percent in the case of the dispersion of shocks to total assets.⁷ The adverse effect of uncertainty on loan supply is also significant when no interaction terms are included.⁸

Based on the estimated coefficients, we can assess the quantitative scale on which uncertainty in banking impacts banks' loan supply. Across all bank-year observations included in the estimations, the change in loans relative to total assets of the previous period (our dependent variable) amounts to 3.9 percent on average. We do an in-sample prediction which sets uncertainty in banking first to its minimum value as observed in the sample and then to its maximum value. For the sake of brevity, only the results for the dispersion of shocks to profitability are considered. It turns out that the change in loans would have been equal to 5.7, i.e. 1.8 percentage points *higher*, if uncertainty in banking

⁷ Given that we have standardized our uncertainty measures, a one unit increase in *UncBank* corresponds to one standard deviation. The bank-level variables are evaluated at their means.

⁸ We present estimation results only for specifications including interaction effects. Results without interaction effects are available upon request.

had been at its minimum. Equivalently, the change in loans would have been equal to -1.5 percent on average, i.e. 5.4 percentage points *lower*, if uncertainty in banking had been at its maximum.⁹

Which banks are most affected by uncertainty in banking?

To account for the effect of (pre-determined) characteristics of banks and following our identification strategy, we interact *UncBank* with the bank-level variables. These interaction terms show that the effect of uncertainty on bank lending is heterogeneous. More liquid banks reduce lending by less given a rise in uncertainty in banking (Table 5, Columns 1 to 3). This suggests that in uncertain times these banks can draw on their liquidity buffers to stabilize lending.

Figure 4 shows average marginal effects of uncertainty in banking on loan supply, conditional on the liquidity ratio of banks. It shows not only the point estimates presented in Table 5, but it also varies the liquid asset share from zero to 80 percent. For all dispersion measures, the contraction in lending following an increase in uncertainty is smaller the more liquid assets a bank holds. More liquid banks can thus shield their supply of loans against an increase in uncertainty. For banks with sufficiently high liquidity, the marginal effects even turn insignificant. In this case, bank lending is not affected by uncertainty in a significant way.

Turning to the effects of the level of capitalization, the results in Table 5 show that higher levels of capital might isolate bank lending against higher uncertainty (Columns 1 and 4). Better capitalized banks reduce lending by less relative to their peers if the dispersion of shocks to total assets or profitability increases. This would be in line with the observation that regulatory capital requirements become increasingly binding in uncertain times as illustrated in the theoretical model (Section 2). Banks with low capital buffers have to adjust by shifting their portfolio from risky investments such as loans to less risky ones. In contrast, better capitalized banks decrease lending relative to the average bank if the dispersion of shocks to short-term funding increases (Column 2).

Figure 5 confirms these results. The negative average marginal effect of uncertainty on loan supply declines with a higher capital ratio. This holds if uncertainty is measured as

⁹ For the other three measures for uncertainty in banking, the numbers are as follows. Dispersion of asset shocks: 11.2 (*UncBank* at minimum) and -14.8 (*UncBank* at maximum); Short-term funding shocks: 7.4 and 0.5; Productivity shocks: 6.5 and -6.9.

the dispersion of shocks to total assets or profitability. In the latter case, the marginal effect even turns positive for highly capitalized banks.

Banks with a higher share of committed credit lines reduce lending by more if they face an increase in uncertainty measured as the dispersion of shocks to short-term funding (Column 2). This is plausible as firms tend to draw on their credit lines in uncertain times.¹⁰ Banks compensate for the increase in loan demand by reducing their supply of non-committed (new) loans accordingly. Cornett and others (2011) document a similar effect in response to (first-order) liquidity shocks for US banks during the crisis.

As regards other determinants of bank lending, Table 5 confirms prior research. Banks extend loan supply relative to their overall balance sheet if they are better capitalized, have a higher deposits-to-assets ratio, and if they hold more liquid assets.

Including the GDP deflator of the respective countries allows interpreting the changes in bank lending in real and not only in nominal terms. The positive point estimate indicates that a one percentage point increase in the inflation rate (measured as GDP deflator) increases nominal loan supply by 0.34 percent. The growth rate of real GDP is positively related to bank lending. A one percentage point increase in real growth leads to an increase in bank lending by 0.62 percent, which can be driven by both demand and supply side effects.

Do effects differ for alternative measures of uncertainty?

For comparison, we consider the effect of alternative uncertainty measures which are related to the financial and the real sector: bank volatility, stock market volatility, and firm return dispersion (Table 6, Columns 1 to 3). In line with our descriptive statistics, bank stock return volatility yields results similar to those for the cross-sectional dispersion measures. Lending declines as uncertainty increases. Hence, cross-sectional dispersion and time-series volatility measures related to the banking sector capture similar features of uncertainty.

A general measure for stock market volatility has no significant effect, in contrast. A higher level of firm return dispersion, which might capture uncertainty in the real sector and borrower default risk, has a negative effect on bank lending. This is in line with Valencia (2013) who shows that banks reduce lending in times of increased default risk

¹⁰ Ivashina and Scharfenstein (2010) and Campello and others (2011) document that private firms drew extensively on committed credit lines during the recent financial crisis.

of banks but also of borrowers triggered by higher uncertainty. In contrast to the dispersion measures derived directly from bank-level data, effects do less depend on banks' balance sheet characteristics.

Liquidity strains in interbank markets increase the uncertainty for banks about costs and access to interbank liquidity. Thus, we include the interbank interest rate spread (Table 6, Column 4). Other than the previous measures, which are based on second moments, the interest rate spread captures first moment shocks. We do not find a significant effect on bank lending except for the interaction with the deposit share. This seems reasonable because banks might be less affected by increased spreads in the interbank market if they can resort to their deposits, which is in line with the findings by Cornett et al. (2011) for US banks.

In unreported regressions, we simultaneously included i) one dispersion measure and its interactions with the bank-level variables *and* ii) one of the aforementioned four measures and the interactions with the bank-level variables. This helps ensure that the estimated effect of our dispersion measure on lending is not driven by omitted variables. The effect of our cross-sectional dispersion measures on bank lending remains qualitatively unaltered, except for the case of dispersion of shocks to profitability: The coefficient drops insignificant if bank stock return volatility is included simultaneously.

5.3 Baseline regressions including country-year fixed effects

In order to control for macroeconomic conditions affecting all banks in one country, we include country-year fixed effects v_{jt} . Now, the country-level variables – including our measure of uncertainty in banking (*UncBank*) – are omitted, and we focus on the interaction effects. The regression model now looks as follows:

$$\frac{\Delta Loans_{ijt}}{Assets_{ijt-1}} = v_i + v_{jt} + \alpha_1 X_{ijt-1} + \alpha_2 UncBank_{jt} * X_{ijt-1} + \varepsilon_{ijt} \quad (14)$$

This specification controls for a wide range of potentially unobservable factors influencing bank lending. The disadvantage is that it does no longer allow assessing the direct impact of uncertainty in banking on bank lending. The previous specification, however, demonstrated that the impact of uncertainty in banking works through bank characteristics.

Table 7 shows the results. The interaction effects are still identified in the regressions, and the results for the impact of uncertainty *conditional* on bank characteristics, i.e. the interaction effects, remain robust in most of the cases: In columns (1) and (3), the interaction term of uncertainty in banking with the liquidity ratio remains significant and

positive, in columns (1) and (4) the same holds true for the interaction of uncertainty in banking and the capital ratio. Again the results for uncertainty measured as the dispersion of shocks to short-term funding deviate from the general picture.

5.4 Robustness tests

We conduct various robustness tests. First, we restrict the analysis to OECD and Euro Area countries. Second, we consider the period before the crisis (1998-2006) and the crisis period (2008-2012).

Overall, the previous findings are confirmed. For the OECD sample (Table 8) higher liquidity or capitalization still allow banks reducing loans by less. Banks continue responding to higher expected loan demand as proxied by the committed loans ratio by reducing the share of loans in their portfolio.

Because the OECD sample might still comprise heterogeneity, we conduct the analysis for the Euro Area (Table 9). Implicitly, we also control for effects of a joint monetary policy. For the Euro Area countries, the effects of higher liquidity buffers stabilizing lending are confirmed for all four uncertainty measures. The results for the short-term funding measure are in line with the others, possibly reflecting the effects of the common monetary policy.

We further investigate the role of banks' balance sheet strength for different time periods. Table 10 is based on a non-crisis sample (1998-2006), while Table 11 is based on the years 2008-2012.¹¹ Results for the pre crisis sample suggest that bank heterogeneity does not matter much for the supply of loans in times of low uncertainty (Table 10). The analysis for the period from 2008 confirms the role of liquidity in stabilizing loan supply if the dispersion of shocks to total assets or productivity are considered (Table 11, columns 1 and 3).

