Does a Low Interest Rate Environment Affect Risk Taking in Austria?

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It has recently been argued that a prolonged period of low interest rates under benign economic conditions tends to produce excessive risk taking in financial markets. The mechanism by which monetary policy affects investors' risk positions has been called the "risk-taking channel" of monetary policy. We discuss this channel and compare it with the more traditional broad credit channel. Furthermore, we provide new evidence on the existence of this channel, using Austrian firm and bank data taken from the OeNB's credit register. In particular, we show that the expected default rates within Austrian banks' business-loan portfolios increased during the period of low refinancing rates from 2003 to 2005. This result is new and important in at least two respects: first, we construct a measure of Austrian banks' portfolio risk on the basis of a matched lender and borrower dataset. Second, we specifically identify the effect of a monetary policy regime which is characterized by interest rates that are held at a low level for too long, as opposed to the more traditional effect of monetary policy "shocks," usually identified through quarter-on-quarter changes in short-term interest rates.

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It has been argued in the recent past that the prolonged period of low interest rates under benign financial and economic conditions from 2003 to 2005 might have produced a sense of overconfidence in financial markets. This overconfidence resulted in higher asset prices and lower volatilities, which boosted collateral values. These then affected risk perceptions and risk attitudes, which increased the supply of credit. Thus, some market observers claim that this period was characterized by a higher risk tolerance of, and "excessive" lending by banks. The concerns about this tendency, however, are related not only to the increased quantity of lending, but more importantly, to the potential deterioration of its quality in terms of riskiness. The channel through which lower interest rates trigger a higher credit supply, together with a deterioration of the amount of risk within portfolios, has recently been labeled the "risk-taking channel" of monetary policy.[2]

This new channel started drawing attention only after its potential repercussions had already materialized. It has been argued that ignoring this channel may have contributed significantly to the buildup of financial imbalances that culminated in the crisis. This implies that monetary policy potentially added to the buildup of financial imbalances via its influence on asset prices, on the volatility in financial markets and, in general, on the perception of risk. The corollary of this hypothesis is that, as long as monetary policy does not actively "lean against the wind," it contributes to the buildup of financial imbalances on account of its interplay with the framework of financial regulations and the pricing of risk in the markets.

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[2] *See Borio and Zhu (2008), who were the first to use the term, although Rajan (2006) had already drawn attention to the mechanism.*

One goal of this study is to discuss potential mechanisms behind the risk-taking channel. In particular, we try to carefully highlight how it differs from the more traditional broad credit channel, since both are affected by changes in risk and market participants' risk perceptions, albeit in different ways.[3]

Thereafter, we discuss the existing empirical literature on the aforementioned mechanisms and present new empirical evidence on the existence of such a monetary transmission channel. In particular, we address the very specific hypothesis that a prolonged period of low interest rates induces banks to take riskier bets. We employ a unique matched borrower-lender dataset drawn from the OeNB's credit register in order to show that calculated expected default rates within Austrian banks' business-loan portfolios increased significantly during the period of low refinancing rates from 2003 to 2005 (by some 9 basis points from 0.53% to 0.62%). In our empirical analysis, we first take a look at the effect that low interest rates over a period of two years have on the economy, rather than at the effects of quarter-on-quarter changes in refinancing rates. Second, we measure the risk carried within the loan portfolio of the lenders, as opposed to a measure of the risk attached to individual borrowers, by using a unique dataset of matched lenders and borrowers. In doing so, we believe to be able to better capture the risk position taken by the lender as reflected in the dataset. Third, we identify a causal relationship between the level of interest rates and our measure of risk by exploiting a natural experiment.

1 The Risk-Taking Channel in the Monetary Transmission Mechanism and Its Implications

1.1 The Risk-Taking Channel: What It Is, What It Is Not

The risk-taking channel refers to the reinforcement of (an expansionary) monetary policy on account of a change in banks' attitude toward, or appetite for risk. If this channel is at work, not only will more firms or projects become creditworthy, because of lower interest rates, but banks will also relax their lending standards or increase their risk appetite and "allow" more risk in their portfolios. The risk-taking channel goes beyond the change in the net worth of both lenders and borrowers due to a change in the interest rate. A "procyclical" change in net worth, which operates through changes in collateral values and risk premiums, has been referred to as the broad credit channel (balance sheet and bank lending channel), the precise implications of which differ significantly from those implied by the risk-taking channel.

For a better insight into the risk-taking channel, it is necessary to understand what we mean by risk taking. Within this context, risk taking refers to the amount of uncertainty a lender is willing to hold in his/her portfolio. For a bank, it refers, among others, to the division between risky and risk-free assets in its portfolio, i.e. its balance sheet. This portfolio composition, however, cannot always be observed, so that some alternative measures have been used in the existing empirical literature to measure the degree of a bank's risk tolerance. Some of the measures that have been used are (1) the volatility of bank's profits,[4] (2) banks' own default

[3] *See, for instance, Bernanke and Blinder (1988) or Bernanke and Gertler (1995).*

[4] *De Nicolò et al. (2010).*

risk[5] or (3) the ratio of risk-weighted assets to total assets.[6] The second part of this study introduces the expected default rate within banks' loan portfolios as an alternative measure.

How much risk a given lender is willing to take at a given point in time depends on his/her own expectations about the future, his/her own risk perceptions, and his/her own risk attitude. Changes in the overall interest rate environment, which may result from monetary policy decisions, will affect expectations about the future, as well as risk perceptions in general, and this will affect the real economy not only through the expectations channel, but also through changes in the valuation of assets, which is an important element of the broad credit channel. Therefore, it is important to distinguish between changes in risk positions due to changes in risk perceptions and expectations and those induced by changes in risk attitudes or risk tolerance.[7]

Thus, if the riskiness of a borrower changes because expectations have changed or because the net worth of the collateral has changed, this would trigger the credit channel. Moreover, an increase in interest rates would raise the probability that a borrower will not pay back his/her loans, so that the lender will tend to decrease the supply of loans to this borrower. A decrease in interest rates, on the other hand, will improve risk perceptions, which will increase asset values and thus the collateral or net worth of the borrower. In this case, the rating of the firm or assets improves because more projects become viable at a lower interest rate, so that the new value of the firm or asset increases. When this occurs, the bank is willing to increase the supply of credit, without having changed its risk tolerance, and will potentially even have improved its risk position.

