The Impact of Uncertainty on Financial Institutions: A Cross-Country Study

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Abstract

We examine the effects of uncertainty on several facets of the financial sector. Using a large country-level unbalanced panel dataset, we show that inflation uncertainty reduces availability of private sector credit; harms banks' efficiency and operational performance, evidenced by lower returns and increased reliance on non-interest income activities; and distorts sectoral stability, as liquidity, banks' appetite for risk and credit risk increases. Our findings, based on the full dataset and country splits, are economically meaningful and provide evidence that uncertainty threatens the overall health of the financial sector.

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1 Introduction

Financial intermediaries play a vital role in an economy by allocating scarce resources towards potential borrowers with the most promising prospects. However, under uncertainty, as relative prices can no longer be predicted with precision, an efficient allocation of funds may fail to materialize. This failure is possibly due to managers' unwillingness to bear risks or, equally, due to a shift in their risk preferences, which ultimately impact the availability of credit, efficiency and the stability of the financial sector. Despite researchers' intensified efforts to understand the effects of uncertainty on the functioning of financial intermediaries in the aftermath of the 2007–08 global financial crisis, most studies have focused on a particular aspect of financial institutions such as credit, profitability, liquidity or loan quality.[1] The literature has not provided a comprehensive view on the overall health of major financial institutions under uncertainty, despite the calls from both academicians and policymakers (see for example, Čihák et al., 2012; Law and Singh, 2014; Arcand et al., 2015).[2]

In contrast to the prior literature, we explore the impact of uncertainty on the overall functioning of the financial sector by taking into account the multidimensional nature of the question under investigation. A broad exploration of uncertainty effects is relevant given the ongoing debate whether monetary policy makers could aim to identify and remove balance sheet impairments which can easily block the flow of funds that the productive sectors seek while they strive to maintain the stability of financial institutions (e.g., see Smets, 2014 and Sannikov and Brunnermeier, 2013).

Our paper contributes to the literature in several ways. First, we investigate the effect of uncertainty on different aspects of financial institutions using a large panel of international

[1] For example, Louzis et al. (2012) examined the determinants of banks' non-performing loans; Delis et al. (2014) investigated US banks' lending decisions during periods of anxiety; and Khan et al. (2017) studied the role of funding liquidity on bank managers' risk-taking behavior.

[2] See, among others, Boyd et al. (2001) who studied the effect of inflation on the development of banking sector and equity market activities; Beck et al. (2013) who compared the relative performance of (Islamic and conventional) banks on different aspects including their business model, efficiency, asset quality and stability.

data from 89 countries for the period between 1996 to 2015, encompassing the period of the global financial crisis. In particular, we focus on financial depth, efficiency and stability of the financial sector under uncertainty. To carry out the investigation, we exploit a new database, the World Bank's Global Financial Development, which provides country-specific information on an annual basis. An examination that utilizes data from several countries is important to capture sufficient variation across countries and time over the entirety of the data. Consequently we can provide a broad view regarding the extent to which uncertainty affects the financial sector. We find that uncertainty curtails the availability of credit to the private sector; harms the efficiency of financial intermediaries, and adversely affects the stability of the financial system. These findings suggest that uncertainty distorts several facets of the financial system.

We also examine whether the uncertainty effects differ between high-income and low-income economies. We show that uncertainty effects on financial depth and non-performing loans are larger in low-income countries than high-income economies. In contrast, we find that uncertainty has a significant impact on bank returns, liquidity and non-interest income in high-income countries. An examination of the control variables in our models yields evidence suggestive of crowding out effects for low-income countries: changes in GDP leading to a decline in the availability of credit to the private sector. We also provide evidence that the impact of foreign bank presence on the availability of credit varies between low- and high-income economies, while such differences are not observed for other aspects.

An important question is whether the empirical results that we present have economic significance. Using the parameter estimates for the full sample, we find that a one standard deviation change in uncertainty could induce a 1.4% change in financial depth from its mean value.[3] Even though this seems small, as Bernanke (1983) and Bernanke and Gertler (1989) discuss, even minor changes in the availability of credit can induce large fluctuations in an

[3]The average ratio of private credit to GDP in our sample is around 70%. Hence, the change in availability of credit to private sector in response to a one standard change in uncertainty can easily amount to a figure around 1% of GDP.

economy. We find that bank returns decline in the order of 2% and non-interest income increases by 1.4%, suggesting a decline in efficiency in the banking sector. What is more worrying is that banks' liquid assets increase by 4% and banks' non-performing loans increase almost 10% in response to a one standard deviation change in uncertainty. Considering that uncertainty could increase considerably in a short period of time, the ultimate effect in all aspects could be much higher than our back of the envelope calculations. Taken together, our empirical results confirm the prediction that uncertainty adversely affects the functioning of the financial sector through several channels.

To ensure robustness of our findings, we considered several variations of the key variables. In contrast to most earlier research, we constructed uncertainty measures from dynamic and static inflation forecasting models in addition to the intra-year standard deviation of inflation. The latter measure, which is commonly used in the literature as "naïve" inflation uncertainty, can still be harmful given that risk insurance is costly and not perfectly available in every country. The other two are more sophisticated measures that capture uncertainty arising from the unexpected component of inflation. We used two variables to capture each of the characteristics—depth, efficiency and stability—of the financial system. All models contained several control variables to mitigate omitted-variables bias: the inflation rate, real GDP growth, trade openness, ongoing banking crises, bank concentration, foreign bank concentration, and international indebtedness relative to GDP.

While our main results are based on fixed effects methods, we demonstrated that the use of the Instrumental Variables Generalized Method of Moments (IV-GMM) estimator did not affect our conclusions. This ruled out potential problems of endogeneity among the explanatory variables, as tests showed that these variables can be treated as exogenous, providing further support for the empirical approach followed throughout the paper. As a robustness check, we also excluded the top and the bottom 1 percentile of the observations based on bank performance, inflation and inflation uncertainty, respectively, to rule out the potential influence of outliers. Results from this exercise yielded similar results. Lastly, we

should note that all variables in our panel regression models are verified to be stationary.[4]

The rest of the paper is organized as follows. Section 2 presents a brief review of the literature. Section 3 describes the data and discusses the construction of uncertainty measures. In Section 4, we initially provide visual evidence of uncertainty effects on the financial sector and then presents the empirical model. Section 5 presents the empirical results, robustness checks and discusses the economic significance of our findings. Section 6 concludes the paper.

2 Literature survey

Our investigation relates to many earlier studies which have separately focused on financial depth and bank lending behavior, as well as the efficiency and stability of financial institutions. An examination of the literature yields a vast body of work which has examined the relationship between financial development and stability.[5] For instance, using aggregate data, Bernanke and Gertler (1989) suggested that countries with developed and deeper financial markets enable firms to have easier access to external funds. This in turn dampens the impact of negative shocks on the economy. da Silva (2002) showed that countries with deeper financial markets experience smoother business cycles, while Raddatz (2006) found that financial depth helps to reduce output volatility in industries which strive for high levels of liquidity. Another strand of papers have shown that bank lending varies over the business cycle, declining during periods of extreme uncertainty or financial crisis (e.g., Ivashina and Scharfstein, 2010; Puri et al., 2011; Delis et al., 2014; Kosak et al., 2015; and Caglayan and Xu, 2016b). Taken together, researchers have argued that financial deepening is important for the smooth functioning of the economy as well as mitigating the adverse effects of shocks.[6] However, to our knowledge, earlier research has not specifically focused on the direct impact of uncertainty on financial depth.

[4]Fisher-type panel unit root test results, which are available upon request from the authors, provided clear evidence against nonstationarity.

[5]See Levine (2005) as well as Demirgüç-Kunt and Levine (2008) for detailed reviews.

[6]Also see Caglayan et al. (2017) on the role of financial depth in the transmission of monetary policy shocks.

Turning to studies that have focused on bank efficiency, we see that researchers have associated significant reductions in bank profitability as a signal of an impending financial crisis (Demirgüç-Kunt and Huizinga, 1999, Bourke, 1989, Cornett et al., 2010b). Bikker and Vervliet (2018) found that low interest rate environments reduce US banks' profitability. In a similar line, Albertazzi and Gambacorta (2009) provided evidence that high risk periods weaken banks' returns. Bolt et al. (2012) further showed the effects of a 1% contraction in real GDP during periods of deep recessions would lead to a 25 basis point decline in banks' ROA (return on assets). Separately, researchers who have examined banks' non-interest income have suggested that an increased level of income from this category leads to higher systemic risk and lower efficiency (e.g., see Brunnermeier et al., 2012). In this context, DeYoung and Roland (2001) and Lepetit et al. (2008) argued that changes in banks' non-interest income in periods of uncertainty can be taken to signal banks' risk appetite and deterioration of the efficient functioning of financial intermediaries.

Several other researchers have examined factors that promote stability of the financial system and confirmed that liquidity plays an important role: an issue which was under the spotlight during the 2008 financial crisis. In order to manage liquidity risk, bank managers generate liquidity on their balance sheet by converting illiquid assets such as bank loans into liquid assets like cash and securities (Berger and Bouwman, 2009). Hence, maintaining the right amount of liquidity is essential to achieve stability. and to overcome cash shortages. Gatev and Strahan (2006) and Gatev et al. (2009), among others, have shown that deposit withdrawals and commitment drawdowns are negatively related to market stress. Acharya and Naqvi (2012) developed a theoretical model to show the positive linkages between abundant liquidity and bank managers' risk-taking behaviors. In addition to liquidity, researchers have used non-performing loans (NPLs) as a separate indicator to monitor stability of banks. NPLs capture the asset quality of banks: higher NPLs indicate that banks are holding riskier assets. To that end, most studies that examined the relation between the macroeconomic environment and credit risk have generally found economic conditions negatively affect NPLs

(e.g., Louzis et al., 2012; Klein, 2013). It is interesting to note that higher management quality can reduce problem loans, as shown in Berger and DeYoung (1997) and Louzis et al. (2012).

