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The interest rate pass-through in the low interest rate environment: Evidence from Germany

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Thünen-Series of Applied Economic Theory
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Working Paper No. 151

**The interest rate pass-through in the low interest rate
environment – evidence from Germany**

by

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2017

The interest rate pass-through in the low interest rate environment

—

evidence from Germany

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Abstract

In this paper it is shown that the ECB's main refinance rate, measured by various Taylor-rules, is far too low for Germany for over half a decade. That entails risks for the stability of Germany's financial system. How strong these risks materialize depends on the extent to which German banks pass on the low policy rates to their customers. In this paper, the interest rate pass-through in Germany in the low interest era is investigated using error-correction models for various bank interest rates. The results indicate a stronger short-term pass-through as well as diminished interest rate margins that weigh on banks' profits. However, there is no evidence for structural changes in the long-term relationship between policy rates and banks' interest rates. While the latter might be soothing for monetary policy makers, the former is rather a reason for concern.

JEL-codes: E430, E580, E580

Keywords: low interest rates, interest rate pass-through, interest rate channel

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1. Germany in the low interest rate environment

Interest rates in Germany are receding since 2008 and are at unprecedented low levels for several years. The reason for the low interest rates are the drastic reductions of the European Central Bank's (ECB) policy rates as a response to the global financial and economic crisis in 2008 and 2009 and the ensuing sovereign debt crisis. Germany's real Gross Domestic Product (GDP) shrunk by over 5 ½ percent in 2009. While Germany recovered swiftly, large parts of the remaining Euro Area fell economically behind. Since the ECB determines its monetary policy based on the aggregate macroeconomic situation of the entire Euro Area, it kept the policy rates at low levels and even reduced them further until they hit the lower zero bound. Recent statements of the ECB indicate that a return to higher policy rates cannot be expected in the near future. It seems reasonable to assume that the ECB will discontinue its various unconventional monetary policy measures¹ before it starts raising its policy rates again. Given Germany's well-utilized capacities, low unemployment level and record-high tax revenues, it is very likely that the ECB's policy rates are by far too low. Taking also into consideration that Germany's inflation rate was, except for a few months,² always positive in the past years, yet below the ECB's inflation target, the real policy rate is negative for a number of years now.

Interest rates are important prices in a market economy. They equilibrate macroeconomic saving and investment plans and ensure an efficient allocation of capital into productive uses. If interest rates are distorted downwards for an extended period of time they can lead to large-scale mal-investments that pose a serious risk to macroeconomic and financial stability. For once, the low interest rates could fuel asset price bubbles in securities and real estate markets ([Borio and Lowe 2002](#) and [Bordo and Landon-Lane 2013](#)) as well as induce higher risk appetite of banks in search for yield ([Delis and Kouretas 2011](#)). Potential bubbles would, at the latest, deflate or burst when interest rates are normalized, with potentially high distress in financial markets. Moreover, German Banks suffer receding interest earnings because outstanding, high-interest credits mature and margins on new credits are smaller³. German banks partially compensated that by enlarging term transformation which increases their vulnerability to interest rate changes, e.g. when the ECB starts raising its policy rate back to pre-crisis levels ([Deutsche Bundesbank 2016, pp. 34-37](#)). A joint survey conducted by the Bundesbank and the German bank regulator among 1.500 small and medium sized banks supports that view. According to that survey, both a continuation of the ultra-low interest rate policy as well as a normalization of interest rates would strain bank's profits ([Deutsche Bundesbank und Bundesanstalt für Finanzdienstleistungsaufsicht 2015, p. 1](#)).

Which policy rate is "appropriate" for Germany's macroeconomic condition can be determined by using the Taylor rule ([Taylor 1993](#)). It describes the policy rate i_t as a function of Inflation(-expectations)⁴ π_t and the output gap \tilde{y}_t .

$$i_t = r_t + \pi^{target} + \alpha(\pi_t - \pi^{target}) + \beta\tilde{y}_t \quad (1)$$

¹ Among other measures, the ECB reduced the minimum reserve requirement from 2% to 1%, it provides unlimited liquidity for its refinancing operations and prolonged their duration (LTROs, TLTROs), it extended the range of securities eligible as collateral and conducts unsterilized purchases of government bonds and other securities of currently 60 billion Euro per month.

² The year-over-year inflation rate (HCPI) (data version of 14th of February 2017) was negative in January (-0.4%) and September (-0.1%) 2015 as well as in February (-0.2%) and April (-0.3%) 2016.

³ The interest rate margin or markup is defined in this paper as the absolute difference between a bank interest rate and the central bank's policy rate.