The risk-taking channel, on the other hand, goes beyond the effects of the interest rate on the riskiness of the borrower, and refers to the fact that the banks' incentive to bear risk related to the provision of loans is affected. In particular, it is assumed that the risk appetite of the bank increases. In other words, banks are willing, *ceteris paribus*, to accept more risk or to increase the supply of credit for the same level of risk.

1.2 What Triggers the Risk-Taking Channel?

In order to gain an insight into what triggers the risk-taking channel, it is important to understand the determinants of risk taking. On account of agency problems and informational frictions, risk taking depends on yield expectations, perceived risk and risk attitudes. There is ample evidence that shows that all three of these factors are subjective and heterogeneous across individuals. However, for a single bank, risk perceptions and expected returns will not be totally subjective, given the rating systems in place. Moreover, we believe that changes in risk perception, which alter the asset valuation and expected returns, will affect the broad credit channel, whereas – as mentioned earlier – the risk-taking channel also refers to a change in risk attitude or risk tolerance. The question is, therefore, what triggers a change in risk attitude, in particular for an institution

[5] *Altunbas et al. (2010).*

[6] *De Nicolò et al. (2010).*

[7] *Here, we distinguish between expectations and risk perceptions, in the sense that the bank may assess general developments in the future and its own situation differently.*

as opposed to an individual, and how can we capture this change.

Borio and Zhu (2008), who were the first to coin the term "risk-taking channel" explain that monetary policy and, in particular, an expansionary monetary policy affects risk taking through three factors: (1) the impact of interest rates on valuations, incomes and cash flows; (2) the search for yield by banks and in general by all financial agents that are faced with small profit margins in a low interest rate environment (search-for-yield effect); and, finally, (3) the effect of communication policies and the reaction function of the central bank. We think that the first factor, as explained above, is a crucial element of the broad credit channel, while the second and third factors are actually new, and are therefore at the heart of the risk-taking channel.

Indeed, the last two triggers mentioned by Borio and Zhu (2008) have not been taken into account in the transmission mechanism before, or at least not explicitly. Banks' search for yield seems to be an important motive behind the increase in excessive lending. If this incentive mechanism is at work, low interest rates make riskier assets more attractive, as banks (and financial institutions in general) are urged to improve their average return on equity. This has the effect that banks will, *ceteris paribus*, invest in riskier assets when interest rates are low, in order to boost their yields. Rajan (2006) argues that this effect is due to "the nature of pre-contracted liabilities" in the form of certain financial institutions promising a given return to both clients and owners. He also introduces the possibility that the way incentives for bank managers are designed influences risk taking.

The third element mentioned by Borio and Zhu (2008) is the credibility of the central bank. In particular, it is believed that there is a moral hazard effect when the reaction function of a central bank tends to be asymmetric with respect to losses, i.e. the central bank reacts more strongly to a fall in asset prices than to a rise (no "leaning against the wind"). Thus, "… encouraging risk-taking by more than equivalent increases would curtail it – an 'insurance effect.'"[8]

Other authors, such as Berger and Udell (2003), introduced the institutional memory hypothesis to explain the procyclicality of bank lending. According to the authors, there is ample evidence that banks take more risk during expansions. The reason for this behavior is "… a deterioration in the ability of a bank to recognize potential loan problems and an easing of credit standards over its own loan cycle".[9] What is interesting about this theory is that it "humanizes" aggregate risk taking in the banking sector and introduces elements of behavioral economics into risk-taking decisions of banks. Indeed, one can think of a series of elements that can trigger an increase in risk taking, such as moral hazard, habit formation,[10] bounded rationality, or just plain animal spirits.

1.3 What Are the Implications for Monetary Policy and Financial Stability?

From the point of view of monetary policy, if the risk-taking channel exists, it will potentially reinforce or amplify monetary policy decisions. Thus, an

[8] *Borio and Zhu (2008, p. 10).*
[9] *Berger and Udell (2003, p. 1).*
[10] *Altunbas et al. (2010).*

expansive monetary policy, for instance, will become even more expansive due to changes in the risk attitude of lenders. In fact, the risk-taking channel could translate into a softening of credit standards, which can lead to excessive lending. This was, in fact, observed at least in some countries during the years of a low interest rate environment that preceded the current crisis.

More important for monetary policy is understanding whether the risk-taking channel reinforces or weakens the other channels of the transmission mechanism. At first sight, it seems that the risk-taking channel reinforces the broad credit channel and, perhaps, the expectation channel, so that the effect of low interest rates on the real economy was underestimated. It remains to be seen whether a symmetric effect will be in place when interest rates are tightened.

The risk-taking channel has been labeled the missing link between monetary policy and financial stability by Borio and Zhu (2008). Indeed, to the extent that monetary policy influences asset prices and their volatilities, monetary policy has an effect on financial stability. Under the risk-taking channel, too successful a monetary policy may be detrimental for financial stability if it encourages excessive lending.

In particular, according to the theory put forward by Berger and Udell (2003), the risk-taking channel can be especially problematic because "banks take significantly more risks during the expansion, but these risks are revealed only later because it takes time for loan performance problems to appear".[11] Thus, the buildup of financial imbalances during the period of low interest rates might not be noticed. Should this lead to excessive lending, destabilizing effects on the economy may ensue, in particular if the behavior of banks turns out to be correlated.