5.5 Are domestic and international banks affected differently?

The analysis so far has shown that bank lending declines when uncertainty increases. But we have not yet accounted for the international dimension of this adjustment. In recent decades, banking has become more international and shocks might be transmitted through international activities of banks (Cetorelli and Goldberg 2011, De Haas and van Horen 2012). Banks might thus adjust their lending decisions in response to uncertainty in the home country or in response to uncertainty in foreign countries. Are foreign-owned

¹¹ We omit the year 2007 because it is not clear whether it should be defined as a crisis or a non-crisis year.

banks affected by less because they can diversify shocks across borders or because they can activate an internal capital market? In this sub-section, we address those questions.

We exploit the (foreign) ownership data by Claessens and van Horen (2014). These data allow analyzing whether foreign-owned banks react differently to uncertainty in their host country compared to domestically-owned banks while controlling for uncertainty in the residence country of the foreign owner. As the database is limited to the years 1995-2009, we assume that the ownership status of the banks has remained unchanged in the years 2010-2012 compared to 2009. The database indicates whether a bank is domestically or foreign-owned. A bank is identified as foreign-owned if foreigners hold 50 percent or more of its shares. In case a bank is foreign-owned, the country of the largest foreign shareholder is indicated. There might be cases in which the bank is identified as foreign-owned but the largest foreign shareholder does not hold the largest amount of shares. However, from the information in the database, we cannot identify such cases.

The database is matched to Bankscope. This implies that subsidiaries are included but not branches. Hence, we can discriminate whether foreign-owned banks, excluding branches, are affected differently by uncertainty in the host country compared to domestically-owned banks.

Using the information on ownership status, we can analyze how a foreign-owned bank hosted in country j responds to uncertainty in this country. At the same time, we can control for uncertainty in country k in which the foreign owner resides. We proceed in a similar way than before and run the following regression model:

$$\begin{aligned} \frac{\Delta Loans_{ijt}}{Assets_{ijt-1}} = & v_i + v_t + \alpha_1 \Delta \log GDPDeflator_{jt} + \alpha_2 \Delta \log GDP_{jt} + \alpha_3 X_{ijt-1} + \alpha_4 Fown(0/1) \\ & + \alpha_5 UncBank_{jt} + \alpha_6 UncBank_{jt} * Fown(0/1) + \alpha_7 UncBank_{kt} + \varepsilon_{kijt} \end{aligned} \quad (15)$$

where $\Delta Loans_{ijt} / Assets_{ijt-1}$ denotes the difference in the loan volume relative to total assets in $t-1$ (in %). We control for time-invariant bank characteristics and common time trends by including separate time and country fixed effects v_i and v_t . All remaining variables are defined as before.

The measure for uncertainty in banking derived from bank-level data in country j – the *host country*, if foreign banks are considered – is captured by $UncBank_{jt}$. We now interact the uncertainty measure in the country of location with the foreign ownership status $Fown(0/1)$. The dummy takes a value of one if the bank is foreign-owned and zero otherwise. Given that a bank is foreign-owned, we additionally consider the effect of

uncertainty in the country of residence of the foreign owner $UncBank_{kt}$. Given a bank is domestically-owned, we set $UncBank_{kt}$ to zero.

Table 12 shows the regression results. Signs and quantities of bank characteristics are comparable to our previous results. Foreign-owned banks respond differently to uncertainty in the host country than domestically-owned banks for the case of the dispersion of shocks to productivity: The average marginal effects reveal that foreign-owned banks increase their loan supply by 0.6 percent, while domestically-owned banks reduce it by 1.1 percent if uncertainty increases by one standard deviation. Our data are not sufficiently detailed to allow assessing whether banks activate their internal capital market. But they are consistent with the reliance of foreign banks on their largest shareholder in terms of liquidity provision. For cases in which the largest shareholder is the parent bank (which is information we do not observe), this liquidity provision could happen through internal capital markets between the parent and the affiliate.

However, we do not find further support for this effect looking at the three other measures for uncertainty in banking (Columns 1, 2, and 4), as suggested by the interaction effect being insignificant. We control for the impact of uncertainty in banking in the country of the largest shareholder as this might impact and presumably reduce the loans supplied by foreign-owned banks. This is indeed the case if we consider the dispersion of shocks to short-term funding (Column 2) or productivity (Column 3).

The finding that foreign-owned banks are shielded against uncertainty in the host country becomes insignificant if we include country-year fixed effects in the host country (v_{jt}) and the country in which the largest foreign shareholder is located (v_{kt}) (Table 13). Hence, there is insufficient variation in the data to distinguish the effects of uncertainty from country-specific shocks.

6 Conclusions

During the financial crisis, loan supply by banks has contracted, both domestically and across borders. The intermediation of credit to the real sector has decreased, and the international banking system has become more fragmented. Motivated by recent literature on uncertainty and its effects on real sector activity, this paper relates uncertainty in banking to the loan supply of domestic and foreign-owned banks.

Our measure of uncertainty in banking is constructed from bank-level data. In a first step, we compute bank-level shocks to growth rates of total assets, short-term funding, productivity, and to levels of profitability. In a second step, we measure uncertainty in

banking as the cross-sectional dispersion of these shocks. A higher cross-sectional dispersion is interpreted as a higher degree of uncertainty in banking. We find that uncertainty in banking fluctuates over time and has increased during the recent crisis.

We use our uncertainty measure derived from bank-level data to analyze the impact of uncertainty in banking on the loan supply by both domestic and foreign-owned banks. Our results show that banks decrease their loan supply during periods of higher uncertainty. This effect is heterogeneous across banks: Lending by banks which are better capitalized and have higher liquidity buffers tend to be affected less. We do not find strong evidence that foreign-owned banks respond differently to uncertainty in the host country than domestically-owned banks.

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Appendix: Stylized Model

In the following, we show how the response of a bank's loan supply (relative to assets in $t-1$) depends on its capital buffer in $t-1$.

If we consider ϕ to be time-varying, we obtain from equation (8):

$$\frac{\partial \left(\frac{\Delta l_t}{t a_{t-1}} \right)}{\partial \sigma_t} = \frac{-\frac{\varphi_t e_{t-1}}{t a_{t-1}} \left(1 + \frac{\tilde{r}_{it}}{\varphi_{t-1} \sigma_{t-1} - \mu} \right)}{(\varphi_t \sigma_t - \mu)^2} < 0$$

The relevant cross derivative is given by:

$$\frac{\partial \left(\frac{\Delta l_t}{t a_{t-1}} \right)}{\partial \sigma_t \partial \varphi_{t-1}} = \frac{\frac{\varphi_t \sigma_{t-1} e_{t-1}}{t a_{t-1}} \tilde{r}_{it}}{(\varphi_t \sigma_t - \mu)^2 (\varphi_{t-1} \sigma_{t-1} - \mu)^2}$$

which is > 0 if $\tilde{r}_{it} > 0$ and < 0 if $\tilde{r}_{it} < 0$.

Appendix: Data Definition and Sources

The results in this paper are based on various data sources. Data at the bank level are obtained from Bankscope. Information on foreign ownership of banks comes from the database provided by Claessens and van Horen (2014). Country-level data are obtained from Bloom (2014), the IMF World Economic Outlook and Datastream.

List of countries

	Euro Area	Non Euro Area
OECD	Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovakia, Slovenia, Spain	Australia, Canada, Chile, Czech Republic, Hungary, Iceland, Israel, Japan, Mexico, New Zealand, Norway, Poland, South Korea, Sweden, Switzerland, Turkey, United Kingdom, United States
Non OECD	Cyprus, Latvia, Malta	Argentina, Brazil, Bulgaria, China, Croatia, India, Indonesia, Lithuania, Romania, Russia, Saudi Arabia, South Africa

Dependent variable

Bank lending: Our measure for bank lending is the difference in total loans relative to total assets in $t-1$ (in %). The data come from Bankscope and the variable total loans is defined as gross loans minus impaired loans.

Bank-level explanatory variables

Capital/assets: To measure capitalization, we use the Tier1 regulatory capital relative to total assets (in %) as obtained from Bankscope.

Committed loans/(committed loans + assets): To control for committed loan obligations, we use committed loans relative to the sum of committed loans and total assets (in %). Data are provided by Bankscope.

Deposits/assets: The variable deposits/assets denotes the share of customer deposits to balance sheet total (in %) as obtained from Bankscope.

Liquid assets/assets: The liquidity ratio is defined as the ratio of banks' liquid assets, i.e. the sum of trading securities, loans and advances to banks, reverse repos and cash collateral, cash and due from banks minus mandatory reserves included in these positions, relative to total assets (in %). Data are taken from Bankscope.