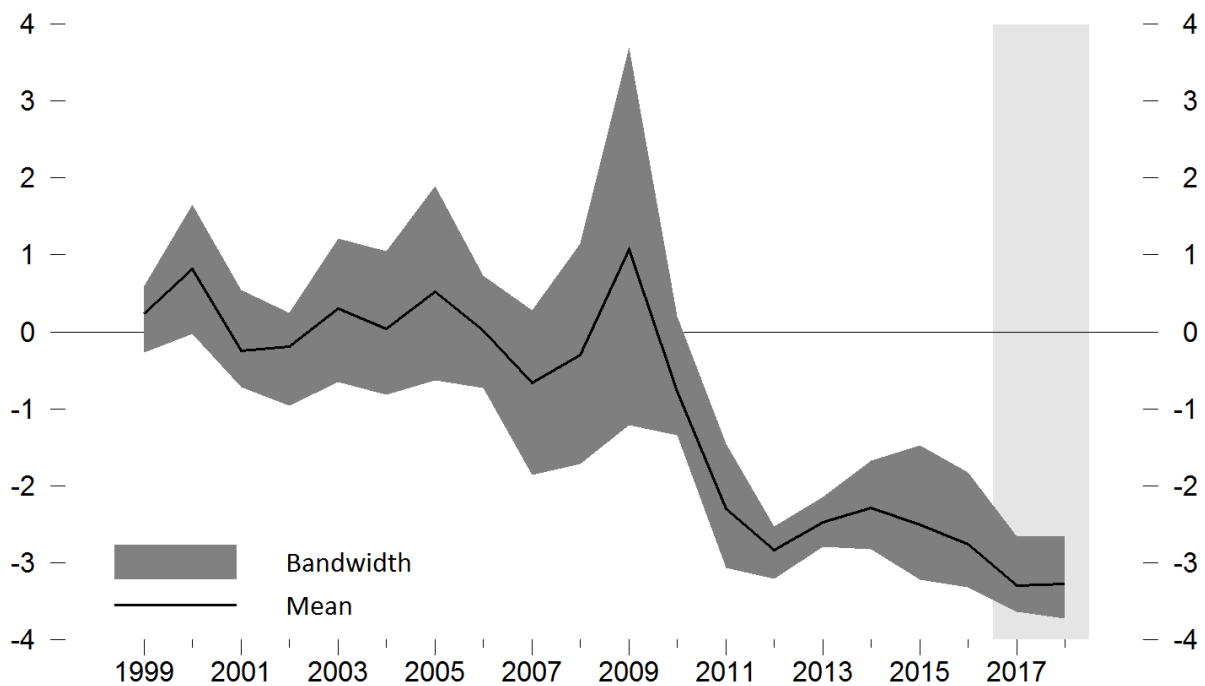
⁴ For an ex-post assessment of the adequacy of monetary policy rates the actual inflation rate is inserted in equation (1). To derive a future path of the policy rate, inflation forecasts of the European Commission (winter forecast 2017) are inserted in equation (1).

In equation (1), r_t denotes the long-term equilibrium real interest rate and π^{target} the inflation target. The parameters α and β represent the weights of the inflation gap and the output gap. Taylor (1993) proposes an equal weighting, i.e. both parameters assume a value of 0.5. In contrast, Taylor (1999) favors a higher weight on the output gap with $\alpha = 0.5$ and $\beta = 1.0$.⁵ The parameter values can also be determined empirically. Since central banks usually change interest rates incrementally, equation (1) is amended by a smoothing parameter (equation 2).

$$i_t = \theta i_{t-1} + (1 - \theta)[r_t + \pi^{target} + \alpha(\pi_t - \pi^{target}) + \beta \tilde{y}_t] + \varepsilon_t \quad (2)$$

In equation (2), θ denotes the additional smoothing parameter and ε the error term. The parameters are estimated using non-linear least squares using annual data from 1974 to 1998. Hence, that estimated Taylor rule models the interest rate setting behavior of the Deutsche Bundesbank prior to the Euro's introduction.

Figure 1: Deviation of the policy rate from Taylor rates



Notes: Annual data; Minimum, maximum and mean difference between the main refinancing rate of the ECB and different Taylor rule interest rates in percentage points. 2017 and 2018 forecasts (shaded).
Source: Own figure and calculations.