The corollary of this is that risk might be crucial for the interplay between periods of low interest rates and financial stability. Changes in this overall assessment of risks may, *ceteris paribus*, induce a weakening or strengthening of all the transmission channels of monetary policy (interest rate channel, bank lending channel, balance sheet channel), but will be reinforced by, in particular, the risk-taking channel, so that the effects of an expansive monetary policy may be underestimated. At the same time, monetary policy might contribute to this risk through its influence on asset prices, on the volatility in financial markets and, in general, on the perception of risk. If monetary policy does not or cannot actively (and effectively) "lean against the wind," it could contribute passively to the buildup of financial imbalances.

2 Empirical Evidence for Other Countries

Given the novelty of the hypothesis of a risk-taking channel, empirical evidence on the importance of this channel is scarce. In particular, its existence is hard to prove because it is difficult to disentangle its effects from other transmission channels. Moreover, measuring risk is in itself nontrivial. In this section, we briefly review some of the strategies that other authors have used, and summarize their findings.

There are two broad types of studies: those using macro data that try to capture the link between monetary policy and risk, and those using micro data that look at bank behavior.

[11] *Berger and Udell (2003, p. 1).*

Among the macro studies, the analysis by Bekaert et al. (2010) is unique in that it provides the first direct evidence that investors' perceived risk aversion is systematically affected by monetary policy. Using a structural VAR, Bekaert et al. (2010) show that, for the period from January 1990 to July 2007, the expansionary U.S. monetary policy decreased risk aversion (measured using the VIX[12]) in the medium run, while uncertainty – as measured by stock market volatility – appeared to be unaffected by monetary policy. On the other hand, they conclude that periods of high uncertainty are followed by a loosening monetary policy stance.

On the other hand, Angeloni and Faia (2009) show, also using a structural VAR, that a decrease in monetary policy rates has a significant positive influence on bank "balance sheet risk" for about two years, both in the U.S.A. and the euro area.

The list of papers that use micro data to study bank behavior has been increasing rapidly in the recent past. These studies focus mainly on providing micro-level panel evidence for the effect of changes in policy rates on individual banks' lending behavior.

De Nicolò et al. (2010) attempt to find evidence of a negative relationship between monetary policy and risk taking through two different exercises. In the first, they find a negative correlation between the policy rate and two ex ante measures of bank risk, taken from the "Survey of Terms of Bank Lending," namely the average internal risk rating and the spread between loan rates and the effective federal funds rate. In a second exercise, they take data from the financial statements of banks and use the ratio of risk-weighted assets to total assets as a measure of risk.[13] After controlling for bank leverage, macroeconomic performance and expectations (of future economic activity), they find a strong negative relationship between the policy rate and the riskiness of the bank. One qualification is that this result does not hold true for banks with a low level of capitalization.

Delis and Kouretas (2010) come to exactly the opposite result. They analyze 3,628 banks in the euro area in the period from 2001 to 2008 and estimate risk equations after controlling for capital regulation and the supervisory environment. Their measure of risk is the ratio of risk assets[14] to total assets and the ratio of nonperforming loans to total loans. They also find a negative relationship between the interest rate and risk taking, which is robust to different interest rates, to different estimation methods and to the use of annual or quarterly data. They find, however, that risk taking is lower for highly capitalized banks.

Jiménez et al. (2008) analyze data on individual loans from the Spanish credit register from 1984 to 2006 and find, after controlling for banks' balance sheet characteristics, including bank leverage, that there is higher risk taking during periods following a monetary policy loosening. Their test shows that the probability of getting a loan, given that your credit history was bad or nonexistent, increases if policy interest rates were low in the quarter

[12] *The Chicago Board Options Exchange Volatility Index (VIX) is a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices.*

[13] *The higher the risk in the portfolio, the closer this number will be to one.*

[14] *Risk assets are defined as: all banks' assets except cash, government securities and balances due from other banks.*

prior to the loan initiation. They find, however, that the riskiness of banks' overall portfolio decreases with low rates. Thus, this effect would actually point to the credit channel and not to the risk-taking channel.

Altunbas et al. (2010) go a step further and use an extensive and unique database that matches balance sheet data at a quarterly frequency for listed banks in the European Union and the U.S.A. with an array of individual proxies of bank risk. They employ a regression approach very similar to that of Jiménez et al. (2008), but focus specifically on bank risk rather than on the default risk of individual borrowers. Controlling for a wide set of aggregate and bank-level characteristics, they find that low or "too low" (as measured by Taylor rule gaps) monetary policy rates lead to increased risk taking in banks' business lending. Their main measure for the "riskiness" of each bank is the expected default frequency (EDF). EDF is a forward-looking indicator of credit risk – based on the model developed by Merton (1974) to price corporate bond debt – and is provided by Moody's KMV.[15]

Maddaloni and Peydró (2010) highlight another interesting component of the micro foundations of the risk-taking channel. Using data from lending surveys in both the euro area and the U.S.A., they show that banks softened their "lending standards" significantly in response to lower policy interest rates during the period from 2003 to 2005. Although they show the effects of this policy and the subsequent crisis in different countries, they do not say anything about the riskiness of banks after they had relaxed their lending standards.

The only evidence outside the U.S.A. or Europe is provided by Ioannidou et al. (2009), who find similar results for Bolivian banks' lending behavior in response to U.S. federal funds rate changes. In particular, they cannot reject the hypothesis that the advancement of loans with a subprime credit rating or of loans to riskier borrowers with current or past nonperformance becomes more likely when the federal funds rate is low. A result unique to their study is that the loan spreads do not increase in line with the changes in the monthly probability of default – spreads may in fact decrease in this probability. Consequently, they conclude that banks do not seem to price the additional risk taken. This is an interesting finding since it contradicts the "search-for-yield" mechanism, which has been a popular explanation for the increase in risk taking in the U.S.A. over the last decade.