In what follows, we provide empirical evidence that uncertainty adversely affects several facets of the financial system. In doing so, we examine three aspects of the financial system rather than just one to develop an understanding of uncertainty effects on the whole system, and show that these effects are economically significant on each dimension.

3 Data

To pursue our study, we acquired data from various sources including the World Bank Global Financial Development Database (GFDD), World Bank World Development Indicators (WDI), DataStream, the US Energy Information Adminstration (EIA) and the Economic Policy Uncertainty (EPU) website.[7] We obtained both overall global and country-level World Uncertainty Index (see Ahir et al., 2018) from the EPU website. The price of crude oil was extracted from the US EIA website.[8]

From the GFDD, we extracted two different measures of financial depth which provided information on the amount of credit available to the private sector. Our first financial depth measure, $FD1$, is the ratio of domestic credit to private sector relative to GDP ($GFDD.DI.14$). This variable gauges the financial resources provided to the private sector through loans, purchases of non-equity securities, and trade credit and other accounts receivable that establish a claim for repayment. Our second financial depth measure, $FD2$, which we used for robustness purposes, is the ratio of private credit to the real sector by deposit money banks and other financial institutions to GDP ($GFDD.DI.12$).[9]

To examine the efficiency of banks, we extracted banks' return of equity ($GFDD.EI.06$)

[7]EPU website: http://www.policyuncertainty.com

[8]EIA crude oil spot prices: https://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm

[9]The second measure does not include credit issued to governments, government agencies, and public enterprises. Furthermore, credit issued by the central bank is excluded.

and non-interest income to total income ($GFDD.EI.03$) from the GFDD. To examine the stability of financial institutions, we obtained the ratio of liquid assets to total deposits and short-term funding ($GFDD.SI.06$) and non-performing loans ($GFDD.SI.02$) from the GFDD. Furthermore, we use gross domestic product ($NY.GDP.MKTP.CD$), the consumer price index ($GFDD.OE.02$), bank concentration ($GFDD.OI.01$), and international debt securities as a percentage of GDP ($GFDD.OI.15$) from the same database. We acquired total exports and total imports from WDI. The monthly consumer price index (CPI) from 1996 to 2015 is downloaded from Datastream. The rest of the data span the period between 1996 and 2015, except for non-performing loans which become available in 1998.

3.1 Generating measures of inflation uncertainty

To construct measures of inflation uncertainty for each country, we used monthly CPI data and followed three different approaches. The first inflation uncertainty measure is based on the annual standard deviation of monthly logarithmic differences in CPI. This uncertainty measure has been implemented by several researchers in the literature including Barro (1996), Judson and Orphanides (1999) and Caglayan and Xu (2016a). In this respect, we use this naïve uncertainty measure to serve as a benchmark.

We then generate two additional model-based measures. The second measure is obtained from a static model. We estimated an AR(p) model which took the following form:

$$\pi_t = \alpha + \sum_{i=1}^{p} \beta_i \pi_{t-i} + \epsilon_t \tag{1}$$

where π_t is the log difference of CPI and ϵ_t is a random term. Using the parameter estimates, we then computed the sum of squared monthly differences between the actual and the observed inflation for each year:

$$\widehat{h}_y = \sum_{m=1}^{12} (\pi_{y,m} - \widehat{\pi}_{y,m})^2 \tag{2}$$

where $\pi_{y,m}$ denotes inflation in year y and month m. The uncertainty measure, $\widehat{h}_y$, obtained

from this approach is our static inflation uncertainty measure. The process is repeated for each country in the dataset where p is set to 4 for parsimony and uniformity.

The last uncertainty measure uses a similar AR(p) model. However, rather than estimating the model for the full sample, we follow a rolling window approach by including an additional observation in each estimation round after predicting the one-step-ahead inflation. The difference between the predicted and the actual inflation rate is recorded as the observed error. We then computed our dynamic inflation uncertainty measure by following equation (2). In both measures, higher levels of the unpredicted component of inflation imply higher uncertainty for the future level of inflation.

4 Preliminary evidence and the model

In this section, we provide visual evidence that uncertainty adversely affects the availability of credit, efficiency and the stability of the financial system. Subsequently, we present our models. All variables defined and discussed in the text are tabulated in Table 1.

Please place Table 1 about here

4.1 Visual inspection

Figure 1 provides the visual association between average dynamic inflation uncertainty and the variables upon which we focus in this study including financial depth, efficiency and the stability of financial intermediaries. These graphs are constructed by aggregating the data on a country basis, where uncertainty is plotted on a logarithmic scale for convenience. The top two graphs, (a-b), depict the association between uncertainty and two different measures of average financial depth. The middle graphs, (c-d), plot uncertainty against average bank profitability and non-interest income to total income, respectively. The last two graphs, (e-f), plot the average bank liquidity and average bank non-performing loans against average inflation uncertainty, respectively.

Please place Figure 1 about here

Figures (a-b) present a clear and negative relationship between average dynamic inflation uncertainty and both financial depth measures. These two graphs show that average credit is lower in countries with high uncertainty. Figures (c-d) present mixed evidence in relation to our expectations between uncertainty and efficiency: Figure (c), contrary to expectations, shows that bank returns increase with uncertainty. However, this result is driven by data aggregation, which occludes the negative bank returns. Figure (d), as expected, shows that banks' non-interest income is increasing with uncertainty. The last two graphs, Figures (e-f), plot banks' liquid asset holdings and banks' non-performing loans, respectively, against uncertainty. The associations depicted in these figures are in line with our expectations.

In Table 2, we provide the pairwise correlations between all variables we use in our models. The table shows that the simple correlation between uncertainty and ROE is weak and insignificant. For the other variables the association is significant at the 1% level.

Please place Table 2 about here

Given the *prima facie* evidence gathered from Figure 1 and Table 2, we proceed to empirically examine the data implementing the models discussed below.

4.2 Empirical model

In what follows, we examine the impact of measures of uncertainty on three characteristics of financial institutions: financial depth, efficiency and stability. To carry out our investigation we employ the following model:

$$Index_{j,t} = \alpha + \beta_1 \hat{h}_{j,t-1} + \lambda Control_{j,t} + time_t + \nu_j + \epsilon_{j,t} \tag{3}$$

where the dependent variable, $Index_{j,t}$ denotes a variable that relates to the health of financial institutions in country j at time t. All variables are measured as of the end of the year with the exception of the uncertainty measure, $\hat{h}_{j,t-1}$, our key explanatory variable, which is

constructed using monthly data over the year.[10] Based on the proxy used, our uncertainty measures capture a different aspect of the observed volatility throughout the year.

We start our investigation by examining the impact of uncertainty on the availability of credit to the private sector. We expect that an increase in uncertainty will lead to a decline in availability of credit to the private sector as bank managers become more conservative in their lending in a volatile environment. Hence, the uncertainty coefficient, β_1, should take a negative sign. We next examine the impact of uncertainty on the efficiency of the financial sector. To do so, we estimate equation (1) by using two different efficiency measures as dependent variables: return on equity (ROE) and the ratio of non-interest income to total income (NII). ROE is a major indicator that researchers have used to investigate the efficiency and operational performance of banks. Similarly, researchers have used NII to capture the extent to which banks resort to riskier strategies.[11] We expect to find a negative impact of uncertainty on bank efficiency, for increases in uncertainty would trigger a fall in bank profitability. In contrast, an increase in uncertainty would encourage bank managers to increase their non-interest activities, as they search for high yield in a period when returns from traditional operations fall and monitoring borrowers and recovery of funds become a difficult task. Finally, to examine bank stability, we use bank liquidity and non-performing loans as a dependent variable in equation (1). In line with the predictions of earlier literature derived from bank-level data, we expect to find that both bank liquidity and non-performing loans would increase with uncertainty.

To address potential specification error, our model contains several control variables ($Control$). Exclusion of the control variables can potentially lead to biased results and wrong conclusions in favor of the uncertainty effects on financial institutions. To that end, research has shown that a model which examines the impact of uncertainty must contain the corresponding level variable from which the uncertainty proxy was derived. Otherwise, one

[10] Details on uncertainty proxies are given in section 3.1.

[11] NII has been used as a forward-looking measure of risk by several researchers, including Buch et al. (2014), Brunnermeier et al. (2012), DeYoung and Roland (2001).

can incorrectly assign the role that the level variable is playing to the uncertainty variable.[12] Thus, our model contains the rate of inflation ($Inflation$) as well as several additional control variables including the GDP growth rate (ΔGDP) and a measure of trade openness ($Openness$) to control for changes in domestic and foreign demand, respectively.

We also use a dummy variable (oBC) to capture the effects of ongoing banking crises. This variable is constructed based on the following rules which are similar to that in Laeven and Valencia (2013). We defined a banking crisis as systemic if there are 1) significant signs of financial distress, captured by significant bank runs, losses in the banking system, and/or bank liquidations; and 2) significant banking policy intervention measures due to significant losses incurred in the banking system. The beginning of a systemic crisis is set to the year when both criteria are met, while the end is defined as the year before both real GDP growth and real credit growth are positive for at least two consecutive years.[13] For EU countries, we used banking crisis periods identified by the ECB (Lo Duca et al., 2017). For non-EU countries, we have identified crisis episodes when the banking system of a country exhibits significant losses pushing the share of non-performing loans above 20%.