When calculating Taylor rates, there is uncertainty not only about the parameter values for α , β and θ but also about the appropriate measurement of inflation. Moreover, the output gap is an unobservable quantity that can be estimated using a variety of statistical approaches. In order to take that uncertainty into account, different measures for inflation and the output gap are applied here. For inflation, the Harmonized Consumer Price Index (HCPI) and the GDP-Deflator are used. With respect to the output gap, two estimates provided by the European Commission are deployed. One is estimated using the Hodrick-Prescott (HP) Filter, the other uses a macroeconomic production function of the Cobb-Douglas type (for technical details see Havik et al. 2014). For the computation and estimation of the Taylor rates, annual data for interest rates, inflation and the output gap of the AMECO-database of the European Commission are used. The equilibrium real interest rate is set to 1.3%. It corresponds to the average real growth rate of Germany's production potential between

⁵ A higher weight on the output gap favors an earlier and more decisive anti-cyclical monetary policy (leaning against the wind).

1995 and 2015 as estimated by the joint forecast group of Germany's leading economic research institutes ([Projektgruppe Gemeinschaftsdiagnose 2016](#)). In case of the estimated Taylor rules, the constant term represents the equilibrium nominal interest rate. The inflation target is set to the inevitable price level increase that was regularly announced by the Deutsche Bundesbank. Combining the various measures and concepts yields twelve different Taylor rates (see figure 5 und table 3 in the appendix).

Figure 1 summarizes the results. It shows the arithmetic mean of the deviation of the ECB's main refinancing rate from the various Taylor rates as well as the largest positive and negative deviation (bandwidth). The comparison of Taylor rates and the policy rate indicates that, until 2010, the ECB's monetary policy was fairly appropriate for Germany's macroeconomic condition. However, since 2011, the ECB's policy rate is by far too low, regardless which Taylor rule is applied. Inputting the European Commission's 2017 winter forecasts for Germany's inflation and output gap into the Taylor rules suggests that this is not going to change in 2017 and 2018, unless the ECB drastically raises interest rates.

2. The Interest rate pass-through in the low interest rate environment

In Germany's primarily bank-based financial system, the banks' behavior plays a crucial role in the transmission of monetary policy impulses over the interest rate channel. A partial or lagged pass-through of lower policy rates decreases the effectiveness of monetary policy but also lowers the risks emanating from the ultra-low interest rates. This study aims at empirically investigating to which extent the low interest rates are passed on to banks' private and corporate credit and deposit customers and whether or not the interest rate pass-through changed close to and at the lower zero bound. The very low interest rates might become a risk for the stability of the financial system, if they compress the banks' interest rate margins because deposit rates hit the lower zero bound while credit interest rates continue to fall because of the competition between banks.

2.1. Empirical model and data

In order to assess the interest rate pass-through, commercial banks' interest rates i_t^{Bank} are modelled depending on the policy rate i_t^{Policy} (equation 3). The parameter β_{Trans} describes, to which extent banks contemporarily transmit changes in the policy rate to their customers. In case of a full pass-through, β_{Trans} assumes a value of 1. The constant term α can be interpreted as the average margin of banks' interest rates on the policy rate.⁶ The margin itself consists of two main components. For one, the banks cover their costs and demand a risk premium. Moreover, they demand a profit markup in case of imperfect competition.

$$i_t^{Bank} = \alpha + \beta_{Trans} i_t^{Policy} \quad (3)$$

Empirically, the interest rate pass-through is modelled in an error-correction model (equation 4). Equation (3) (excluding the constant term) represents the long-term equilibrium relationship between the central bank's policy rate and the commercial banks' interest rates. This approach has the advantages of avoiding spurious regression results because of potentially non-stationary variables while also explicitly modeling the short-term and long-term relationships between the ECB's policy rate and commercial banks' interest rates as well as their short-term dynamics.

⁶ More precisely, the constant term represents the banks' margin at a policy rate level of 0. If the margin is independent from the policy rate's level, it remains constant, if banks fully and instantaneously pass on changes of the policy to their customers.

$$\begin{aligned}\Delta i_t^{Bank} = & \alpha + \alpha_{LI} D_t + \beta_{Trans_LI} D_t i_t^{Policy} + \gamma (i_{t-1}^{Bank} - \beta_{Trans} i_{t-1}^{Policy}) \\ & + \sum_{i=0}^2 b_i \Delta i_{t-i}^{Policy} + \sum_{i=1}^2 \beta_i \Delta i_{t-i}^{Bank} + u_t\end{aligned}\quad (4)$$

In the error-correction model, β_{Trans} still models the short-term interest rate pass-through. The parameter γ denotes the adjustment parameter to the long-run equilibrium. If γ is significantly smaller than 0, there exists a long-run equilibrium relationship and, hence, both interest rates are co-integrated. The parameters b_i and β_i describe the short-term dynamics of both interest rates and u_t represents the error term. In order to assess whether the interest rate pass-through has changed in the low interest rate environment, equation (4) contains two additional terms. D_t denotes a dummy variable that assumes a value of 0 until May 2009 and a value of 1 thereafter. The parameter α_{LI} measures the change in the interest rate margin in the low interest rate phase and the parameter β_{Trans_LI} measures the deviation of the short-term pass-through parameter from its value prior to the low interest rate phase.