3 Empirical Evidence for Austria

In this section, we analyze only a particular aspect of the risk-taking channel as presented above, using a unique dataset that matches lenders and borrowers and that accounts for a major part of Austrian business lending.[16] Our data allow us to assess whether the period of historically low interest rates between June 6, 2003, and December 6, 2005, during which the ECB kept refinancing rates at an, for that time,

[15] *A well-known indicator of credit risk, Moody's EDF figures are used not only by banks, but also by central banks and regulators (e.g. ECB, 2010). Furthermore, this indicator proved to be a good predictor of default during the recent crisis (Munves et al., 2009).*

[16] *The corporate loans comprised in this dataset account for an average 43% of total Austrian business loans from 2000 to 2008. Over the same period, corporate lending accounted for an average 36% of Austrian banks' balance sheets.*

unprecedented low of 2% p.a.,[17] significantly affected the degree of risk within banks' business-loan portfolios.

Our exercise is most closely related to Altunbas et al. (2010) and De Nicolò et al. (2010), who estimate the effect of policy interest rates on banks' EDF and risk-weighted assets, respectively. While their measure of banks' risk position is closely related to the way we assess the riskiness of banks' business-loan portfolios, we focus on the effect of a particular monetary policy phase as opposed to quarter-on-quarter changes in interest rates. We believe that this is an important exercise since a central part of the hypothesis of Borio and Zhu (2008) of a risk-taking channel refers to periods in which policy interest rates are "too low for too long."

The remainder of this section is structured as follows: In section 3.1, we briefly describe our data sources, while section 3.2 illustrates our measure of banks' loan-portfolio risk and section 3.3 presents our empirical approach and results.

3.1 The Dataset

Our data on borrower information is drawn from annual balance sheet and income statements of Austrian firms, collected by the OeNB in the course of its refinancing activities. In addition to the balance sheet data, the OeNB collects monthly data on banks that extend loans of more than EUR 350,000 in its central credit register (GKE).[18] The individual data on both firms and banks are strictly confidential and available to us only in anonymized form. Furthermore, the data have to be aggregated for any publication in order to comply with data confidentiality legislation.

Using these two datasets, we are able to match the characteristics of each borrower to the loans and other forms of bank credit advanced by his/her lenders. Unfortunately, the OeNB's credit department does not record annual balance sheets and income statements for all of the firms whose financial obligations are in the GKE sample. This is due to the fact that GKE reports are mandated by law, while reporting the balance sheet and income statement is voluntary. Thus, our sample of firms is biased toward relatively large and sound businesses and, therefore, any result on risk taking found in this study should be interpreted as an estimate of a lower bound for the true amount of risk taking.

Apart from annual balance sheets and income statements, we also observe whether individual borrowers went bankrupt and, if so, on which date they filed for bankruptcy protection. Within our sample of about 8,000 Austrian firms that were operational in the period from 1994 to 2008, we observe a total of 533 bankruptcies, which we use as our proxy for the event of default. The low number of bankruptcies is not surprising, given that our matched borrower-lender sample consists of relatively large and sound businesses.

3.2 Measuring the Risk in Banks' Loan Portfolios

In order to understand the effects of a period of low interest rates on banks' risk-taking behavior, we construct a measure of each bank's risk position at

[17] *Compared to today's low level of interest rates, 2% does no longer seem to be "too low." However, given the fact that the output gap was much more positive then, while inflation was higher, the real interest rate of that period was comparatively lower than today's real interest rate.*

[18] *Details on the data collection criteria can be found in the official standards for reporting to the central credit register, which are publicly available at http://www.oenb.at/de/img/gke-richtlinie-20080729-e-1_tcm14-88442.pdf.*

any given point in time. Most previous studies employing matched borrower-lender data focus on the riskiness of individual loans or assets to construct empirical tests for the risk-taking channel. Thus, the evidence found in those studies reveals an increase in the amount of risk taken in newly extended individual loans due to relatively cheaper refinancing conditions. Such evidence alone, however, is not sufficient to conclude that banks were taking more risk overall. It might very well be that more risky newly extended loans are perfectly hedged by other assets on the lenders' books. Therefore, in close relation to Altunbas et al. (2010) and De Nicolò et al. (2010), we choose to construct a measure of risk for the overall business loan portfolio (as reflected in the dataset) of each bank. Such a measure does not reflect the overall risk position of the lender, since business-lending is only one, albeit important, component of the balance sheet for most Austrian banks.[19]

As a first step, we use the borrowers' annual balance sheets and income statements to estimate a probability of default (PD) for each of the firms in our sample. We proxy the event of default, using the bankruptcies observed within our sample of firms. This is a very conservative proxy for the event of default on a firm's financial obligations, and it would be preferable, in principle, to use a less stringent measure, such as late or insufficient payments on a loan-by-loan basis. Unfortunately, we do not have access to such a measure, and thus consider our estimates a lower bound for the true PD of a given borrower.

In close alignment with earlier work by Hayden (2003), we estimate logit models for every year from 2000 to 2008, using annual balance sheet and income statement information for every borrower that is available at the time of prediction.[20] In other words, our estimates for the year 2000 employ balance sheet information from 1994 up to 2000, those for 2001 use data up to 2001, etc. These regressions allow us to construct an "ex ante" (out of sample) estimate of the PD for each borrower at each point in time between 2000 and 2008. We employ these estimates as our core measure of each firm's creditworthiness.