In addition to the aforementioned variables, three more control variables are used in the model. These variables measure bank concentration ($Bank\_Concentration$), foreign bank concentration ($Foreign\_Banks$), and international indebtedness as a percentage of GDP ($Debt/GDP$). The former two variables control for the country-specific banking environment, and the last variable captures the role of foreign debt. We also include time fixed effects in all models to allow for macro events that our control variables fail to capture. The last two terms of the model depict country-specific fixed effects, ν_j, and the idiosyncratic error associated with country j at time t, $\epsilon_{j,t}$.

[12] See Huizinga (1993) along these lines.

[13] Our definition, as the Laeven and Valencia (2013) data only cover the 1970–2011 period.

5 Empirical findings

In this section, we present our empirical findings. Our main results are obtained using the fixed effect methodology with cluster-robust standard errors to account for heteroscedasticity and within-panel serial correlation in the idiosyncratic error term. The clusters are defined by the country. We also present results based on the IV-GMM approach to show that our results are robust to the choice of estimation method. All our models also contain year dummies. Therefore, country-specific fixed effects capture country-level events that the control variables do not, while the year dummies control for the changes in unobservable shocks that may affect the functioning of global financial institutions.[14]

5.1 Uncertainty effects on aggregate credit

Table 3 presents the results for uncertainty effects on financial depth. The first three columns present results for our first financial depth ($FD1$) measure, which is constructed as a ratio of domestic credit provided to the private sector by financial corporations through loans, purchases of non-equity securities, trade credit and other accounts receivable that establish a claim for repayment. This is a standard proxy used in the finance and growth literature. The last three columns lay out the results for the alternative definition of financial depth ($FD2$) which captures the ratio of private credit to the real sector from deposit money banks and other financial institutions to GDP, excluding credit issued to governments, government agencies, and public enterprises.[15] For each group, we initially present results for the uncertainty measure which is obtained from a dynamic inflation forecasting model followed by the uncertainty measure from a static inflation forecasting model and the annual standard deviation of inflation. Regression results for all three uncertainty measures provide a similar view: inflation uncertainty has a negative and significant effect on financial depth.

[14] We carried out the Hayashi C test (see Hayashi, 2000, pp 233–34 and Baum et al., 2007) to examine whether the independent variables in these estimated models can be treated as exogenous. Based on this test, we cannot reject the null hypothesis of exogeneity, and thus employed the fixed effects model for our study.

[15] This proxy is a somewhat narrower indicator. See footnote 9.

Please place Table 3 about here

The level of inflation, change in real GDP, openness, bank concentration and the presence of foreign banks have no significant effect on financial depth. However, we find that the coefficient associated with an ongoing banking crisis (oBC) is positive and highly significant. This result suggests that financial depth increases during periods of banking crisis, reflecting the expansionary policies carried out by governments and central banks to promote recovery. It should be stressed that this finding does not imply a deepening of financial depth in the year of a banking/financial crisis, but rather throughout the period of financial crisis. For instance, during the initial stages of the 2007–08 financial crisis, there was an acute credit crunch in the markets. However, as the Federal Reserve, the Bank of England and the European Central Bank carried out expansionary polices, the initial adverse effects of the crisis on credit markets were mitigated and credit was made available to potential investors. In addition, our empirical results show that a country's ratio of international debt issues to GDP ($Debt/GDP$) has a positive impact on financial depth. This is sensible as $Debt/GDP$ measures the stock of outstanding international bonds relative to a country's economic activity and increases with countries' income level (Beck et al., 2010). This finding suggests that funds raised from external creditors are injected into the economy through the financial system.

Overall, the results in Table 3 confirm that uncertainty has a negative effect on financial depth. These results are robust to the use of three different uncertainty proxies and two different measures of financial depth. Yet, it would be useful to evaluate the findings reported in Table 3 by considering other studies which have used bank-level data to examine bank loans over the business cycle. Researchers have shown that following monetary and financial shocks bank loans decline sharply, making it difficult for bank-dependent borrowers to raise funds from financial institutions (e.g., Ferri et al., 2014). Research has revealed that the cyclicality of loans leads to inefficiencies in credit allocation, as during the expansionary state of the economy banks can easily grant credit to firms with marginally positive or even negative

net present value projects as bank lending standards decline and competition increases while risks are underestimated. Contrarily, during recessionary periods, banks can even reject loan applications of firms with positive net present value projects due to increased risk premiums. No doubt, this behavior reflects banks' increased risk aversion during recessionary periods (see Ruckes, 2004 and Bassett et al., 2014). Furthermore, researchers also argued that the extent of asymmetric information over the business cycle can affect banks' risk preferences. Hence, during the expansionary phase of the business cycle, banks tend to grant more loans than in recessionary periods, as lenders suffer less from asymmetric information problems during the upward phase of the economy. Moreover, the business cycle can affect the cost of monitoring borrowers which in turn can lead to fluctuations in bank credit (e.g., Athanasoglou et al., 2014). If these bank-level observations are valid, then there will be similar implications for overall private sector credit. Given that financial crises trigger deep recessions, our findings complement the findings reported in the literature.

5.2 Uncertainty effects on bank efficiency

In this section, we discuss uncertainty effects on financial institutions' efficiency as we examine banks' return on equity and banks' non-interest income to total income ratio.

Inspecting the first three columns of Table 4, we see that uncertainty has a negative and significant impact on banks' return on equity, ROE, in all models.[16] As in the previous table, uncertainty measures are based on dynamic and static inflation forecasting models as well as the annual standard deviation of inflation. In models that focus on ROE, we see that the level of inflation, GDP growth, openness, bank concentration and the debt to GDP ratio have no significant impact on bank returns. The results show that bank returns during

[16]We are thankful to an anonymous reviewer who pointed out that in many developing countries, a significant portion of bank profits is derived from lending to the central government. As a result, higher uncertainty in these countries may actually lead to higher profits as the risk premium on government bonds increases. Likewise, because real interest rates on consumer and business loans are usually higher than the average rates in developed countries, profitability can increase if the risk premiums on such loans increase along with uncertainty. Indeed, when we examine results for income group splits, we find that the coefficient estimates for ROE as well as NII are both significant for the high-income country group and not for the low-income country group.

ongoing banking crisis episodes are negatively and significantly affected at the 1% level. These observations complement findings reported in the literature. For example, Albertazzi and Gambacorta (2009) have argued that bad economic conditions worsen the quality of banks' loan portfolio, and, therefore, generate credit losses and reduction in bank profits. In a similar line, Cornett et al. (2010a) have reported that banks of all size groups suffered as bank performance decreased before and during the recent financial crisis. Examining the control variables, we find that only foreign bank concentration has a negative and significant impact on banks' return on equity. This is consistent with the literature which has shown that the entry of foreign banks render national banking markets more competitive, reduce profitability and costs of financial intermediation in the industry (e.g., Claessens et al., 2001; and Claessens and Horen, 2014).

Please place Table 4 about here

Next, we examine the impact of uncertainty on banks' non-interest income activities. This set of activities, including income from trading and securitization, investment banking and advisory fees and service charges, are considered to be separate from the traditional deposit taking and lending functions of banks (see Brunnermeier et al., 2012) and deemed to act as a forward-looking measure of bank risk. As a consequence, changes in non-interest income activities may adversely affect banks' earnings volatility because of a higher degree of financial leverage. We report the impact of uncertainty on banks' non-interest income ratio in the last three columns of Table 4. We find that the uncertainty effect on non-interest income is positive and significant at the 1% level in all models. These results suggest that when income from traditional lines of business declines (which in consequence leads to a decline in earnings to equity, as shown in the first columns), banks engage in other activities to boost their profitability. This finding is consistent with the risk-taking channel through search for yield (Rajan, 2006).

In fact, a number of researchers have found a significant positive relationship between non-interest income activities and earnings volatility (see DeYoung and Roland, 2001, Stiroh,

2004, Lepetit et al., 2008 and Abuzayed et al., 2018). For instance, Lepetit et al. (2008) argued that non-interest income activities[17] are considered to be riskier than traditional credit creation, as it might be easier for customers to switch banks for these types of services rather than traditional banking activities such as relationship lending. DeYoung and Torna (2013) found that banks with increased exposure to activities such as investment banking, insurance underwriting and venture capital also tended to take more risk in their traditional banking activities. They argued that such banks were more aggressive in their lending behavior, had less diversified and riskier loan portfolios, and funded their loan books with less stable deposit bases. Hence, an increase in the non-interest income ratio can severely affect the efficiency of banks' operations.

Turning to other variables in the model we find that openness, bank concentration, the debt to GDP ratio and the presence of foreign banks have no significant role in explaining the behavior of non-interest income. In contrast, we find that inflation and changes in GDP both exhibit a positive and significant impact. An increase in inflation may be taken as an indicator of increasing economic activity. When economic activity increases, banks become involved in non-interest income activities to extract more rent. Similar to the previous models, an ongoing banking crisis exhibits a positive and statistically significant coefficient, indicating that banks' non-interest income activities increase throughout such episodes. In periods of continuing crisis, as banks experience lower lending, their non-interest earning activities increase while managers search for higher returns. Although boosting returns through such activities may sound reasonable, increasing income through these more volatile activities during times of higher uncertainty may adversely affect the efficiency of the financial system.