Log total assets: To obtain a measure for bank size we use the logarithm of banks' total assets (in thousands of USD) as obtained from Bankscope.

Uncertainty in banking measures

Total assets: We use total assets in thousands of USD as provided by Bankscope.

Productivity: Productivity is estimated as proposed by Levinsohn and Petrin (2003). For the free input variables, we choose total long-term funding and personnel expenses. The intermediate input good is proxied by total equity and the fixed input is given by fixed assets. For the output variable, we use total loans defined as gross loans minus impaired loans. Data are in thousands of USD and obtained from Bankscope.

Profitability (RoA): Return on assets (RoA) is the ratio of operating profits to total assets (in %) and calculated from data available in Bankscope.

Short-term funding: The variable short-term funding (in thousands of USD) is obtained by taking the sum of deposits from banks, repos and cash collateral, and other deposits and short-term borrowings as provided by Bankscope.

Alternative uncertainty measures

Bank volatility: To construct a measure for bank volatility, we use weekly bank price indices from Datastream. As they are not available for some countries, we resort to aggregates for the particular region. The measure for bank volatility is computed as the volatility of weekly bank index returns for each year (in %).

Economic policy uncertainty: As a measure for economic policy uncertainty, we use the index for the US provided by Scott Baker, Nicholas Bloom and Steven J. Davis at www.PolicyUncertainty.com. To obtain the measure at annual frequency we take the end of year value.

Firm return dispersion: From Bloom (2014), we also take a measure to control for uncertainty in the real sector. Data come from the WRDS international equity database and is used to construct the standard deviation of quarterly returns across firms. For our analysis, we use the value for the last quarter of the respective year (in %).

Forecast dispersion: To obtain data on disagreement in forecasts, we make use of the dataset by Bloom (2014) [http://www.stanford.edu/~nbloom/index_files/Page315.htm]. The data provide the dispersion of one year ahead GDP growth forecasts reported by the Consensus forecast database. For our analysis, we use the value for the last quarter of the respective year (in %).

GDP growth: Data on annual real GDP growth are taken from the IMF World Economic Outlook (in %).

Stock market volatility: To construct a measure for stock market volatility, we use monthly stock price indices from Datastream. We resort to monthly frequency as this is available for all countries. The stock market volatility measure is computed as the volatility of monthly stock market index returns for each year (in %).

Interbank interest rate spread: To obtain a measure for strains in interbank markets, we take the difference between the interbank interest rate (Code INTER) and the central bank discount rate or short-term euro repo rate (Code PRATE) as provided by Datastream.

Internationalization

Foreign ownership: Data on foreign ownership are taken from Claessens and van Horen (2014) and matched with bank-level information from Bankscope. The data are available for 5,324 banks in 137 countries for the period 1995-2009. We keep all banks which are located in one of our sample countries. For the years 2010 to 2012, we project the ownership status of the year 2009 forward.

Table 1: Descriptive Statistics for Bank-Level Variables

This table shows summary statistics for the explanatory variables. Descriptive statistics are based on the banks belonging to one of our sample countries, over the period 1998–2012. *Liquid assets/assets* measures the fraction of the liquidity held by a bank relative to total assets (in %). To measure capitalization we use the *Capital/assets* ratio (in %). *Deposits/assets* denote the share of customer deposits to balance sheet total (in %). *Log total assets* denote the logarithm of bank assets in thousands of USD. To control for committed loan obligations, we use the ratio *Committed loans/(committed loans + assets)* (in %). For more details, see the description in the Data Appendix.

	Obs.	Mean	Std. dev.	Skewness	Kurtosis	Min	Max
Liquid assets/assets	34,686	17.47	15.85	1.64	5.68	1.14	77.55
Capital/assets	27,762	14.04	8.08	2.92	14.22	4.86	58.74
Deposits/assets	73,683	65.84	22.83	-1.18	3.87	0.58	95.81
Log total assets	74,537	13.81	1.91	0.59	3.49	9.80	19.73
Comm. loans/ (comm. loans + assets)	43,456	5.85	7.37	2.69	11.75	0.00	44.09

Table 2: Descriptive Statistics for Banking Sector Uncertainty

This table shows summary statistics for the cross-sectional uncertainty measures derived from bank-level data. The measures are based on balance sheet data (*total assets* and *short-term funding*), *productivity* and profitability (*RoA*). *Total assets* is in thousands of USD. *Short-term funding* (in thousands of USD) is obtained by taking the sum of deposits from banks, repos and cash collateral, and other deposits and short-term borrowings. *Productivity* is estimated as proposed by Levinsohn and Petrin (2003). *RoA* is the ratio of operating profits to total assets (in %). For each of these variables, we first compute time-varying bank specific shocks as described in Section 3.2. We then calculate the cross-sectional dispersion per country and year by taking the standard deviation across the shocks of all banks in one country and year. For more details, see the description in the Data Appendix.

	Obs.	Mean	Std. dev.	Skewness	Kurtosis	Min	Max
Total assets	684	11.64	5.55	0.79	3.78	0.00	36.88
Short-term funding	676	64.98	29.30	0.70	4.71	0.00	223.99
Productivity	536	16.06	13.75	3.27	20.29	0.00	132.06
RoA	683	1.05	0.65	1.66	8.98	0.00	5.95

Table 3: Correlation Matrix: Bank-Level versus Alternative Uncertainty Measures

This table shows pairwise correlations between the cross-sectional uncertainty measures derived from bank-level data and common measures for uncertainty across the whole sample for the period 1998-2012. Correlation coefficients significant at the 10% level or better are written in bold. The cross-sectional uncertainty measures derived from bank-level data include the cross-sectional standard deviation for all banks in one country and year and for each of the considered variables, i.e. total assets, short-term funding, bank productivity and return on assets (RoA). The alternative measures for uncertainty in the broader macro economy include *Bank volatility* computed as the volatility of weekly bank index returns for each year, *Stock market volatility* computed as the volatility of monthly stock market index returns for each year, *Economic policy uncertainty* for which we use the index for the US, annual real *GDP growth*, *Forecast dispersion* which gives the dispersion of one year ahead GDP growth forecasts, and *Firm return dispersion* calculated as the standard deviation of quarterly returns across firms. For more details and data sources, see the description in the Data Appendix.

	Total assets	Short-term funding	Productivity	RoA	Bank volatility	Stock market volatility	Economic policy uncertainty	GDP growth	Forecast dispersion	Firm return dispersion
Total assets	1.00									
Short-term funding	0.25	1.00								
Productivity	0.25	0.14	1.00							
RoA	0.51	0.21	0.25	1.00						
Bank volatility	0.19	0.11	0.04	0.29	1.00					
Stock market volatility	0.20	0.02	0.02	0.29	0.49	1.00				
Economic policy uncertainty	-0.10	0.03	-0.03	-0.04	0.16	-0.01	1.00			
GDP growth	0.02	-0.01	-0.05	-0.12	-0.32	-0.16	-0.21	1.00		
Forecast dispersion	-0.06	0.01	0.28	0.16	0.38	0.12	0.06	-0.16	1.00	
Firm return dispersion	0.06	-0.02	0.14	0.19	0.33	0.19	0.19	-0.19	0.31	1.00

Table 4: Uncertainty in Banking versus Alternative Uncertainty Measures

The following tables show regressions in which the dependent variables are our uncertainty measures based on (a) total assets, (b) short-term funding, (c) productivity, and (d) return on assets (RoA). The sample covers 48 countries over the period 1998-2012. The explanatory variables are alternative measures of uncertainty and include *Bank volatility* computed as the volatility of weekly bank index returns for each year, *Stock market volatility* computed as the volatility of monthly stock market index returns for each year, *Economic policy uncertainty* for which we use the index for the US, annual real *GDP growth*, *Forecast dispersion* which gives the dispersion of one year ahead GDP growth forecasts, and *Firm return dispersion* calculated as the standard deviation of quarterly returns across firms. All regressions include time fixed effects, except the one including economic policy uncertainty as this variable does not vary across countries, as well as country fixed effects. For more information on the variables, see the Data Appendix.