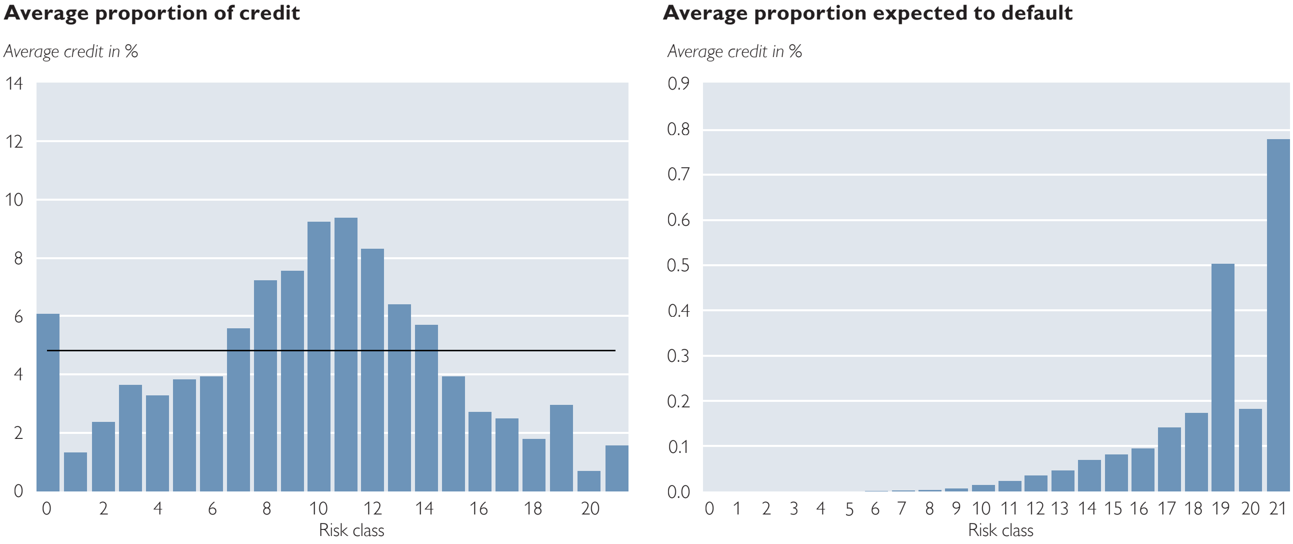
In practice, however, when banks and other investors take decisions on where to invest their money, they use ordinal rating scales – such as those published by Standard & Poor's or Moody's – rather than direct estimates of each borrower's PD. Partially, this is because rating scales are easier to interpret than a specific estimate of the PD, but also because rating scales additionally take into account information about firms that is not directly observable from balance sheets or income statements. For this reason the OeNB has developed a rating scale that maps PDs into 21 risk classes in order to assess whether individual banks' valuation of firms complies with the conditions for refinancing eligibility. This rating scale is designed in such a way that the OeNB can map PDs, as

[19] *For instance, numerous other balance sheet items – ranging from interbank transactions via securities positions to external assets – are associated with risk and are far more important for the overall risk position of many banks. These and other bank-specific variables are taken into account in the analysis by the inclusion of bank fixed effects.*

[20] *Hayden (2003) estimates PDs in order to evaluate alternative rating models for Austrian firms on the basis of a sample from 1987 through 1999. For details of our estimation procedure, see Gaggl and Valderrama (2011). The results reported in this article employ PDs that predict the event of default within a three-year horizon. Gaggl and Valderrama (2011) also analyze alternative prediction horizons and show that the effects of bank risk taking in response to long periods of cheap refinancing conditions are the stronger, the longer the prediction horizon.*

Chart 1

The Average Bank's Loan Portfolio and Expected Default Rate (2000 to 2008)



Source: Authors' calculations.

reported by banks on the basis of their individual internal rating models, into a unified rating scheme. Furthermore, each of these risk classes can be mapped into an S&P equivalent rating. In order to illustrate the distribution of Austrian banks' business lending across the risk classes used in practice, we thus employ the OeNB rating scale to map our estimates of each borrower's PD into a risk rating.[21]

Once we have assigned every firm to a risk class, we can illustrate the composition of risk in each bank's business-loan portfolio by looking at the share of credit extended to each risk class at any given point in time. Using our sample of matched bank-firm pairs, we compute these shares with monthly frequency for the period from January 2000 to August 2008.[22]

The left-hand panel of chart 1 plots the aforementioned shares for the average Austrian bank in our sample. As a reference, the horizontal line in the left-hand panel of chart 1 indicates a uniform distribution across risk classes. One can see that the bulk of business lending by the average Austrian bank was extended to firms in risk classes 3 to 15. Nevertheless, there is also a non-negligible proportion of lending within risk class 16 or higher. While this chart illustrates the composition of risk within the average Austrian bank's business-loan portfolio relative to the OeNB's rating scale, this distribution does not represent a cardinal measure of risk. In other words, the left-hand panel of chart 1 does not reveal the relative riskiness of individual risk classes. Thus, it is very difficult to measure

[21] *The precise specification of the OeNB rating scale is confidential and we are not allowed to present it here. However, we only use the OeNB rating scale as an illustrative tool, and none of the central empirical results reported in this paper depend on the precise specification of this rating scale.*

[22] *We restrict our analysis to the period before the failure of Lehman Brothers since we focus on identifying potential causes for the financial crisis thereafter, but we do not seek to analyze the crisis itself. For details on the precise construction of all the risk measures in this study, see Gaggl and Valderrama (2011).*

changes in risk taking on the basis of movements within such a distribution. This is because the shape of the distribution depends heavily on the design of the underlying rating scale.

Therefore, instead of analyzing the shape of the distribution in the left-hand panel of chart 1, we choose to construct a single cardinal measure for the amount of risk carried within a banks' business-loan portfolio. The idea behind this measure is illustrated in the right-hand panel of chart 1. There, we weight the proportion of credit extended to each risk class with the average PD within that risk class. We interpret this measure as the expected default rate within each risk class since it represents the proportion of credit that is expected to be defaulted upon. This alternative illustration highlights that only loans to very high risk classes effectively result in significant expected loss rates, and thus allows a cardinal interpretation.

Furthermore, adding these default rates across all risk classes produces a cardinal measure of the calculated expected default rate within the bank's overall business-loan portfolio.[23] The expected default rate for the average Austrian bank in our sample is 0.52% between 2000 and 2008, based on our estimates of PDs for a three-year bankruptcy horizon.