Taking these findings together, we conclude that uncertainty affects the efficiency of financial intermediaries negatively by reducing banks' operational performance and increasing risk-taking activities. Our findings are consistent with Kok et al. (2015), who have also

[17]Activities such as cash withdrawal fees, bank account management, or data processing.

shown that greater reliance on non-interest income is related to weaker bank profitability. The significance of ongoing banking crises in the model constitutes further evidence that efficiency worsens during periods of banking crises when asymmetric information problems heighten.

5.3 Uncertainty effects on bank stability

Table 5 presents uncertainty effects on banks' liquidity and non-performing loans. We measure liquidity by the ratio of liquid assets to short-term funding plus total deposits. Non-performing loans are defined as a ratio of defaulting loans to total gross loans.

The first three columns show that inflation uncertainty has a positive and significant effect on liquidity at the 1% level. Our finding complements the literature which demonstrated that during periods of disturbance, banks increase their liquid asset holdings (e.g., Cornett et al., 2011). Several authors such as Gatev and Strahan (2006) and Gatev et al. (2009), have found that deposit withdrawals and commitment drawdowns are negatively associated to market stress. To be more specific, when a crisis occurs outside the banking system (e.g., in the commercial paper market), the funds that investors remove from these instruments would flow primarily into the banking system, because banks would be seen as a safe haven given government guarantees on deposits.[18] In models associated with liquidity, except for foreign banks, other variables do not play a significant role. However, over the years, deregulation of branching, activity restrictions and foreign banks' presence in countries have increased the intensity of competition among banks. Such changes in the financial markets have reduced the cost of financial intermediation and profitability. In that sense, the presence of foreign banks promoted the efficient use of liquid assets, which is captured by a negative and highly significant coefficient in the first three columns of Table 5.

[18] We also checked whether liquidity will increase further during periods of extreme inflation uncertainty. To capture asymmetric uncertainty effects, we generate a dummy variable which we set to 1 if $\hat{h}_{j,t}^{Ext} \geq 70$ and 0 otherwise. We find that liquidity further increases during these severe uncertain phases. Results are available upon request.

Please place Table 5 about here

Nevertheless, availability of excess liquidity can induce bank managers to seek higher returns and encourage excessive credit volumes as bank managers may misprice the down-side risks (e.g., Acharya and Naqvi, 2012). This is further acerbated as loan officers are compensated based on the volume of loans they book, while they are only penalised if the bank suffers from a liquidity shortfall. Moreover, during periods of high macroeconomic risk, investors would prefer to save with banks rather than making direct investments elsewhere. As a consequence, high levels of liquid assets may induce bank managers to engage in risker activities, at the detriment of stability of the financial system.[19] To that end, in Table 4, we have already shown that banks increase their non-interest income activities in periods of uncertainty.

The next three columns present the impact of uncertainty on non-performing loans. In particular, we find strong positive results based on both static and dynamic uncertainty measures, yet there is no significant impact when we use the standard deviation of inflation as a measure of uncertainty. Furthermore, as expected, we find that an ongoing banking crisis displays a positive and significant coefficient. These findings are consistent with the literature on loan quality and the macroeconomic environment (e.g., Loutskina, 2011; and Klein, 2013). In particular, during periods of tranquility, banks have fewer problem loans as both businesses and households have sufficient streams of revenues and income to repay their debts. However, rapid growth in an economy is often associated with a deterioration in lending standards. Consequently, debt servicing and repayment of loans would be severely affected by economic downturns and changes in credit markets. As a result, when a recession sets in, the risk of insolvency significantly increases, as weaker and less efficient businesses and consumers with burdensome mortgages fail to pay back their loans (e.g., Louzis et al., 2012; Klein and Olivei, 2008; Klein, 2013; and Claessens et al., 2014).

[19] Lepetit et al. (2008) argued that non-interest income activities such as cash withdrawal fees, bank account management, or data processing are considered to be riskier than traditional credit extension, as customers can easily switch banks for these types of services rather than standard banking activities.

In models that explain non-performing loans under uncertainty, we find no impact due to inflation, changes in GDP and bank concentration. In contrast, we find that openness has a positive effect. This may be due to the fact that openness, as it increases competition, reduces firms' profitability. Hence, in competitive markets, weak firms fail, leading to an increase in non-performing loans of banks. We also find that the ratio of foreign debt to GDP has a positive effect on non-performing loans. The presence of foreign banks has a negative impact on non-performing loans, possibly due to their ability to sift firms with low quality investment projects from their loan portfolio (Claessens and Horen, 2014).

In summary, our results reveal that uncertainty affects the stability of global financial institutions negatively, with higher liquidity asset holdings and lower asset quality.

5.4 Further evidences on country-income splits

We have examined three different aspects of financial markets, financial depth, efficiency and stability, to provide a broader view on the impact of uncertainty on the health of the financial sector. We augment each model with several country-specific variables as well as country and year fixed effects which control for annual or country-specific shocks that our control variables fail to capture. Our findings, which are robust to the use of different measures of uncertainty, show that inflation uncertainty has a negative impact on the financial sector. In what follows, we present further evidence in support of our findings, based on high *versus* low-income country splits. In doing so, we can test whether uncertainty effects differ across income groups. For brevity, we present the results only for the dynamic uncertainty measure. The results from other measures provide a similar view and are available from the authors. Table 6 presents the results for high-income (H_inc) *versus* low-income (L_inc) country categories.[20] All models in the table contain the same set of control variables as employed in the earlier tables.

[20]The World Bank has divided the world's economies into four different income categories by the level of income: high, upper-middle, lower-middle and low. Our high-income group is comprised of countries whose income levels fall within the high and upper-middle income category, and low-income group is composed of countries whose income is at the lower-middle and low income category.

The results are displayed in the order: financial depth (wider and narrower definitions), return on equity and non-interest income, liquidity and non-performing loans. The first two columns of the table show that uncertainty has a negative effect on both high- and low-income countries for both financial depth measures. In particular, we find that uncertainty has a larger coefficient for low-income countries: an increase in uncertainty leads to a sharper decline in financial depth in low-income countries, all things equal. This result is expected, as inflation is a bigger concern for low-income countries.

Please place Table 6 about here

When we turn to variables that measure efficiency in financial institutions, we find that uncertainty has the expected effects as shown in Table 4. Uncertainty effects are significant for bank returns and non-interest income only in high-income countries. Insignificant effects of uncertainty on profitability in low-income countries could be due to the presence of government-owned institutions without a profit-maximizing mandate.[21] Similarly, in a financially underdeveloped environment, banks would not necessarily be experiencing changes in their non-interest income. Therefore, a lack of significance in low-income countries should not be too surprising for these variables.

Regarding the stability dimension of financial intermediaries, we find again that the effect of uncertainty on liquidity and non-performing loans are in line with Table 5. In the case of liquidity, the effect of uncertainty is significant only for high-income countries. Yet, inflation uncertainty is significant at the 1% level for both high- and low-income economies. In fact the uncertainty effect on non-performing loans is significantly higher in low-income countries than that in high-income countries. During periods of banking crises, both high and low-income countries experienced significant lower profitability. In addition, we find that foreign banks were less profitable only in developed countries (Demirgüç-Kunt and Huizinga, 1999).

[21] As a significant portion of bank profits is derived from lending to the central government, increasing uncertainty may actually yield profits as the risk premium on government bonds increases.

When we inspect the role of control variables, we find similar results compared to our earlier observations in most cases. One of the most interesting differences relates to the role of changes in GDP. We find that the effect is highly significant and negative for low-income countries for most of the models, whereas it is generally insignificant for the high-income countries. This finding suggests that if government expenditures are the main driver of growth in low-income countries, then expansionary fiscal policies simply crowd out the private sector from the capital markets. The banking crisis variable assumes similar effects in relation to our earlier findings, and we observe no significant differences between high- and low-income country groups except for the case of efficiency, ROE and NII results given in columns 3 and 4. Results in column 3 show that the coefficient of the bank crisis dummy is much larger for low-income countries, while results in column 4 show that the same coefficient is larger for high-income countries. This suggests that the financial sector in high-income countries bounces back from financial crises more quickly than that in low-income countries. This is perhaps due to the fact that banks in low-income countries have to play further roles in supporting the economy, such as holding a large stock of sovereign debt.[22]

Furthermore, we find that pooling country income information as we did in Tables 3–5 masks the effect of foreign bank presence on credit between country groups. As columns 1 and 2 show, for high-income countries there is a strong positive relationship between foreign ownership and credit, while for low-income countries, we find a significant negative relationship. This may be because foreign banks increase access to financial services and enhance financial and economic performance of their borrowers (Claessens et al., 2001). However, research has also shown that foreign banks can target certain type of borrowers undermining the consumers general access to financial services. Such actions in return worsen the credit pool and lower financial development in emerging countries where relationship lending is important (Claessens and Horen, 2014).

[22]This makes sense if the financial sector in low-income countries is dominated by large state-owned banks.

5.5 Further robustness checks

To further ascertain the robustness of our findings, we carried out several sensitivity analyses.[23] We first examined whether using an instrumental variables technique would make a difference. Fixed effects models are estimated assuming that explanatory variables are exogenous or predetermined. If endogeneity appears among the regressors, these models will yield biased estimates. To guard against this possibility, we estimated the model using the IV-GMM methodology using 2 to 3 lagged values of inflation uncertainty, inflation, real GDP growth and openness as instruments. The results are given in Table 7 using the dynamic uncertainty measure.[24] Notice that the sign, size and the significance of the uncertainty coefficients in all columns are similar to our earlier findings. Also notice that the Hansen C test, equivalent to a Durbin–Wu–Hausman test of OLS versus IV, cannot reject the null hypothesis that the specified regressors can be treated as exogenous. These observations provide evidence that the empirical approach and the associated results are valid.