a) Dispersion of shocks to total assets growth

	(1)	(2)	(3)	(4)	(5)	(6)
Bank volatility	0.332*** (0.121)					
Stock market volatility		0.104 (0.108)				
Economic policy uncertainty			-0.014** (0.005)			
GDP growth				-0.022 (0.087)		
Forecast dispersion					-0.978** (0.388)	
Firm return dispersion						-0.016 (0.067)
Constant	11.298*** (1.219)	12.632*** (1.163)	13.244*** (0.609)	13.248*** (0.930)	13.625*** (1.533)	12.088*** (1.559)
Observations	658	647	684	681	240	405
R ²	0.107	0.093	0.016	0.094	0.182	0.111
Number of countries	48	47	48	48	17	31

b) Dispersion of shocks to short-term funding growth

	(1)	(2)	(3)	(4)	(5)	(6)
Bank volatility	1.861** (0.843)					
Stock market volatility		0.245 (0.771)				
Economic policy uncertainty			0.029 (0.030)			
GDP growth				0.070 (0.468)		
Forecast dispersion					-0.167 (2.345)	
Firm return dispersion						-0.128 (0.252)
Constant	52.379*** (4.840)	62.505*** (6.523)	61.533*** (3.549)	60.960*** (6.677)	55.496*** (8.530)	59.049*** (6.724)
Observations	651	639	676	675	235	397
R ²	0.055	0.038	0.002	0.039	0.122	0.078
Number of countries	48	47	48	48	17	31

c) Dispersion of shocks to productivity growth

	(1)	(2)	(3)	(4)	(5)	(6)
Bank volatility	-0.032 (0.430)					
Stock market volatility		0.310 (0.329)				
Economic policy uncertainty			-0.003 (0.013)			
GDP growth				0.084 (0.242)		
Forecast dispersion					0.577 (2.058)	
Firm return dispersion						0.343 (0.237)
Constant	16.674*** (3.854)	14.629*** (3.184)	16.469*** (1.580)	16.399*** (2.574)	13.115** (6.122)	7.819 (7.336)
Observations	528	517	536	534	195	318
R ²	0.034	0.032	0.000	0.034	0.054	0.056
Number of countries	47	46	47	47	16	30

d) Dispersion of shocks to RoA

	(1)	(2)	(3)	(4)	(5)	(6)
Bank volatility	0.074*** (0.022)					
Stock market volatility		0.034* (0.018)				
Economic policy uncertainty			-0.000 (0.001)			
GDP growth				-0.030*** (0.010)		
Forecast dispersion					-0.001 (0.059)	
Firm return dispersion						0.022*** (0.006)
Constant	0.955*** (0.132)	0.971*** (0.123)	1.092*** (0.066)	1.508*** (0.137)	0.957*** (0.170)	0.516*** (0.176)
Observations	657	646	683	680	239	404
R ²	0.158	0.087	0.001	0.111	0.105	0.093
Number of countries	48	47	48	48	17	31

Table 5: Uncertainty in Banking and Loan Supply: Macro Controls

This table reports fixed effects regressions. The dependent variable is the change in loans divided by total assets of the previous period. The explanatory variables include macro variables, bank-level variables, the cross-sectional uncertainty measures derived from bank-level data (UncBank) (as denoted in columns 1 to 4), and interactions of the latter with the bank-level variables. All bank-level variables are lagged by one period. The sample comprises yearly data of banks in 48 countries over the time period 1998-2012. The regressions take into account bank and year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. All variables are centered around their means if they are interacted to facilitate interpretation of estimated coefficients. All measures for uncertainty in banking derived from bank-level data are standardized. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

<i>Dep. var.: ΔLoans/assets_{t-1}</i>	(1)	(2)	(3)	(4)
	<i>Uncertainty in banking (UncBank)</i>			
	Total assets dispersion	Short-term funding dispersion	Productivity dispersion	RoA dispersion
Δ Log GDP deflator _t	0.341*** (0.059)	0.352*** (0.059)	0.317*** (0.059)	0.322*** (0.059)
Δ Log real GDP _t	0.618*** (0.083)	0.658*** (0.088)	0.563*** (0.084)	0.623*** (0.083)
Liquid assets/assets _{t-1}	0.082*** (0.022)	0.065** (0.029)	0.082*** (0.023)	0.089*** (0.022)
Capital/assets _{t-1}	0.108* (0.056)	0.234*** (0.062)	0.152*** (0.056)	0.081 (0.054)
Deposits/assets _{t-1}	0.058* (0.032)	0.070** (0.032)	0.069** (0.031)	0.065** (0.031)
Log total assets _{t-1}	-3.962*** (0.924)	-3.393*** (0.913)	-3.527*** (0.906)	-3.771*** (0.869)
	0.101**	0.180***	0.113**	0.087**
Comm. loans/(comm. loans + assets) _{t-1}	(0.045)	(0.053)	(0.048)	(0.044)
Uncertainty in banking (UncBank) _t	-4.309*** (0.674)	-0.355 (0.504)	-2.510*** (0.512)	-1.335*** (0.339)
Liquid assets/assets _{t-1} x UncBank _t	0.036* (0.019)	0.033** (0.016)	0.060*** (0.022)	0.007 (0.014)
Capital/assets _{t-1} x UncBank _t	0.086** (0.041)	-0.132*** (0.036)	0.001 (0.039)	0.085*** (0.028)
Deposits/assets _{t-1} x UncBank _t	-0.001 (0.014)	-0.016 (0.012)	-0.006 (0.019)	-0.027* (0.015)
Log total assets _{t-1} x UncBank _t	0.720*** (0.175)	-0.248* (0.146)	0.270 (0.185)	0.130 (0.127)
Comm. loans/(comm. loans + assets) _{t-1} x UncBank _t	-0.045 (0.033)	-0.118*** (0.036)	-0.020 (0.040)	0.023 (0.021)
Observations	10,282	10,282	10,164	10,282
R ²	0.216	0.208	0.208	0.212
Number of banks	2,355	2,355	2,323	2,355

Table 6: Uncertainty in Banking and Loan Supply: Alternative Measures

This table reports fixed effects regressions. The dependent variable is the change in loans divided by total assets of the previous period. The explanatory variables include macro variables, bank-level variables, an alternative uncertainty measure (UNC) (as denoted in columns 1 to 4), and interactions of the latter with the bank-level variables. All bank-level variables are lagged by one period. The sample comprises yearly data of banks in 48 countries over the time period 1998-2012. The regressions take into account bank and year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. All variables are centered around their means to facilitate interpretation of interaction effects. All measures for uncertainty in banking derived from bank-level data are standardized. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

<i>Dep. var.: $\Delta Loans/assets_{t-1}$</i>	(1)	(2)	(3)	(4)
	<i>Alternative uncertainty measure (UNC)</i>			
	<i>Bank stock return volatility</i>	<i>Stock market volatility</i>	<i>Firm return dispersion</i>	<i>Interbank interest rate spread</i>
$\Delta \text{Log GDP deflator}_t$	0.361*** (0.058)	0.344*** (0.063)	0.417** (0.171)	0.328*** (0.120)
$\Delta \text{Log real GDP}_t$	0.488*** (0.091)	0.619*** (0.087)	0.283* (0.145)	0.632*** (0.091)
Liquid assets/assets _{t-1}	0.087*** (0.023)	0.105*** (0.025)	0.101*** (0.027)	0.088*** (0.024)
Capital/assets _{t-1}	0.142*** (0.054)	0.147*** (0.056)	0.139** (0.059)	0.135** (0.061)
Deposits/assets _{t-1}	0.052* (0.031)	0.067** (0.031)	0.032 (0.032)	0.082** (0.033)
Log total assets _{t-1}	-3.727*** (0.893)	-3.579*** (0.900)	-3.723*** (1.018)	-3.615*** (0.949)
Comm. loans/(comm. loans + assets) _{t-1}	0.095** (0.044)	0.086* (0.045)	0.104** (0.051)	0.088* (0.048)
Uncertainty (UNC) _t	-1.555*** (0.246)	-0.291 (0.294)	-1.180** (0.550)	-0.223 (0.435)
Liquid assets/assets _{t-1} x UNC _t	0.005 (0.009)	0.019 (0.012)	0.031* (0.016)	-0.005 (0.013)
Capital/assets _{t-1} x UNC _t	0.071*** (0.015)	0.020 (0.024)	-0.018 (0.039)	0.008 (0.022)
Deposits/assets _{t-1} x UNC _t	0.010 (0.007)	0.017* (0.009)	0.026 (0.020)	0.030*** (0.010)
Log total assets _{t-1} x UNC _t	0.195*** (0.054)	-0.033 (0.066)	0.011 (0.152)	0.047 (0.089)
Comm. loans/(comm. loans + assets) _{t-1} x UNC _t	-0.003 (0.012)	-0.011 (0.019)	-0.059* (0.033)	0.014 (0.020)
Observations	10,277	10,248	8,562	9,495
R-squared	0.214	0.205	0.201	0.206
Number of banks	2,354	2,344	1,828	2,134