In what follows, we will employ this statistic to assess whether extensive periods of extremely accommodating monetary policy affect the amount of risk within banks' loan portfolios.

3.3 Assessing the Effect of "Too Low Interest Rates for Too Long": A Natural Experiment

In order to test whether interest rates that were "too low for too long" lead to an increase in Austrian banks' risk positions, we adapt an empirical strategy called "difference-in-differences," which enjoys great popularity in applied empirical microeconomics due to the seminal work by Card and Krueger (1994). This empirical strategy is useful whenever one seeks to analyze a discrete policy change and the policy measure under review does not vary at the level of the individuals affected. In our case, the individuals are banks, and the ECB refinancing rate is the policy instrument.

The basic idea behind this method is best explained within the context of a randomized medical experiment. Suppose we wanted to assess the effectiveness of Aspirin in reducing fever for a group of patients showing up at a doctor's office. We would randomly select two groups of patients and take their temperature. In the next step, we would give one group an actual Aspirin and prescribe a sugar pill to the other group.[24] After an hour we would take everybody's temperature for a second time and compute the difference in average temperatures of the treatment group as well as the difference in average temperature of the control group (i.e. sugar pill). The difference between the two differences would tell us the effectiveness of Aspirin in reducing fever. The difficulty with applying this

[23] *This measure is intended to convey information similar to expected default frequencies (EDFs), as reported by Moody's KMV. Furthermore, this measure is closely related to the ratio of risk-weighted assets to assets used by De Nicolò et al. (2010). It is important to note, however, that the measure employed in our paper is independent of the precise definition of the underlying rating scale.*

[24] *It is important to note that the group of patients that visit the doctor's office is not a random selection (they are all sick). However, who receives the actual drug and who receives the placebo is random, i.e., the doctor flips a coin to assign each patient to one of the two groups.*

method to economics is the construction of pseudo-randomized groups, which is usually referred to as the design of a "natural experiment."

Within the context of this study, we want to analyze the effect of a certain monetary policy regime (Aspirin in the example given above) on the risk-taking behavior of banks (the changes in patients' temperature in the aforementioned example). Using interest rates for the ECB's main refinancing facility makes it easy to identify a unique period of historically low refinancing rates between June 6, 2003, and December 6, 2005. This period can be considered a unique "policy regime" since refinancing rates had until then never been as low and had also never remained unchanged for such a long period of time.[25]

As a first step, we perform a pseudo-randomization by restricting our analysis to periods during which we argue that monetary policy, as measured by the ECB refinancing rate, can be considered exogenous – or, statistically speaking, "random" – to the Austrian economy. We accomplish this by comparing the actual ECB refinancing rate to a hypothetical "reference policy rate" for Austria, in order to gauge whether, from an Austrian perspective, monetary policy had potentially been "too tight" or "too loose." If the chosen reference policy represents the policy actions that would have been chosen based exclusively on the Austrian economy, then any deviation from that reference policy represents an intervention that must have been exogenous to the Austrian economy. Thus, for this identification strategy to be valid, it is crucial to identify a reference rule that is a good predictor for observed ECB policy rates, when applied to euro area data. A natural choice for such a reference policy is a Taylor rule, which predicts a policy interest rate based on inflation and output gaps.[26] Using this reference policy, we construct a Taylor rule gap, defined as the difference between realized ECB refinancing rates and those predicted by the Austrian Taylor rule, which identifies periods during which – according to the method applied – monetary policy was exogenous to the Austrian economy. In particular, we interpret the ECB's refinancing rate as being "tight" whenever the Austrian Taylor rule gap is less than –25 basis points, while we consider it to be "loose" whenever the Austrian Taylor rule gap exceeds 25 basis points. Our choice of thresholds is guided by the observation that the ECB usually changes its refinancing rates in increments of at least 25 basis points.

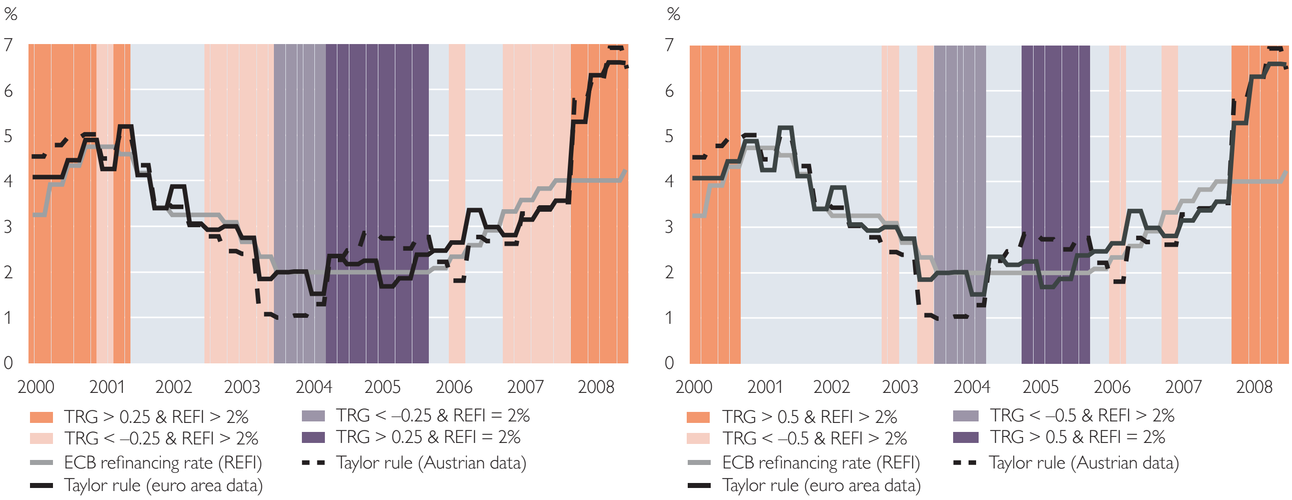
[25] *Even though only a fraction of banks is actually refinanced by the central bank and for many banks yield curve changes have a greater direct impact on refinancing conditions, monetary policy (i.e. the refinancing rate) nevertheless influences the spread between the short-term and long-term interest rates.*