Please place Table 7 about here

Secondly, we examined whether inflation uncertainty is picking up any effect emanating from other sources of uncertainty.Hence, we augmented our models with two different types of uncertainty measures: the country level World Uncertainty Index (WUI), proposed by Ahir et al. (2018), and oil price uncertainty. The rationale for including the country level WUI is that it covers 143 countries and constructed using country reports from the same source tailored to national economic and political developments. Oil price uncertainty is included into our models to gauge the stability of the macroeconomy as it may capture volatility effects emanating from commodity markets. Results given in Table 8 show that the sign and significance of the dynamic inflation uncertainly is similar to our earlier results and that the added uncertainty measures do not affect our claims. In addition, we also re-estimated our

[23] We would like to thank an anonymous reviewer for suggesting these additional sensitivity checks.
[24] Results for the static and standard inflation volatility measures were similar and available upon request.

models by replacing the country-level WUI with the aggregate WUI and the EPU proposed by Baker et al. (2016). Results from these exercises did not qualitatively change our main findings. Hence, we refrained from presenting these results, which are available from the authors, to save space.[25]

Please place Table 8 about here

We also examined whether our results could be driven by outliers. We reestimated all models after excluding the top and bottom 1 percentile of the observations based on bank performance, inflation and inflation uncertainty to overcome the influence of the outliers. This exercise yielded similar results and are available upon request. Finally, we carried out additional checks to see if the results are sensitive to high/low income groupings. We found weak results for the high income country group, while results for the low-income (i.e. the remaining) countries were similar to our earlier findings. For the high-income countries, key variables had less variability both between countries and over time, weakening findings for this group.[26]

5.6 Economic significance of our findings

Examining data that relate to the three characteristics of the financial institutions including financial depth, efficiency and stability, we have demonstrated that uncertainty adversely affects the health of financial systems. However, the coefficient estimates do not necessarily highlight the magnitude of this adverse effect. To overcome this hurdle, we used the point estimate of the dynamic uncertainty impact coefficient ($\hat{\beta}_h$) for each of the variables in Tables 3–5 and computed the corresponding elasticity. Then, we calculate the implied percentage

[25] Ahir et al. (2018) argue that the WUI is more consistent and replicable across countries in comparison to the EPU index because the construction of the EPU relies on data from a large set of newspapers from different countries.

[26] We examined several variants of high income *versus* the rest of country data splits including the OECD *versus* the rest of the world, the OECD + 6 Major Emerging Countries vs the rest of the world. These results are available upon request.

change of the financial indicator in response to a one standard deviation (sigma) change in dynamic uncertainty.[27] Table 9 presents these findings.

Please place Table 9 about here

Starting with financial depth, regardless of the measure used, we find that a one sigma increase in uncertainty leads to a 1.4% contraction in credit available to the private sector from its mean.[28] Given that the average ratio of private credit to GDP in our sample is around 70%, the expected change in the size of private credit can be calculated to be in the order of 1% of GDP, which is substantial. Significant reductions in availability of credit will push the economy into a recession, as businesses and consumers would not be able to raise funds to invest or spend when funds are needed the most. In return, banks will suffer as weaker or less efficient borrowers will fail to pay their earlier debts due to the recession. As a consequence, bank profitability from traditional activities will decline, forcing managers to seek higher returns elsewhere. To that end, we find that a one sigma increase in uncertainty from its mean would lead to almost a 2% contraction of banks' return on equity. Examining the changes in non-interest income of banks in response to a similar change in uncertainty, we see that bank NII activities would increase by 1.38% to a similar size increase in uncertainty. When we turn to the effect of uncertainty on the stability of the financial sector, we find that banks will increase their liquid assets by 3.83% in response to a one sigma increase in uncertainty to weather the difficult times. The largest impact is observed for non-performing loans, which increase by almost 10%. In that sense, we see that the adverse effects of an increase in uncertainty will be observed in all financial sectors.

Given these results, it is clear that an increase in uncertainty significantly undermines

[27]The elasticity is computed at the mean value of the financial indicator and the uncertainty measure using $\partial Index/\partial h \times \bar{h}/\overline{Index}$, where $\bar{h}$ and $\overline{Index}$ denotes the average values of inflation uncertainty and the variable corresponding financial indicators, respectively.

[28]Note that here we report the implied percentage change at the mean value of each financial indicator in response to a one standard deviation shock in uncertainty, i.e. $Elasticity \times h_{sigma}/\bar{h} = \Delta(Index)/\overline{Index}$. To compute the percentage point changes in an indicator, one should calculate the product of the value given under Impact and the mean of the indicator.

the health of the financial system. Although the responses of some variables may appear to be small, it is useful to recall that seemingly small shocks can lead to large fluctuations in aggregate economic activity (see Bernanke, 1983 and Bernanke and Gertler, 1989). For instance, the calculated change in financial depth, although small, may be sufficiently large enough to push the economy into a recessionary phase. Furthermore, the fact that we observe the highest response to a one sigma change in uncertainty on variables which we use to measure stability of the system (bank liquidity and non-performing loans) is worrisome as this confirms the findings of Bloom (2009), who argues that sharp drops in economic activity happen in response to shocks to volatility.

At this point, one can also consider the extent to which uncertainty would affect the financial system of a specific country of interest. Although within the context of our analysis it is not possible to provide an exact answer, we can make an educated guess using the parameter estimates estimated for high and low-income countries. Therefore, for each variable, we compute separate elasticities for high and low-income countries and then examine the maximum uncertainty effect for a number of countries.[29]

Consider two low-income countries such as the Philippines and Pakistan. Using the point estimates that relate to low-income countries, we compute that financial depth ($FD1$) in these countries would decline approximately by 17% and 35% as uncertainty reaches its maximum observed level. These are substantial changes. In the case of high-income countries we take Spain and the USA as an example. For Spain, we compute that financial depth would decline by 3.1% and in the USA by 2%. When we compute expected changes in bank returns, we find that bank returns would decline by 5% in Spain and 3.4% in the USA. To ascertain these estimates it would be useful to carry out country-specific analyses as our predictions are based on elasticities obtained for a large cross-country panel dataset. Yet what we present here shows that sudden bursts in uncertainty may have substantial adverse

[29]Rather than examining the effect of a one standard deviation change in uncertainty, we calculate maximum effects. We follow this approach because uncertainty happens in bursts, for short periods of time, affecting the whole of the economy as discussed in Bloom (2009).

effects on the financial system.

6 Conclusion

There is an ongoing debate as to whether monetary policy authorities should strive to identify and remove balance sheet impairments which can easily block the flow of funds that productive sectors of the economy seek while promoting the proper functioning of the financial sector. To that end, several studies have examined bank behavior over the business cycle or during periods of banking crises, while several others have looked at the efficient allocation of bank loans during periods of instability. Our study complements this line of literature, as we examine the extent to which uncertainty affects the functioning and soundness of financial intermediaries. In contrast to the literature, we do so by presenting evidence from three aspects of financial intermediation: availability of credit in an economy, profitability and bank liquidity. To carry out our analysis, we use a comprehensive panel dataset comprised of 89 countries over 20 years.

Our investigation provides evidence that an increase in uncertainty would reduce the availability of credit from financial institutions, lower bank returns and increase liquidity. Significant changes in these aspects potentially imply that the health of the financial system is at risk. Under uncertainty, banks' non-performing loans increase significantly. These findings are robust to a battery of sensitivity checks. We also show that our findings are economically meaningful. For instance, we compute that financial depth would decline in the order of 1.4% for a one sigma increase in uncertainty. Similarly, we compute that banks' return on assets would decline at around 2% and non-interest income will increase in the order of 1.4%, suggesting a deterioration in financial sector efficiency. Our empirical analysis also predicts a 10% increase in non-performing loans of banks and a 4% increase in bank liquid assets if uncertainty were to increase by one standard deviation. These figures suggest that uncertainty threatens the health of the financial sector.

Given that small changes in the availability of credit can induce large fluctuations in an

economy, as Bernanke (1983) and Bernanke and Gertler (1989) discuss, attention should be paid to the overall health of the financial system rather just one aspect when examining factors that affect the financial markets. Further research would be desirable to understand uncertainty effects on the health of the financial sector at the country level. Such an investigation should consider the differences that may emerge due to bank ownership because bank managers may react differently to uncertainty as public *versus* private bank mandates are expected to differ.[30]

[30]We thank the referee for pointing out this important issue.