Table 7: Uncertainty in Banking and Loan Supply: Country-Year Fixed Effects

This table reports fixed effects regressions. The dependent variable is the change in loans divided by total assets of the previous period. The explanatory variables include macro variables, bank-level variables, the cross-sectional uncertainty measures derived from bank-level data (UncBank) (as denoted in columns 1 to 4), and interactions of the latter with the bank-level variables. All bank-level variables are lagged by one period. The sample comprises yearly data of banks in 48 countries over the time period 1998-2012. The regressions take into account bank and country-year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. All variables are centered around their means if they are interacted to facilitate interpretation of estimated coefficients. All measures for uncertainty in banking derived from bank-level data are standardized. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

<i>Dep. var.: ΔLoans/assets_{t-1}</i>	(1)	(2)	(3)	(4)
	<i>Uncertainty in banking (UncBank)</i>			
	Total assets dispersion	Short-term funding dispersion	Productivity dispersion	RoA dispersion
Liquid assets/assets _{t-1}	0.075*** (0.023)	0.094*** (0.029)	0.088*** (0.025)	0.078*** (0.023)
Capital/assets _{t-1}	0.124** (0.058)	0.230*** (0.070)	0.161*** (0.061)	0.110* (0.057)
Deposits/assets _{t-1}	0.059* (0.033)	0.042 (0.037)	0.058* (0.033)	0.064* (0.033)
Log total assets _{t-1}	-3.608*** (0.969)	-3.052*** (0.999)	-3.370*** (0.978)	-3.594*** (0.895)
Comm. loans/(comm. loans + assets) _{t-1}	0.098** (0.047)	0.156*** (0.055)	0.094** (0.048)	0.088* (0.046)
Liquid assets/assets _{t-1} x UncBank _t	0.082*** (0.023)	-0.004 (0.015)	0.098*** (0.023)	0.025 (0.017)
Capital/assets _{t-1} x UncBank _t	0.118*** (0.045)	-0.101*** (0.039)	-0.064* (0.035)	0.082*** (0.030)
Deposits/assets _{t-1} x UncBank _t	-0.024 (0.021)	0.010 (0.018)	0.005 (0.025)	-0.043** (0.017)
Log total assets _{t-1} x UncBank _t	0.479*** (0.166)	-0.456*** (0.165)	-0.372* (0.216)	0.255** (0.130)
Comm. loans/(comm. loans + assets) _{t-1} x UncBank _t	-0.066* (0.035)	-0.105*** (0.037)	-0.005 (0.045)	-0.019 (0.025)
Observations	10,282	10,282	10,164	10,282
R ²	0.305	0.300	0.297	0.306
Number of banks	2,355	2,355	2,323	2,355

Table 8: Uncertainty in Banking and Loan Supply: OECD Countries

This table reports fixed effects regressions. The dependent variable is the change in loans divided by total assets of the previous period. The explanatory variables include macro variables, bank-level variables, the cross-sectional uncertainty measures derived from bank-level data (UncBank) (as denoted in columns 1 to 4), and interactions of the latter with the bank-level variables. All bank-level variables are lagged by one period. The sample comprises yearly data of banks in 33 OECD countries over the time period 1998-2012. The regressions take into account bank and country-year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. All variables are centered around their means if they are interacted to facilitate interpretation of estimated coefficients. All measures for uncertainty in banking derived from bank-level data are standardized. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

<i>Dep. var.: ΔLoans/assets_{t-1}</i>	(1)	(2)	(3)	(4)
	<i>Uncertainty in banking (UncBank)</i>			
	Total assets dispersion	Short-term funding dispersion	Productivity dispersion	RoA dispersion
Liquid assets/assets _{t-1}	0.063*** (0.024)	0.061** (0.028)	0.067*** (0.025)	0.057** (0.024)
Capital/assets _{t-1}	0.117* (0.060)	0.178** (0.071)	0.128** (0.063)	0.093 (0.058)
Deposits/assets _{t-1}	0.060* (0.034)	0.049 (0.038)	0.060* (0.034)	0.059* (0.034)
Log total assets _{t-1}	-3.506*** (0.957)	-3.148*** (0.978)	-3.479*** (0.949)	-3.529*** (0.883)
Comm. loans/(comm. loans + assets) _{t-1}	0.093* (0.048)	0.141** (0.056)	0.088* (0.050)	0.082* (0.047)
Liquid assets/assets _{t-1} x UncBank _t	0.056*** (0.017)	0.007 (0.015)	0.102*** (0.024)	0.016 (0.016)
Capital/assets _{t-1} x UncBank _t	0.104** (0.045)	-0.067* (0.037)	-0.065 (0.044)	0.110*** (0.031)
Deposits/assets _{t-1} x UncBank _t	-0.037* (0.020)	0.004 (0.017)	0.052** (0.024)	-0.038** (0.019)
Log total assets _{t-1} x UncBank _t	0.256 (0.169)	-0.449*** (0.146)	-0.434* (0.229)	0.196* (0.112)
Comm. loans/(comm. loans + assets) _{t-1} x UncBank _t	-0.071** (0.036)	-0.091** (0.040)	0.018 (0.047)	-0.005 (0.025)
Observations	9,383	9,383	9,277	9,383
R ²	0.288	0.286	0.286	0.292
Number of banks	2,071	2,071	2,041	2,071

Table 9: Uncertainty in Banking and Loan Supply: Euro Area

This table reports fixed effects regressions. The dependent variable is the change in loans divided by total assets of the previous period. The explanatory variables include macro variables, bank-level variables, the cross-sectional uncertainty measures derived from bank-level data (UncBank) (as denoted in columns 1 to 4), and interactions of the latter with the bank-level variables. All bank-level variables are lagged by one period. The sample comprises yearly data of banks in 17 Euro Area member countries over the time period 1998-2012. The regressions take into account bank and country-year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. All variables are centered around their means if they are interacted to facilitate interpretation of estimated coefficients. All measures for uncertainty in banking derived from bank-level data are standardized. The p-values are as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
<i>Dep. var.: $\Delta \text{Loans}/\text{assets}_{t-1}$</i>	<i>Uncertainty in banking (UncBank)</i>			
	Total assets dispersion	Short-term funding dispersion	Productivity dispersion	RoA dispersion
Liquid assets/assets _{t-1}	0.079*** (0.027)	-0.035 (0.029)	0.121*** (0.031)	0.065** (0.027)
Capital/assets _{t-1}	0.263** (0.103)	0.172** (0.085)	0.248*** (0.096)	0.283*** (0.094)
Deposits/assets _{t-1}	0.107** (0.044)	0.059 (0.044)	0.115** (0.045)	0.117*** (0.043)
Log total assets _{t-1}	-13.118*** (1.738)	-12.515*** (1.737)	-12.435*** (1.737)	-12.885*** (1.701)
Comm. loans/(comm. loans + assets) _{t-1}	0.094 (0.067)	0.086 (0.061)	0.100* (0.059)	0.054 (0.058)
Liquid assets/assets _{t-1} x UncBank _t	0.096*** (0.020)	0.031** (0.015)	0.210*** (0.052)	0.076** (0.031)
Capital/assets _{t-1} x UncBank _t	0.266*** (0.087)	-0.067 (0.044)	0.482*** (0.101)	0.369*** (0.077)
Deposits/assets _{t-1} x UncBank _t	0.044** (0.021)	0.018 (0.015)	0.083** (0.035)	0.068*** (0.020)
Log total assets _{t-1} x UncBank _t	0.010 (0.330)	-0.512*** (0.177)	0.611* (0.355)	0.186 (0.163)
Comm. loans/(comm. loans + assets) _{t-1} x UncBank _t	0.077 (0.064)	-0.029 (0.035)	0.044 (0.058)	0.078 (0.053)
Observations	3,174	3,174	3,170	3,174
R ²	0.664	0.657	0.664	0.664
Number of banks	1,077	1,077	1,076	1,077

Table 10: Uncertainty in Banking and Loan Supply: 1998-2006

This table reports fixed effects regressions. The dependent variable is the change in loans divided by total assets of the previous period. The explanatory variables include bank-level variables, the cross-sectional uncertainty measures derived from bank-level data (UncBank) (as denoted in columns 1 to 4), and interactions of the latter with the bank-level variables. All bank-level variables are lagged by one period. The sample comprises yearly data of banks in 48 countries over the time period 1998-2006. The regressions take into account bank and country-year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. All variables are centered around their means if they are interacted to facilitate interpretation of estimated coefficients. All measures for uncertainty in banking derived from bank-level data are standardized. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