[26] *This method is often used, successfully, to model the refinancing rate. This does not mean that the ECB follows a Taylor rule; and naturally, the ECB's monetary policy decisions must apply to the entire euro area, and cannot be geared toward individual countries. From a statistical perspective, however, this is not sufficient to state a causal relationship between monetary policy and the risk-taking behavior of Austrian banks. If, for instance, a certain monetary policy decision is largely geared toward Germany (given its weight in the euro area average) and the Austrian economy is in synch with Germany at that time, from a statistical perspective, such a monetary policy decision is to be regarded as if it had been geared toward Austria. In such a case, an estimated correlation between a change in the ECB's monetary policy and Austrian economic developments does not provide clear evidence about causality. For details on the precise Taylor rule specifications, see Gaggl and Valderrama (2011), who show that the results presented in this study are robust to various specifications of the reference rule. The effects identified in this study are based on a Taylor rule with equal weights on inflation and output stabilization, and all equilibrium variables (or targets) are proxied by a Hodrick-Prescott trend. This is a very agnostic specification of a Taylor rule, as it allows for changes in the ECB's targets for inflation and output gaps, as well as for changes in the target for the equilibrium short-term real interest rate.*

Chart 2

Design of the Natural Experiment

Austrian Taylor rule gap (TRG) of at least 25 basis points | **Austrian Taylor rule gap (TRG) of at least 50 basis points**



Source: Authors' calculations.

The left-hand panel of chart 2 illustrates the division of our sample into subperiods in which we consider the refinancing rate to be exogenous to Austria. The figure also illustrates the Taylor rule predictions for both Austria and the euro area. One can clearly see that the Austrian Taylor rule predicts a larger deviation than the euro area Taylor rule in almost all of the highlighted periods. To ensure that our analysis is not contaminated by the few selected periods during which the euro area Taylor rule is a worse predictor for observed ECB policy than the Austrian Taylor rule, we select an alternative set of subperiods in which the Austrian Taylor rule gap is larger than 50 basis points in absolute value. The right-hand panel of chart 2 illustrates that, for this alternative specification, there is no case where the euro area Taylor rule gap exceeds the Austrian Taylor rule gap in the same direction. Hence, we argue that during the selected subperiods, the ECB refinancing rate was not geared either directly or indirectly – for instance, through the tight link between Austria and Germany – toward the Austrian economy.

In the next step we restrict our focus to the "treatment" period, starting in the third quarter of 2003 and ending in the fourth quarter of 2005. This period can be divided into two subperiods: an earlier subperiod during which the Austrian economy was characterized by inflation and output gaps below the euro area average (Taylor rule gap less than –25 basis points), and a later subperiod, during which Austrian output gaps and inflation were increasing rapidly and, hence, above the euro area average (Taylor rule gap greater than 25 basis points), which began as early as in the second quarter of 2004. The former was characterized by the aftermath of the bursting of the dot-com bubble, while the latter was a period of rapid recovery and the onset of a long-lasting boom that continued until the most recent global financial crisis.

Accordingly, the very accommodating monetary policy – refinancing rates had just been lowered to an unprecedented low of 2% p.a. – an adequate

Table 1

The Effect of an Extended Period of Low Interest Rates on Riskiness

	$i_{ECB} > 2\%$	$i_{ECB} = 2\%$	Difference
Experiment 1: Taylor rule gap of at least 25 basis points			
Taylor rule gap smaller than –25 basis points	0.4960	0.5269	0.0309
	(0.0066)	(0.0121)	(0.0201)
Taylor rule gap larger than 25 basis points	0.4574	0.6171	0.1598
	(0.0069)	(0.0141)	(0.0499)
Difference	–0.0386	0.0903	0.1289
	(0.0225)	(0.0466)	(0.0495)
Experiment 2: Taylor rule gap of at least 50 basis points			
Taylor rule gap smaller than –50 basis points	0.5213	0.5269	0.0056
	(0.0106)	(0.0121)	(0.0199)
Taylor rule gap larger than 50 basis points	0.4416	0.6639	0.2223
	(0.0074)	(0.0199)	(0.0624)
Difference	–0.0797	0.1370	0.2167
	(0.0266)	(0.0613)	(0.0631)

Source: Authors' calculations.

Note: Standard errors in parenthesis.

policy for the earlier subperiod. In fact, the Austrian Taylor rule suggests an even more expansionary policy than the ECB chose to implement. During the later subperiod, the Austrian Taylor rule suggests a sharp tightening of monetary policy, but ECB refinancing rates remained unchanged.

This provides a case study that allows us to analyze whether policy interest rates that stay "too low for too long" have a significant impact on banks' risk-taking behavior. The second column of table 1 illustrates that, indeed, the average expected default rate of Austrian banks, as defined in the previous section, increased by about 9 basis points, from 0.53% to 0.62%. However, even though this increase is statistically significant, it does not prove that the ECB's monetary policy caused the increase in banks' risk positions. As in the example of the medical experiment given above, we need to compare this increase to a counterfactual change in risk positions during periods in which the path of ECB policy rates was not flat (the change in temperature of the group that received the sugar pill).