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Table 1: Variable Definitions

Variable	Definition	Source
A. Dependent variables		
1). Financial Depth		
Domestic credit to private sector (% of GDP) ($FD1$)	The ratio of domestic financial resources by financial intermediaries to the private sector with respect to GDP ($GFDD.DI.14$).	GFDD
Private sector credit to GDP ($FD2$)	Deposit money bank credit to the private sector as a percentage of GDP ($GFDD.DI.12$).	GFDD
2). Bank Efficiency		
Bank Return on Equity (ROE)	Commercial banks' pre-tax income to yearly averaged equity ($GFDD.EI.10$)	GFDD
Non-interest income to total income (NII)	Bank income that has been generated by non-interest related activities as a percentage of total income ($GFDD.EI.03$).	GFDD
3). Bank Stability		
Liquidity	The ratio of the value of liquid assets to short-term funding plus total deposits ($GFDD.SI.06$).	GFDD
Non-performing loans $NPLs$	Ratio of defaulting loans to total gross loans ($GFDD.SI.02$) .	GFD
B. Uncertainty proxies		
Unexpected Inflation Volatility ($\hat{h}$)	Constructed based on i) dynamic recursive forecasting ($unexpD$) or ii) static forecasting ($unexpS$) methods or iii) by the within year standard deviation of inflation.	Datastream
C: Control Variables		
Real GDP Growth (ΔGDP)	First difference of real gross domestic production at purchaser's prices ($NY.GDP.MKTP.CD$).	GFDD
Openness	The ratio of a country's exports of goods and services to country's GDP ($NE.EXP.GNFS.ZS$).	WDI
oBC	Dummy variable that captures an ongoing banking crisis in the banking system ($GFDD.OI.19$).	GFDD
Bank_Concentration (%)	Assets of three largest commercial banks as a share of total commercial banking assets ($GFDD.OI.01$).	GFDD
Debt/GDP (%)	The amount of international debt securities as a percentage of GDP. ($GFDD.OI.15$).	GFDD
Foreign_Banks (%)	The percentage of the number of foreign owned banks to the number of the total banks in an Economy. A bank is defined as foreign if 50 percent or more of the bank's shares are owned by foreigners ($GFDD.OI.15$).	GFDD
WUI	World uncertainly index covers 143 countries since 1996, based on the frequency counts of "uncertainty" (and its variants) in the quarterly Economist Intelligence Unit (EIU) country reports.	
Vol_Oil	Oil price volatility.	

Notes: GFDD: Global Financial Development Database; WDI: World Development Indicator.

Table 2: Pairwise Correlations

	$FD1$	$FD2$	ROE	NII	Liq	$NPLs$	$\hat{h}$	$Inflation$	ΔGDP	$Openness$	$Bank\_Con$	$Debt/GDP$	$Foreign$
$FD1$	1												
$FD2$	0.990***	1											
ROE	-0.142***	-0.170***	1										
NII	0.0227	0.0327	-0.0238	1									
Liq	-0.0754**	-0.0683*	0.0588*	0.391***	1								
$NPLs$	-0.206***	-0.182***	-0.264***	0.0446	-0.0467	1							
$\hat{h}$	-0.168***	-0.165***	-0.0525	0.146***	0.0990***	0.182***	1						
$Inflation$	-0.331***	-0.334***	0.0473	0.163***	0.0286	0.208***	0.502***	1					
ΔGDP	0.152***	0.143***	0.0598*	-0.0585*	-0.0804**	-0.138***	-0.385***	-0.361***	1				
$Openness$	0.203***	0.212***	-0.0172	0.0297	0.0803**	-0.0901**	-0.0231	-0.118***	-0.0277	1			
$Bank\_Con$	0.121***	0.133***	0.0232	0.00629	0.0933**	-0.0968***	-0.0222	-0.115***	-0.0736*	0.174***	1		
$Debt/GDP$	0.426***	0.436***	-0.121***	0.186***	0.225***	-0.116***	-0.0719*	-0.169***	-0.0249	0.271***	0.197***	1	
$Foreign$	-0.187***	-0.178***	-0.0144	-0.0385	0.0000655	0.0372	-0.0269	-0.0312	-0.0294	0.342***	-0.148***	-0.00101	1

Notes: $FD1$ is the ratio of domestic credit to private sector relative to GDP. $FD2$ is the ratio of private credit to the real sector by deposit money banks and other financial institutions to GDP. ROE is commercial banks' pre-tax income to yearly averaged equity. NII is the bank income that has been generated by non-interest related activities as a percentage of total income. Liq is the ratio of the value of liquid assets to short-term funding plus total deposits. $NPLs$ is the ratio of defaulting loans to total gross loans. $\hat{h}$ is the uncertainty based on dynamic recursive forecasting model. $Inflation$ is calculated as first logarithmic difference of prices. ΔGDP is calculated as the change in gross domestic product. $Openness$ refers to the ratio of a country's exports of goods and services to country's GDP. $Bank\_Con$ measures the assets of three largest commercial banks as a share of total commercial banking assets. $Debt/GDP$ is the ratio of the amount of international debt securities as a percentage of GDP. $Foreign$ is the percentage of the number of foreign owned banks to the number of the total banks in an Economy. *, ** and *** denote $p < 0.05$, $p < 0.01$ and $p < 0.001$, respectively.

Table 3: Inflation Uncertainty Effects on Financial Depth

	$FD1$			$FD2$		
	unexpD	*unexpS*	*volCPI*	*unexpD*	*unexpS*	*volCPI*
$\hat{h}$	-0.00117***	-0.00189***	-0.0199***	-0.00117***	-0.00188***	-0.0198***
	(0.000242)	(0.000395)	(0.00451)	(0.000235)	(0.000381)	(0.00437)
Inflation	0.262	0.209	0.200	-0.230	-0.283	-0.292
	(0.795)	(0.813)	(0.811)	(0.700)	(0.716)	(0.715)
ΔGDP	-0.211	-0.217	-0.220	-0.162	-0.167	-0.170
	(0.145)	(0.145)	(0.148)	(0.128)	(0.128)	(0.131)
Openness	-0.183	-0.183	-0.183	-0.168	-0.167	-0.167
	(0.164)	(0.164)	(0.164)	(0.139)	(0.139)	(0.139)
oBC	10.73***	10.72***	10.77***	12.64***	12.63***	12.68***
	(3.980)	(3.980)	(3.977)	(3.720)	(3.720)	(3.716)
Bank_Con	-0.116	-0.116	-0.119	-0.0781	-0.0778	-0.0808
	(0.0953)	(0.0954)	(0.0953)	(0.0922)	(0.0922)	(0.0923)
Debt/GDP	0.275**	0.276**	0.274**	0.288**	0.289**	0.287**
	(0.122)	(0.122)	(0.122)	(0.114)	(0.114)	(0.114)
Foreign_Banks	0.0920	0.0922	0.0946	0.0948	0.0950	0.0973
	(0.136)	(0.136)	(0.136)	(0.127)	(0.127)	(0.127)
i.year	YES	YES	YES	YES	YES	YES
Country	YES	YES	YES	YES	YES	YES
Cons	59.59***	59.57***	59.66***	55.77***	55.75***	55.85***
	(7.993)	(7.991)	(7.995)	(7.653)	(7.652)	(7.649)
N	1504	1504	1504	1496	1496	1496
R^2	0.371	0.371	0.370	0.424	0.424	0.423

Notes: The table presents estimates of model 3 for three uncertainty proxies where $FD1$ and $FD2$ are the two financial depth measures used as dependent variables. *unexpD* is inflation uncertainty obtained from the dynamic model. *unexpS* is inflation uncertainty obtained from static model. *volCPI* is inflation uncertainty obtained from the intra-year standard deviation of inflation. See Table 2 for variable definitions. In all models, country, year fixed effects are included. N denotes for number of observations. R^2 denotes goodness of fit. Robust standard errors, clustered by country are in parentheses. *, ** and *** denote $p < 0.05$, $p < 0.01$ and $p < 0.001$, respectively.

Table 4: Inflation Uncertainty Effects on Efficiency

	ROE			*NII*		
	unexpD	*unexpS*	*volCPI*	*unexpD*	*unexpS*	*volCPI*
$\hat{h}$	-0.000348***	-0.000454**	-0.0153***	0.000585***	0.000973***	0.00828***
	(0.000128)	(0.000222)	(0.00312)	(0.0000932)	(0.000154)	(0.00197)
Inflation	1.623	1.609	1.580	2.902***	2.929***	2.929***
	(1.272)	(1.265)	(1.250)	(0.580)	(0.592)	(0.589)
ΔGDP	0.0798	0.0782	0.0760	0.190**	0.192**	0.194**
	(0.141)	(0.140)	(0.141)	(0.0810)	(0.0813)	(0.0821)
Openness	-0.0372	-0.0371	-0.0369	0.0514	0.0512	0.0511
	(0.0637)	(0.0637)	(0.0637)	(0.0644)	(0.0643)	(0.0645)
oBC	-15.25***	-15.25***	-15.27***	3.440**	3.443**	3.412**
	(2.448)	(2.446)	(2.450)	(1.333)	(1.334)	(1.333)
Bank_Con	-0.00309	-0.00332	-0.00282	0.0434	0.0432	0.0449
	(0.0605)	(0.0606)	(0.0604)	(0.0389)	(0.0389)	(0.0389)
Debt/GDP	0.00152	0.00138	0.00185	0.0187	0.0185	0.0196
	(0.0235)	(0.0236)	(0.0235)	(0.0250)	(0.0250)	(0.0252)
Foreign_Banks	-0.130**	-0.129**	-0.131**	-0.0749	-0.0749	-0.0765
	(0.0555)	(0.0556)	(0.0554)	(0.0650)	(0.0650)	(0.0651)
i.year	YES	YES	YES	YES	YES	YES
Country	YES	YES	YES	YES	YES	YES
Cons	22.28***	22.28***	22.30***	30.61***	30.62***	30.57***
	(5.438)	(5.439)	(5.432)	(3.643)	(3.643)	(3.643)
N	1521	1521	1521	1522	1522	1522
R^2	0.186	0.186	0.187	0.383	0.383	0.382

Notes: The table presents estimates of model 3 for three uncertainty proxies where *ROE* and *NII* are the two efficiency measures used as dependent variables. See Table 3 for variable definitions. In all models, country, year fixed effects are included. N denotes for number of observations. R^2 denotes goodness of fit. Robust standard errors, clustered by country are in parentheses. *, ** and *** denote $p < 0.05$, $p < 0.01$ and $p < 0.001$, respectively.