<i>Dep. var.: ΔLoans/assets_{t-1}</i>	(1)	(2)	(3)	(4)
	<i>Uncertainty in banking (UncBank)</i>			
	Total assets dispersion	Short-term funding dispersion	Productivity dispersion	RoA dispersion
Liquid assets/assets _{t-1}	0.157*** (0.050)	0.138** (0.057)	0.170*** (0.051)	0.159*** (0.051)
Capital/assets _{t-1}	0.065 (0.116)	0.229 (0.142)	0.061 (0.116)	0.071 (0.113)
Deposits/assets _{t-1}	0.041 (0.044)	0.063 (0.065)	0.047 (0.044)	0.045 (0.043)
Log total assets _{t-1}	-6.770*** (1.476)	-7.280*** (1.524)	-6.916*** (1.445)	-6.750*** (1.481)
Comm. loans/(comm. loans + assets) _{t-1}	0.033 (0.072)	0.084 (0.091)	0.023 (0.071)	0.005 (0.072)
Liquid assets/assets _{t-1} x UncBank _t	0.039 (0.043)	0.032 (0.047)	-0.083 (0.074)	-0.015 (0.037)
Capital/assets _{t-1} x UncBank _t	-0.050 (0.107)	-0.205*** (0.077)	-0.006 (0.146)	0.132 (0.084)
Deposits/assets _{t-1} x UncBank _t	0.014 (0.056)	-0.029 (0.061)	-0.059 (0.115)	0.038 (0.050)
Log total assets _{t-1} x UncBank _t	0.087 (0.343)	0.782* (0.404)	1.177* (0.698)	0.319 (0.264)
Comm. loans/(comm. loans + assets) _{t-1} x UncBank _t	-0.147* (0.083)	-0.091 (0.085)	-0.118 (0.143)	-0.120* (0.070)
Observations	3,265	3,265	3,249	3,265
R-squared	0.12	0.13	0.12	0.12
Number of banks	673	673	662	673

Table 11: Uncertainty in Banking and Loan Supply: 2008-2012

This table reports fixed effects regressions. The dependent variable is the change in loans divided by total assets of the previous period. The explanatory variables include bank-level variables, the cross-sectional uncertainty measures derived from bank-level data (UncBank) (as denoted in columns 1 to 4), and interactions of the latter with the bank-level variables. All bank-level variables are lagged by one period. The sample comprises yearly data of banks in 48 countries over the time period 2008-2012. The regressions take into account bank and country-year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. All variables are centered around their means if they are interacted to facilitate interpretation of estimated coefficients. All measures for uncertainty in banking derived from bank-level data are standardized. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

<i>Dep. var.: ΔLoans/assets_{t-1}</i>	(1)	(2)	(3)	(4)
	Total assets dispersion	Short-term funding dispersion	Productivity dispersion	RoA dispersion
	<i>Uncertainty in banking (UncBank)</i>			
Liquid assets/assets _{t-1}	0.142*** (0.027)	0.166*** (0.034)	0.166*** (0.029)	0.153*** (0.026)
Capital/assets _{t-1}	0.287*** (0.085)	0.343*** (0.100)	0.334*** (0.094)	0.258*** (0.083)
Deposits/assets _{t-1}	-0.050 (0.034)	-0.059 (0.043)	-0.046 (0.038)	-0.064* (0.036)
Log total assets _{t-1}	-11.157*** (1.568)	-10.419*** (1.586)	-10.762*** (1.581)	-10.774*** (1.542)
Comm. loans/(comm. loans + assets) _{t-1}	0.242*** (0.067)	0.263*** (0.078)	0.267*** (0.063)	0.211*** (0.076)
Liquid assets/assets _{t-1} x UncBank _t	0.047** (0.020)	-0.009 (0.016)	0.097*** (0.031)	0.012 (0.019)
Capital/assets _{t-1} x UncBank _t	0.074 (0.056)	-0.051 (0.044)	0.054 (0.066)	0.058 (0.046)
Deposits/assets _{t-1} x UncBank _t	-0.027 (0.023)	-0.010 (0.020)	0.057* (0.034)	-0.010 (0.022)
Log total assets _{t-1} x UncBank _t	0.437** (0.211)	-0.522*** (0.157)	0.069 (0.296)	-0.222 (0.140)
Comm. loans/(comm. loans + assets) _{t-1} x UncBank _t	-0.106** (0.045)	-0.100** (0.043)	-0.082 (0.066)	-0.033 (0.039)
Observations	6,213	6,213	6,121	6,213
R-squared	0.31	0.31	0.31	0.31
Number of banks	2,109	2,109	2,080	2,109

Table 12: Uncertainty in Banking and Loan Supply: Foreign Ownership and Macro Controls

This table reports fixed effects regressions. The dependent variable is the change in loans divided by total assets of the previous period. The explanatory variables include macro variables, bank-level variables, the dummy variable FOWN(0/1) indicating a bank's foreign ownership status (0: domestically-owned; 1: foreign-owned), the cross-sectional uncertainty measures derived from bank-level data (UncBank) (as denoted in columns 1 to 4) in the host country j , its interaction with the dummy variable FOWN(0/1), and the cross-sectional uncertainty measure derived from bank-level data in the residence country k of the largest shareholder. All bank-level variables are lagged by one period. The sample comprises yearly data of banks for which (foreign) ownership status is available in the database by Claessens and van Horen (2014) in 48 countries over the time period 1998-2012. The regressions take into account bank and year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. All variables are centered around their means if they are interacted to facilitate interpretation of interaction effects. All measures for uncertainty in banking derived from bank-level data are standardized. The p-values are as follows: *** p<0.01, ** p<0.05, * p<0.1.

<i>Dep. var.: $\Delta Loans/assets_{t-1}$</i>	(1)	(2)	(3)	(4)
	<i>Uncertainty in banking (UncBank)</i>			
	Total assets dispersion	Short-term funding dispersion	Productivity dispersion	RoA dispersion
$\Delta \text{Log GDP deflator}_t$	0.323*** (0.060)	0.341*** (0.062)	0.349*** (0.061)	0.338*** (0.060)
$\Delta \text{Log real GDP}_t$	0.867*** (0.113)	0.854*** (0.116)	0.807*** (0.118)	0.787*** (0.113)
Liquid assets/assets _{t-1}	0.099*** (0.036)	0.099*** (0.037)	0.081** (0.037)	0.092** (0.036)
Capital/assets _{t-1}	0.223** (0.108)	0.229** (0.107)	0.245** (0.113)	0.231** (0.104)
Deposits/assets _{t-1}	-0.012 (0.043)	-0.014 (0.044)	0.023 (0.045)	-0.008 (0.043)
Log total assets _{t-1}	-5.334*** (1.015)	-5.297*** (0.974)	-5.368*** (0.991)	-5.620*** (1.057)
Comm. loans/(comm. loans + assets) _{t-1}	0.027 (0.065)	0.028 (0.072)	0.054 (0.060)	-0.001 (0.065)
Fown(0/1)	2.401 (4.271)	3.692 (3.683)	2.288 (3.439)	0.711 (3.618)
Uncertainty in banking (UncBank) _{it}	-1.591** (0.658)	0.243 (0.410)	-1.083** (0.503)	-1.781*** (0.629)
Fown(0/1) x UncBank _{it}	-0.686 (0.908)	-0.022 (0.628)	1.651** (0.720)	0.502 (0.964)
Uncertainty in banking (UncBank) _{kt}	-0.961 (0.741)	-1.495* (0.772)	-0.781** (0.323)	-0.080 (0.418)
Observations	2,576	2,566	2,464	2,573
R ²	0.281	0.268	0.266	0.274
Number of banks	636	636	611	636

Table 13: Uncertainty in Banking and Loan Supply: Foreign Ownership and Country-Year Fixed Effects

This table reports fixed effects regressions. The dependent variable is the change in loans divided by total assets of the previous period. The explanatory variables include bank-level variables, the dummy variable FOWN(0/1) indicating a bank's foreign ownership status (0: domestically-owned; 1: foreign-owned), the cross-sectional uncertainty measures derived from bank-level data (UncBank) (as denoted in columns 1 to 4) in the host country j , its interaction with the dummy variable FOWN(0/1) indicating a bank's foreign ownership status (0: domestically-owned; 1: foreign-owned). All bank-level variables are lagged by one period. The sample comprises yearly data of banks for which (foreign) ownership status is available in the database by Claessens and van Horen (2014) in 48 countries over the time period 1998-2012. The regressions take into account bank, host country-year and home country-year fixed effects. Standard errors are clustered by individual bank and depicted in parentheses. All variables are centered around their means if they are interacted to facilitate interpretation of interaction effects. All measures for uncertainty in banking derived from bank-level data are standardized. The p-values are as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