To construct a counterfactual, we study the remaining periods in which ECB refinancing rates were changing relatively frequently, but the particular policy choices were still exogenous to the Austrian economy. As one can see in the left-hand panel of chart 2, these periods can likewise be split into two types of subperiods: periods during which economic conditions were benign in comparison with the euro area average (Taylor rule gap in excess of 25 basis points) – and, hence, the Austrian Taylor rule suggests a more restrictive monetary policy than had actually been administered – and periods during which a more accommodative monetary policy would have been called for (Taylor rule gap less than –25 basis points) from an Austrian perspective. Therefore, in analogy to the "treatment" period, we compute the difference in banks' average expected default rates between the two types of subperiods. The first column of table 1 shows that this counterfactual difference is slightly negative, but statistically sinsignificant. This means that, in periods during which ECB refinancing rates were not kept flat for an extended period of time, banks' risk positions did not change significantly in response to a switch from a situation in which monetary policy was "too tight" to one in which it was "too loose," as identified by the Austrian Taylor rule gap.

The comparison of these two differences allows us to conclude that the measured increase in risk taking within the "treatment" period is about 13 basis points greater than during the counterfactual period. This effect is statistically significant and sizeable relative to the unconditional overall sample average of 0.52%.

However, since the euro area Taylor rule gap has the same sign and is even larger than the Austrian Taylor rule gap during some of the selected subperiods, one must raise the concern that the ECB's policy decisions may have been endogenous to the Austrian economy in at least some of the periods analyzed. To accommodate this concern, we perform the same exercise as that described above on a slightly more restrictive pseudo-randomization scheme, requiring the Austrian Taylor rule gap to be greater than 50 basis points in absolute value. This alternative selection criterion is illustrated in the right-hand panel of chart 2. As can be seen at the bottom of table 1, this alternative specification reveals an even larger increase of about 22 basis points in average expected default rates. Thus, our analysis provides some evidence that apart from other possible influencing factors the low interest rate period between June 6, 2003, and December 6, 2005, induced Austrian banks to significantly increase their risk taking.

The analysis presented here implies, however, that the "intervention period" (2003–2005) and "control periods" (2000–2002 and 2006–2008, respectively) differ exclusively with regard to the monetary policy regime and to Austrian inflation and output gaps relative to the euro area, respectively. Since this assumption is most likely not met, Gaggl and Valderrama (2011) apply an extended analysis, controlling for a number of important macro and individual bank factors which may have had a considerable influence on Austrian banks' risk-taking behavior. In particular, it is found that the results presented here are robust to the following control variables: the levels of Austrian inflation and output gaps, the spread between long- and short-term interest rates in Austria (term spread) as well as the spread between Austrian and European long-term interest rates (country-risk spread), credit growth in Austria, the share of business loans in the entire portfolio of Austrian banks and the share of business loans in the given sample of total Austrian business loans. Furthermore, Gaggl and Valderrama (2011) control at the bank level for size, capitalization, liquidity, the number of bank-business relationships as well as unobserved bank heterogeneity (fixed effects).

Controlling for bank capitalization, for instance, rules out the concern that the regulatory changes due to the Basel II Accord might be causing the observed effect. Specific contractual terms agreed upon by individual banks and their clients are captured by fixed effects. Moreover, structural changes in management practices and risk management (e.g. owing to the Basel-II-induced changeover to Value-at-Risk analysis) may be ruled out as primary cause for the observed effects, as the analysis presents qualitatively equivalent results when the periods (in the extended analysis) before and after the intervention phase are considered separately as counterfactual.

Based on the extended analysis in Gaggl and Valderrama (2011) it can be argued that the chosen empirical analysis indeed identifies a causal relationship between the period of low interest rates from 2003 to 2005 and Austrian banks‘ business lending risk position.

4 Conclusions

In this paper, we briefly discussed some of the main characteristics of a channel within the monetary transmission mechanism – usually referred to as the risk-taking channel of monetary policy – the potential existence and economic relevance of which has been acknowledged only recently. If this channel is at work, monetary policy affects the economy not only through its impact on the valuation of assets, the current riskiness of borrowers and expectations regarding their future development, but also by affecting the risk attitude of lenders. Thus, it may have important implications not only for monetary policy, but also for financial stability. The risk-taking channel implies that monetary policy contributes, in part, to the buildup of financial imbalances, which could – in the worst case scenario – culminate in a financial crisis that is brought about both by excessive lending and, in particular, by the deterioration of lenders‘ portfolios.

The candidate mechanisms driving this undesirable side effect of an expansive monetary policy are diverse, and there is neither conclusive empirical evidence nor a theoretical consensus on the relative importance of one or the other of the proposed explanations. The potential existence of this additional component within the transmission mechanism first attracted attention during a prolonged period of low interest rates, which was – quite importantly – accompanied by benign economic and financial conditions. Thus, it is not surprising that the most frequently cited cause for the risk-taking channel are so-called "search for yield" motives, which are said to arise whenever banks' and investors‘ profit margins are squeezed substantially on account of interest rates that are "too low for too long." Nevertheless, there are a host of additional forces claimed to be driving, or at least contributing to, this phenomenon, such as the particular contractual agreements between investors and financial institutions, as well as the incentives given to bank and investment fund managers. Explanations derived from nonrational human behavior are yet another possibility.

The quoted scarcity of empirical evidence for both the existence of and the driving forces behind the risk-taking channel can be attributed to the inherent difficulties in disentangling this channel from the more traditional broad credit channel. In part, this is due to the lack of appropriate datasets that are detailed enough to test the proposed hypotheses. More importantly, however, there is a lack of formal theoretical models, which flesh out the details of either channel and allow for precise formulations of testable hypotheses that distinguish between the two mechanisms.

The empirical analysis in this study adds to the literature on the existence of the risk-taking channel. Using a unique sample of matched lenders and borrowers, we present evidence that the entirely flat path of ECB policy interest rates in the period from June 6, 2003, to December 6, 2005, caused a significant increase in the amount of risk taking in Austrian lending to businesses. Moreover, our identification strategy reveals that, from an Austrian perspective, ECB refinancing rates in this period had been "too low for too long," which confirms one of the potential causes cited most for the risk-taking channel.

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