Table 5: Inflation Uncertainty Effects on Stability

	Liquidity			*NPLs*		
	unexpD	*unexpS*	*volCPI*	*unexpD*	*unexpS*	*volCPI*
$\hat{h}$	0.00150***	0.00250***	0.0278***	0.000782***	0.000920***	0.0302
	(0.000124)	(0.000210)	(0.00275)	(0.0000862)	(0.000101)	(0.0376)
Inflation	0.215	0.286	0.301	0.365	0.363	0.367
	(0.511)	(0.502)	(0.506)	(0.742)	(0.741)	(0.734)
ΔGDP	0.0452	0.0522	0.0564	-0.116	-0.116	-0.102
	(0.0901)	(0.0907)	(0.0900)	(0.193)	(0.193)	(0.197)
Openness	-0.115	-0.116	-0.116	0.113**	0.113**	0.113**
	(0.0826)	(0.0826)	(0.0827)	(0.0482)	(0.0481)	(0.0481)
oBC	-0.507	-0.499	-0.559	6.480***	6.480***	6.452***
	(2.200)	(2.200)	(2.198)	(1.041)	(1.041)	(1.040)
Bank_Con	0.0838	0.0833	0.0870	0.0317	0.0317	0.0336
	(0.0577)	(0.0576)	(0.0577)	(0.0214)	(0.0214)	(0.0216)
Debt/GDP	0.0487	0.0483	0.0505	0.0286**	0.0286**	0.0298**
	(0.0485)	(0.0484)	(0.0487)	(0.0125)	(0.0125)	(0.0122)
Foreign_Banks	-0.280***	-0.280***	-0.283***	-0.0990**	-0.0991**	-0.100**
	(0.0780)	(0.0779)	(0.0783)	(0.0453)	(0.0453)	(0.0453)
i.year	YES	YES	YES	YES	YES	YES
Country	YES	YES	YES	YES	YES	YES
Cons	37.49***	37.52***	37.40***	4.282	4.291	4.221
	(4.875)	(4.871)	(4.885)	(2.906)	(2.905)	(2.924)
N	1528	1528	1528	1234	1234	1234
R^2	0.149	0.150	0.144	0.411	0.411	0.408

Notes: The table presents estimates of model 3 for three uncertainty proxies where *Liquidity* and $NPLs$ are the two stability measures used as dependent variables. See Table 3 for variable definitions. In all models, country, year fixed effects are included. N denotes for number of observations. R^2 denotes goodness of fit. Robust standard errors, clustered by country are in parentheses. *, ** and *** denote $p < 0.05$, $p < 0.01$ and $p < 0.001$, respectively.

Table 6: Results for Income Groups

	$FD1$	$FD2$	ROE	NII	$Liquidity$	$NPLs$
$L\_inc * \hat{h}$	-0.0563***	-0.0432***	-0.120	0.00398	0.0352	0.0386***
	(0.0158)	(0.0131)	(0.150)	(0.0117)	(0.0270)	(0.00847)
$H\_inc * \hat{h}$	-0.000980***	-0.000980***	-0.000301*	0.000566***	0.00141***	0.000791***
	(0.000230)	(0.000223)	(0.000161)	(0.000101)	(0.000143)	(0.000106)
$L\_inc * Inflation$	-0.986	-0.900	2.164	-1.602	-0.105	0.140
	(1.672)	(1.554)	(4.529)	(2.068)	(2.231)	(1.152)
$H\_inc * Inflation$	0.725	0.226	1.363	2.953***	-0.181	-0.114
	(0.774)	(0.639)	(1.316)	(0.549)	(0.556)	(0.912)
$L\_inc * \Delta GDP$	-2.933**	-2.262*	-3.654	-2.951***	-0.327	-2.267***
	(1.331)	(1.295)	(2.512)	(0.956)	(1.279)	(0.738)
$H\_inc * \Delta GDP$	-0.192	-0.147	0.111	0.217**	0.0442	-0.109
	(0.126)	(0.111)	(0.140)	(0.0828)	(0.0867)	(0.202)
$L\_inc * Openness$	0.432	0.442	-0.0378	0.363***	0.304	0.249***
	(0.348)	(0.325)	(0.190)	(0.119)	(0.323)	(0.0842)
$H\_inc * Openness$	-0.322	-0.310*	-0.0189	0.0207	-0.155*	0.0778*
	(0.197)	(0.164)	(0.0607)	(0.0759)	(0.0846)	(0.0426)
$L\_inc * oBC$	13.88**	15.95***	-29.44***	-0.744	-4.574	7.896***
	(5.328)	(5.487)	(10.93)	(2.859)	(5.296)	(2.586)
$H\_inc * oBC$	9.763**	11.71***	-13.78***	3.830***	-0.0659	6.167***
	(4.407)	(4.075)	(1.977)	(1.369)	(2.342)	(1.081)
$L\_inc * Bank\_Con$	-0.0972	-0.0789	0.126	0.0250	0.0429	-0.0202
	(0.155)	(0.148)	(0.132)	(0.0458)	(0.0703)	(0.0319)
$H\_inc * Bank\_Con$	-0.130	-0.0865	-0.00801	0.0653	0.113	0.0489*
	(0.104)	(0.101)	(0.0522)	(0.0522)	(0.0812)	(0.0281)
$L\_inc * Debt/GDP$	0.294	0.460	-0.771	0.339	-0.203	0.328**
	(0.412)	(0.457)	(0.717)	(0.274)	(0.442)	(0.138)
$H\_inc * Debt/GDP$	0.281**	0.293**	-0.000659	0.0169	0.0529	0.0283**
	(0.122)	(0.114)	(0.0242)	(0.0250)	(0.0494)	(0.0125)
$L\_inc * Foreign\_Banks$	-0.347*	-0.375**	-0.0577	-0.0690	-0.126	-0.177***
	(0.192)	(0.184)	(0.141)	(0.133)	(0.156)	(0.0478)
$H\_inc * Foreign\_Banks$	0.246**	0.257**	-0.135***	-0.0764	-0.319***	-0.0657
	(0.118)	(0.103)	(0.0491)	(0.0591)	(0.0857)	(0.0599)
$i.year$	YES	YES	YES	YES	YES	YES
$Country$	YES	YES	YES	YES	YES	YES
$Cons$	59.36***	55.34***	21.61***	28.73***	35.37***	3.286
	(7.424)	(6.908)	(4.874)	(3.895)	(5.481)	(2.828)
N	1504	1496	1521	1522	1528	1234
R^2	0.397	0.453	0.227	0.394	0.169	0.453

Notes: The table presents estimates for high and low income countries using dynamic uncertainty measure. The high-income (low-income) countries are high and upper-middle (lower-middle and low group). The model is estimated for financial depth, stability and efficiency measures. See Table 3 for definitions.

Table 7: Inflation Uncertainty Effects on Banks: IV-GMM Results

	$FD1$	$FD2$	ROE	NII	Liq	$NPLs$
$\hat{h}$	-0.00175***	-0.00198***	-0.000199	0.000863**	0.00223***	0.000891***
	(0.000575)	(0.000569)	(0.000668)	(0.000354)	(0.000557)	(0.000231)
$Inflation$	-0.187	0.517	4.873*	-0.214	0.934	-1.734
	(1.508)	(1.463)	(2.489)	(1.547)	(1.193)	(1.411)
$realGDP\_growth$	-0.0981	0.0485	0.673**	-0.0412	0.154	-0.437
	(0.155)	(0.155)	(0.313)	(0.139)	(0.119)	(0.315)
$Openness$	-0.236***	-0.220***	0.0114	0.0417	-0.0968***	0.0939***
	(0.0885)	(0.0794)	(0.0395)	(0.0436)	(0.0372)	(0.0192)
oBC	10.16***	11.89***	-14.82***	3.918***	-0.0776	6.756***
	(2.216)	(1.942)	(2.429)	(1.037)	(1.216)	(0.682)
$Bank\_Con$	-0.0981**	-0.0659	-0.0265	0.0660**	0.0716**	0.0369**
	(0.0442)	(0.0404)	(0.0493)	(0.0284)	(0.0360)	(0.0150)
$Debt\_GDP$	0.290***	0.306***	-0.00238	0.0248	0.0398	0.0305***
	(0.0608)	(0.0529)	(0.0151)	(0.0237)	(0.0262)	(0.00819)
$Foreign\_Banks$	0.0745	0.0652	-0.0904*	-0.0610	-0.266***	-0.0902***
	(0.0560)	(0.0514)	(0.0533)	(0.0429)	(0.0420)	(0.0239)
$i.year$	YES	YES	YES	YES	YES	YES
$Country$	YES	YES	YES	YES	YES	YES
N	1474	1466	1487	1487	1493	1231
Hansen J test (p_value)	0.454	0.243	0.132	0.219	0.426	0.432
C test (p_value)	0.369	0.139	0.624	0.467	0.266	0.0873

Notes: The table presents the IV-GMM estimates of model 3 using the dynamic uncertainty measure for financial depth, efficiency and stability measures. See Table 2 for variable definitions. In all models, country, year fixed effects are included. N denotes for number of observations. *Hansen J test* is test of overidentifying restrictions. *C test* denotes Hayashi C statistic for exogeneity. Robust standard errors, clustered by country are in parentheses. *, ** and *** denote $p < 0.05$, $p < 0.01$ and $p < 0.001$, respectively.