<i>Dep. var.: $\Delta Loans/assets_{t-1}$</i>	(1)	(2)	(3)	(4)
	<i>Uncertainty in banking (UncBank)</i>			
	Total assets dispersion	Short-term funding dispersion	Productivity dispersion	RoA dispersion
Liquid assets/assets _{$t-1$}	0.150*** (0.046)	0.150*** (0.046)	0.133*** (0.048)	0.149*** (0.046)
Capital/assets _{$t-1$}	0.345** (0.135)	0.346** (0.135)	0.413*** (0.146)	0.342** (0.133)
Deposits/assets _{$t-1$}	-0.048 (0.048)	-0.047 (0.048)	-0.020 (0.050)	-0.047 (0.048)
Log total assets _{$t-1$}	-6.840*** (1.353)	-6.838*** (1.349)	-6.573*** (1.383)	-6.845*** (1.350)
Comm. loans/(comm. loans + assets) _{$t-1$}	0.016 (0.060)	0.017 (0.059)	0.008 (0.061)	0.018 (0.060)
Fown(0/1)	10.301 (6.273)	10.308* (6.251)	7.972 (6.306)	11.959** (5.855)
Fown(0/1) x UncBank _{it}	0.035 (1.289)	0.096 (0.795)	-1.114 (1.455)	0.837 (1.255)
Observations	2,577	2,567	2,564	2,574
R ²	0.579	0.578	0.578	0.578
Number of banks	636	636	633	636

Figure 1: Uncertainty in Banking

This graph shows the evolution of our cross-sectional uncertainty measures derived from bank-level data over time. The measures are based on balance sheet data (total assets/ short-term funding), productivity (productivity shock) and profitability (RoA). *Total asset* is in thousands of USD. *Short-term funding* (in thousands of USD) is obtained by taking the sum of deposits from banks, repos and cash collateral, and other deposits and short-term borrowings. *Productivity* is estimated as proposed by Levinsohn and Petrin (2003). *RoA* is the ratio of operating profits to total assets (in %). For each of these variables, we compute in a first step time-varying bank specific shocks as described in Section 3.2. In a second step, we calculate the cross-sectional dispersion per country and year by taking the standard deviation across the shocks of all banks in one country and year. The graphs show the average across all countries in the sample (solid line), the average across Euro Area countries (dashed line) and the average across Non-Euro Area countries (dotted line). For better comparison, all variables are standardized (zero sample mean, unit sample standard deviation).

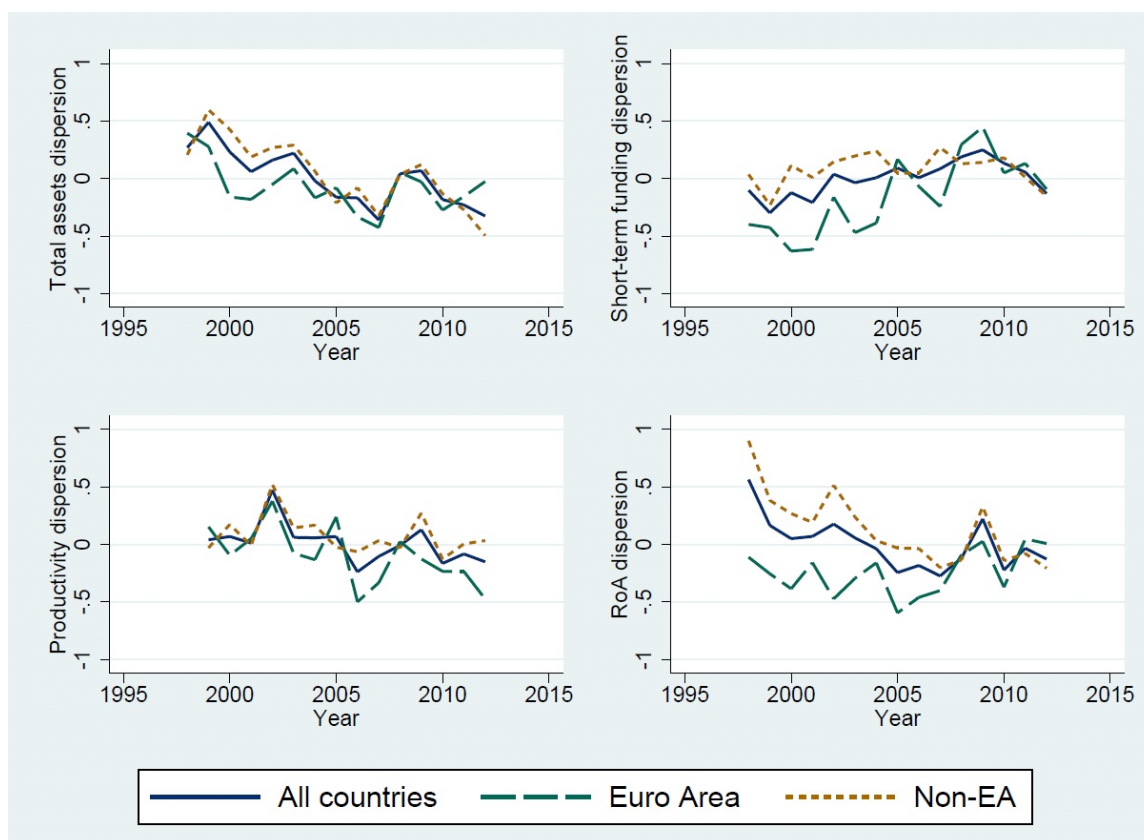


Figure 2: Alternative Uncertainty Measures over Time

This graph shows the evolution of alternative uncertainty measures over time. The variables that proxy uncertainty include *Bank volatility* computed as the volatility of weekly bank index returns for each year, *Stock market volatility* computed as the volatility of monthly stock market index returns for each year, *Economic policy uncertainty* for which we use the index for the US, annual real *GDP growth*, *Forecast dispersion* which gives the dispersion of one year ahead GDP growth forecasts, and *Firm return dispersion* calculated as the standard deviation of quarterly returns across firms. The graphs show the average across all countries in the sample (solid line), the average across Euro Area countries (dashed line) and the average across Non-Euro Area countries (dotted line) for the period 1998-2012.

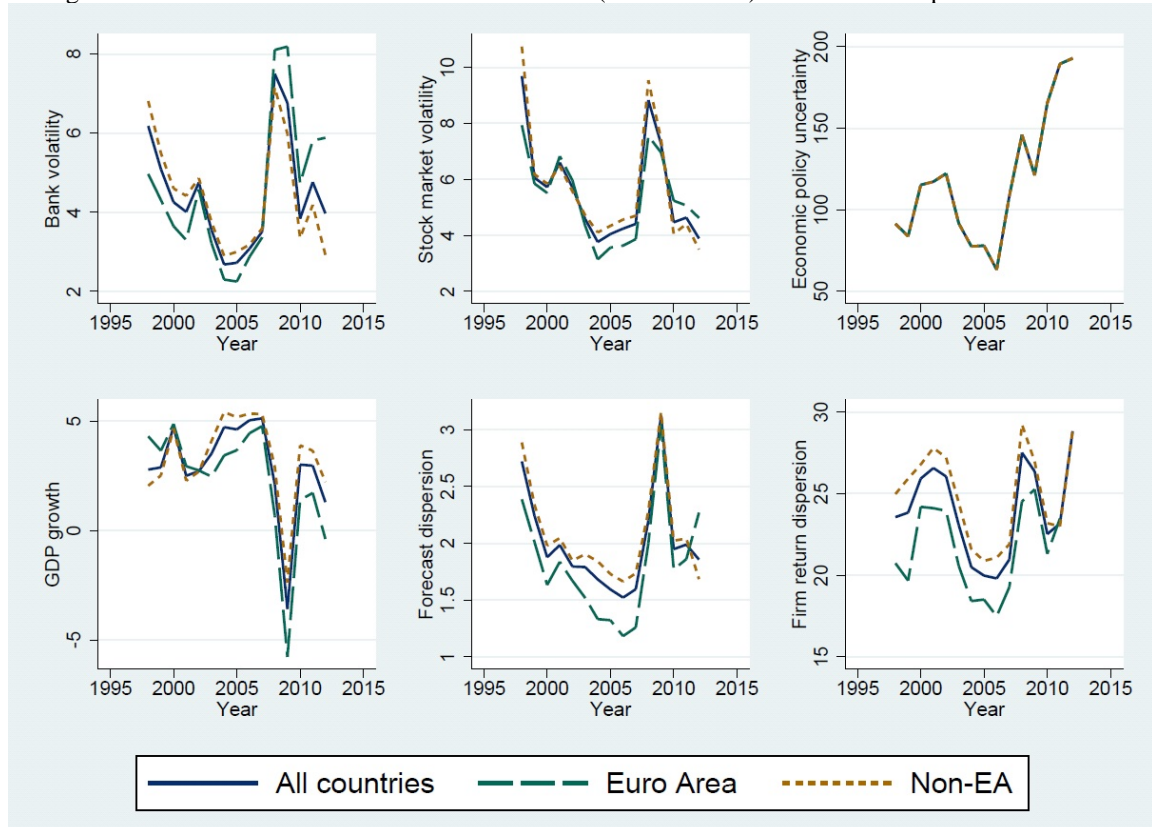


Figure 3: Time Series Plots: Uncertainty in Banking versus Alternative Uncertainty Measures

The following graphs show time series plots of our cross-sectional uncertainty measures derived from bank-level data against alternative measures of uncertainty. The measures for uncertainty in banking are based on a) *Total assets* in thousands of USD, b) *Short-term funding* (in thousands of USD) obtained by taking the sum of deposits from banks, repos and cash collateral, and other deposits and short-term borrowings, c) *Productivity* estimated as proposed by Levinsohn and Petrin (2003), d) *RoA* which is the ratio of operating profits to total assets (in %). The variables that proxy uncertainty include *Bank volatility* computed as the volatility of weekly bank index returns for each year, *Stock market volatility* computed as the volatility of monthly stock market index returns for each year, *Economic policy uncertainty* for which we use the index for the US, annual real *GDP growth*. For better comparison, all variables are standardized (zero sample mean, unit sample standard deviation).