Table 8: Country-level World Uncertainty Index (WUI) and Oil Uncertainty Augmented Model

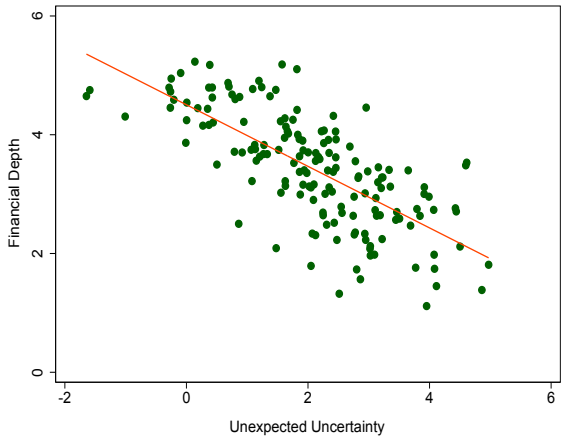
	$FD1$	$FD2$	ROE	NII	Liq	$NPLs$
$\hat{h}$	-0.000967***	-0.00105***	-0.000287**	0.000544***	0.00148***	0.000735***
	(0.000207)	(0.000212)	(0.000129)	(0.000104)	(0.000155)	(0.0000961)
$Inflation$	-0.504	-0.544	1.708	2.339***	0.839	0.440
	(1.002)	(0.763)	(1.571)	(0.577)	(0.611)	(0.734)
ΔGDP	-0.260	-0.196	0.116	0.177	0.0141	-0.105
	(0.235)	(0.211)	(0.250)	(0.180)	(0.163)	(0.195)
$Openness$	0.0283	0.0255	-0.0474	0.0685	-0.107	0.117**
	(0.137)	(0.113)	(0.0826)	(0.0728)	(0.102)	(0.0549)
oBC	12.29***	13.39***	-15.97***	3.405**	0.711	5.860***
	(3.478)	(3.298)	(2.727)	(1.440)	(2.382)	(0.932)
$Bank\_Con$	-0.152	-0.109	-0.00495	0.0487	0.107*	0.0310
	(0.0930)	(0.0921)	(0.0674)	(0.0359)	(0.0635)	(0.0225)
$Debt/GDP$	0.132*	0.188**	-0.0229	0.0350	0.0265	0.0434**
	(0.0720)	(0.0801)	(0.0248)	(0.0462)	(0.0599)	(0.0197)
$Foreign\_Banks$	0.0553	0.0512	-0.122	-0.0757	-0.327***	-0.121***
	(0.147)	(0.137)	(0.0761)	(0.0802)	(0.0938)	(0.0443)
Vol_Oil	-7.901***	-7.940***	-0.412	8.700***	0.0895	0.372**
	(2.242)	(2.156)	(0.846)	(0.984)	(1.445)	(0.164)
$WUI\_Country$	5.879	7.111	1.992	-0.939	-2.448	2.036
	(14.47)	(12.41)	(10.51)	(9.923)	(11.56)	(5.550)
$i.year$	YES	YES	YES	YES	YES	YES
$Country$	YES	YES	YES	YES	YES	YES
$Cons$	437.8***	434.7***	39.56	-384.3***	34.99	-14.85
	(106.0)	(102.1)	(40.75)	(48.37)	(70.12)	(9.029)
N	1315	1307	1325	1328	1331	1147
R^2	0.341	0.389	0.195	0.440	0.165	0.425

Notes: The table presents estimates of model 3 using inflation uncertainty from the dynamic model for financial depth, stability and efficiency measures. The model is augmented by country-level world uncertainly index $WUI_$Country and oil price volatility Vol_Oil. See Table 2 for variable definitions. In all estimations, country, year fixed effects are included. N denotes for number of observations. R^2 denotes goodness of fit. Robust standard errors, clustered by country are in parentheses. *, ** and *** denote $p < 0.05$, $p < 0.01$ and $p < 0.001$, respectively.

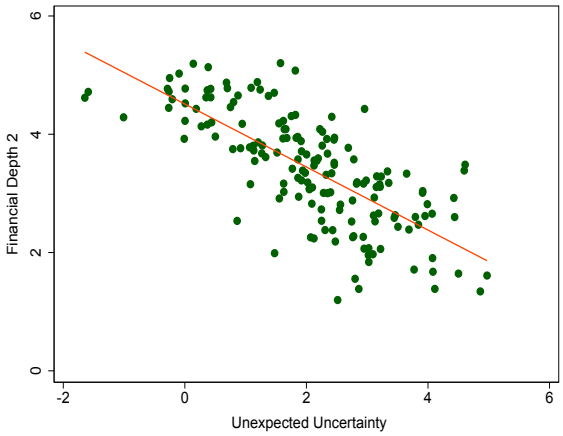
Table 9: Economic Impact

A	$\hat{\beta}_h$	Elasticity	Impact	**B**	$\hat{\beta}_h$	Elasticity	Impact
$FD1$	-0.117	-0.076	1.392	$FD2$	-0.117	-0.078	-1.425
ROE	0.035	0.107	-1.963	NII	0.059	0.076	1.389
$Liquidity$	0.150	0.209	3.828	$NPLs$	0.078	0.545	9.983

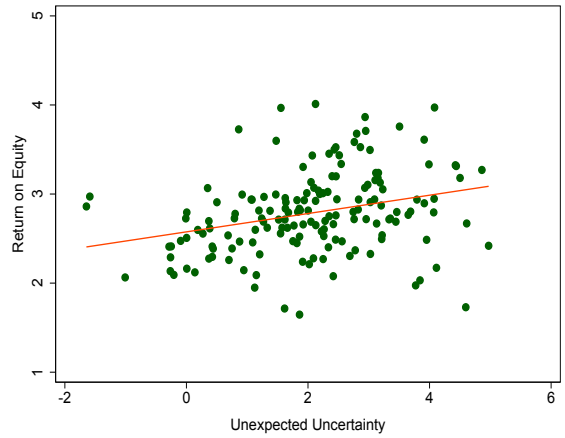
Notes: β_h is the uncertainty impact coefficient from models (column 1) in Tables 3-6 and has been multiplied by 100; $Impact$ is the implied percentage change in $Index$ (%) in response to a one standard deviation increase in uncertainty.



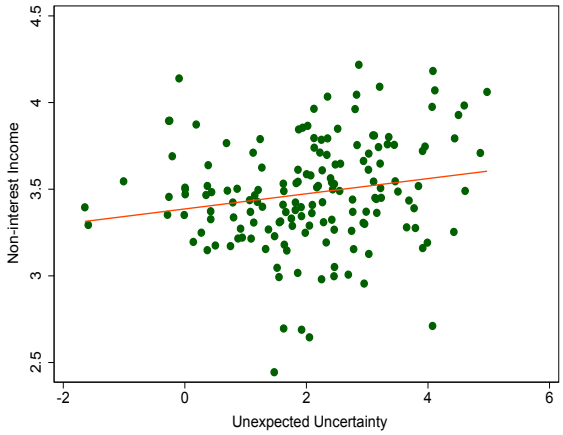
(a) Financial Depth *vs* Uncertainty



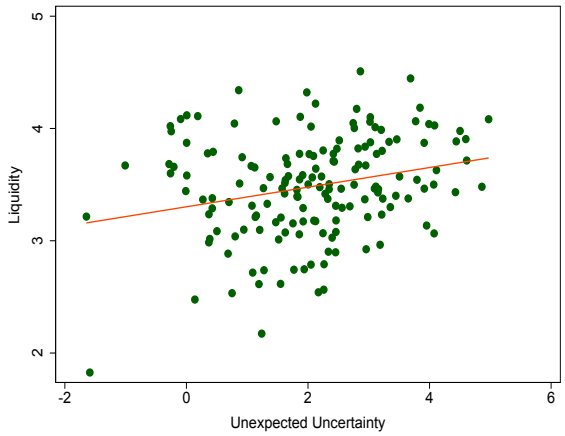
(b) Financial Depth 2 *vs* Uncertainty



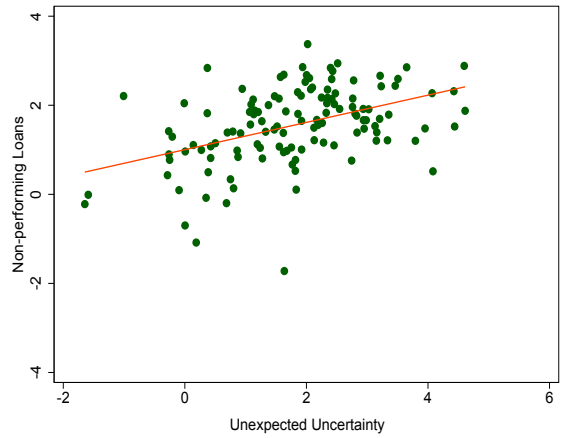
(c) Banks' profitability *vs* Uncertainty



(d) Banks' Non-Interest income to total income *vs* Uncertainty



(e) Banks' Liquidity *vs* Uncertainty



(f) Banks' Non-performing loans *vs* Uncertainty

Figure 1: Cross-country Dynamic Inflation Uncertainty Effects on Financial Sector