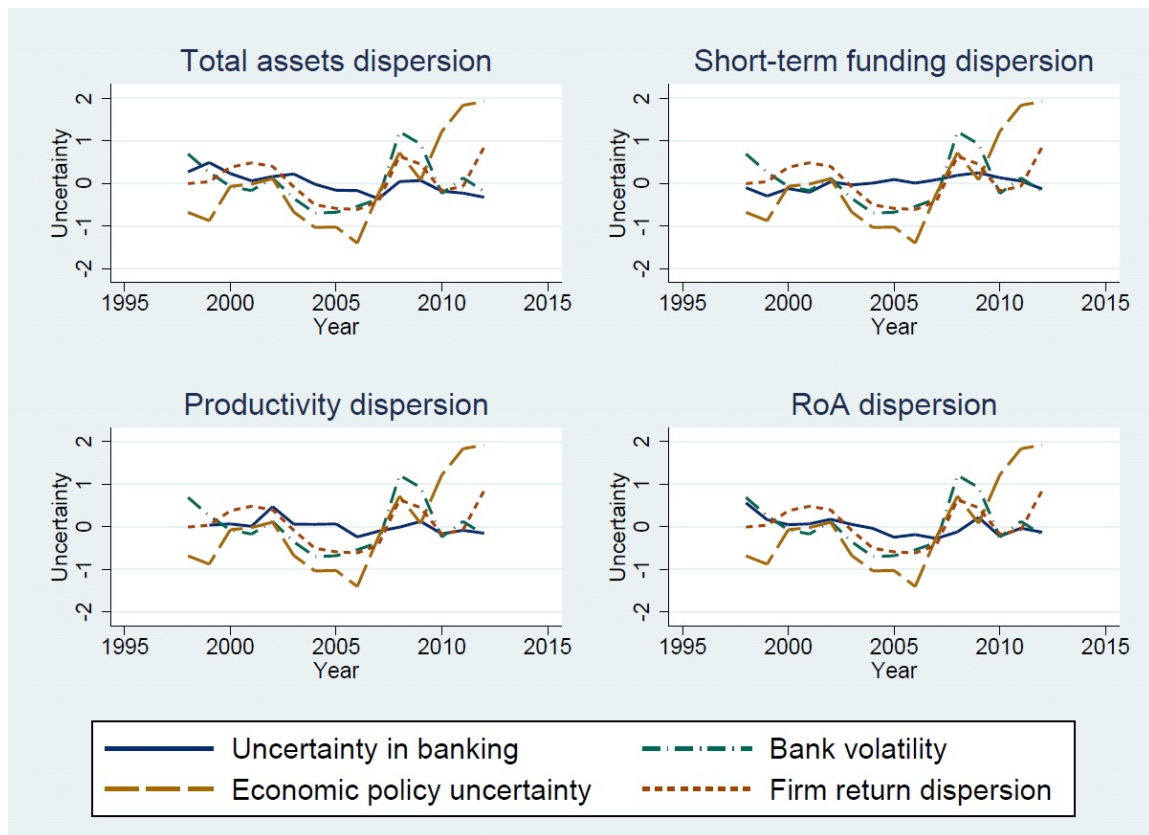


Figure 4: Average Marginal Effects Conditional on Liquidity

The following graph shows the average marginal effects of our cross-sectional uncertainty measures derived from bank-level data (*UncBank*) on loan supply conditional on the range of values for the *Ratio of liquid assets to assets* (in %) as observed in the sample. The measures for uncertainty in banking are based on a) *Total assets* in thousands of USD, b) *Short-term funding* (in thousands of USD) obtained by taking the sum of deposits from banks, repos and cash collateral, and other deposits and short-term borrowings, c) *Productivity* estimated as proposed by Levinsohn and Petrin (2003), d) *RoA* which is the ratio of operating profits to total assets (in %). The estimated marginal effects are denoted by dots, which are surrounded by 95% confidence bands.

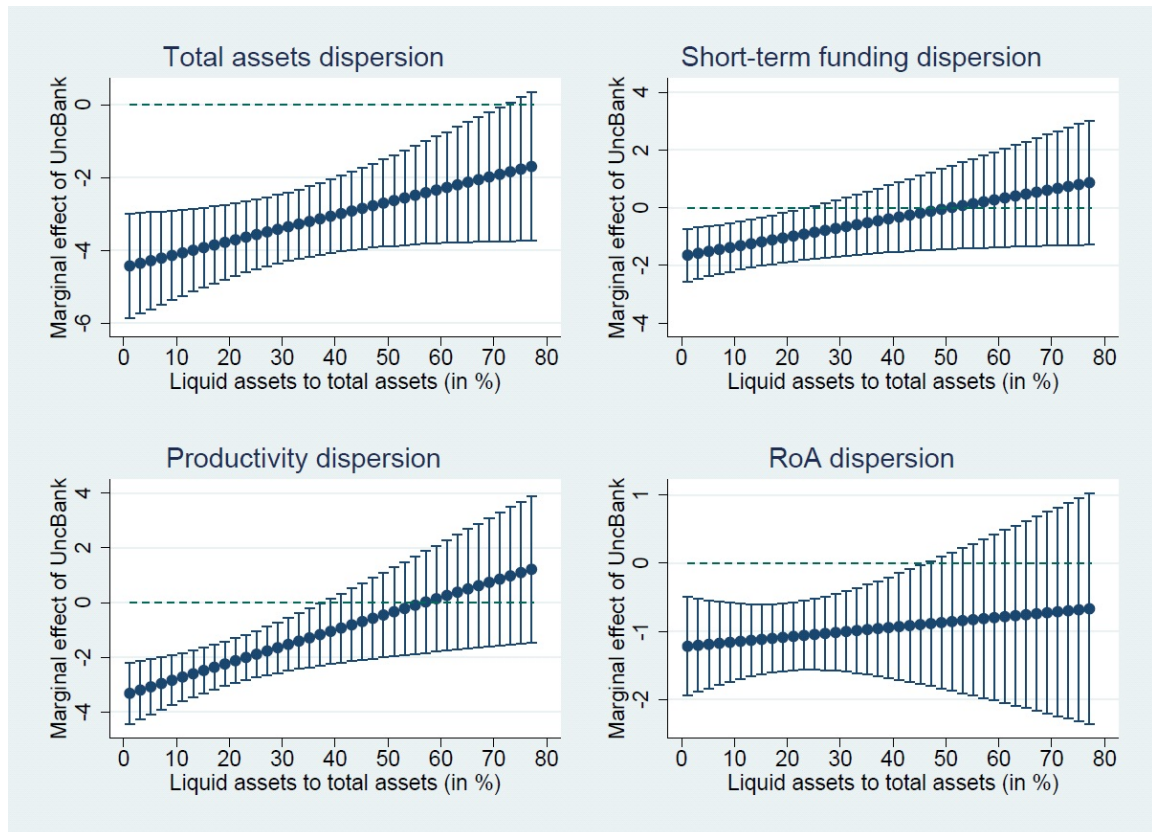


Figure 5: Average Marginal Effects Conditional on Capital Ratio

The following graph shows the average marginal effects of our cross-sectional uncertainty measures derived from bank-level data (*UncBank*) on loan supply conditional on the range of values for the *Tier 1 regulatory capital ratio* (in %) as observed in the sample. The measures for uncertainty in banking are based on a) *Total assets* in thousands of USD, b) *Short-term funding* (in thousands of USD) obtained by taking the sum of deposits from banks, repos and cash collateral, and other deposits and short-term borrowings, c) *Productivity* estimated as proposed by Levinsohn and Petrin (2003), d) *RoA* which is the ratio of operating profits to total assets (in %). The estimated marginal effects are denoted by dots, which are surrounded by 95% confidence bands.