Equation (4) is estimated using the two-stage least squares approach proposed by [Engle and Granger \(1987\)](#). Furthermore, it is tested for structural breaks before and during the low interest rate phase using the [Andrews and Plowberger \(1994\)](#) test for structural breaks at unknown breakpoint with p-values suggested by [Hansen \(1997\)](#). The identified breaks are appropriately modeled with dummy variables. Moreover, the measure of [Krasker and Welsch \(1982\)](#) for outliers is used to detect outliers which are, if necessary, removed.

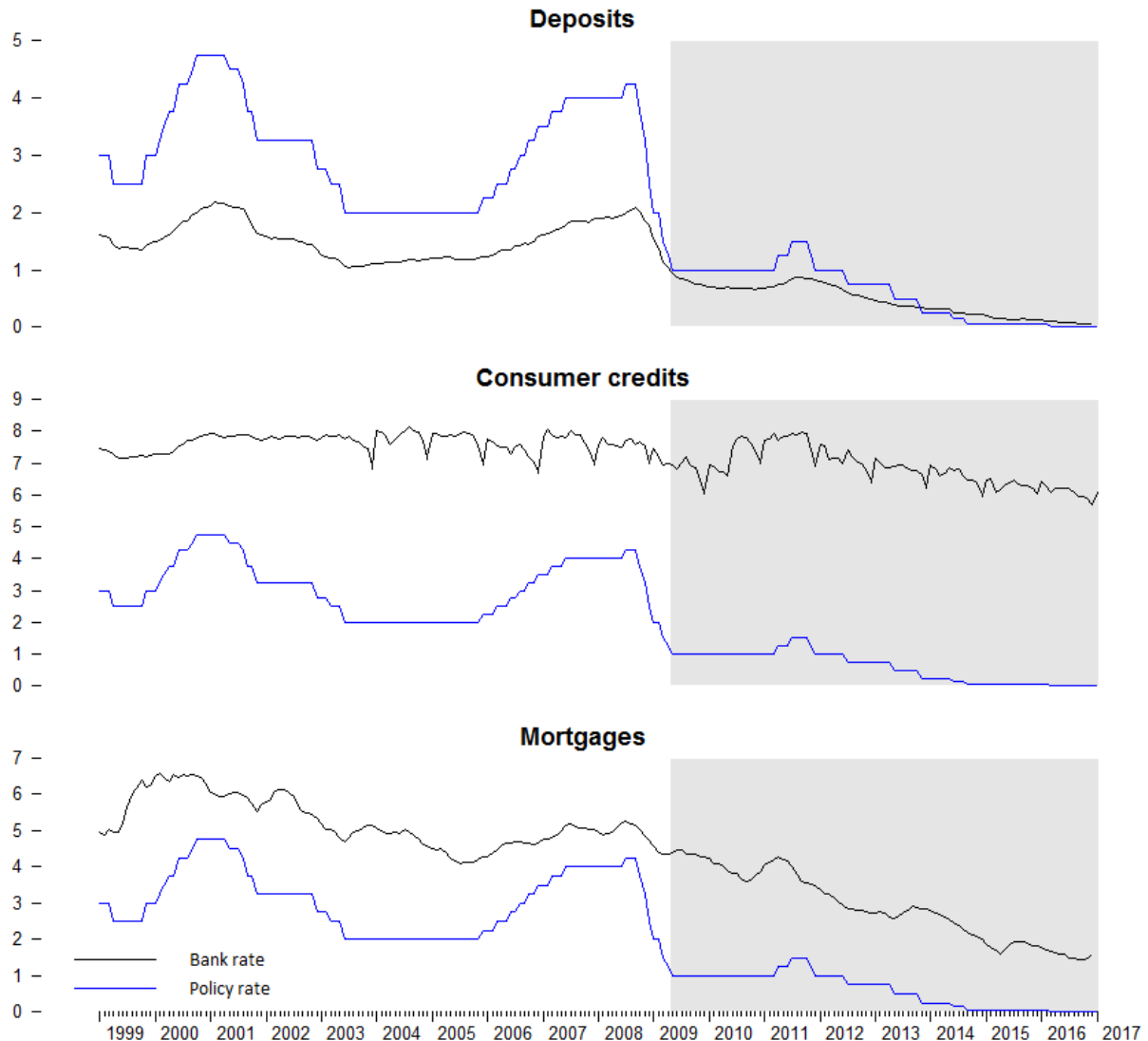
The data are obtained from the monthly interest rate statistic (new business, German contribution) of the ECB and the Deutsche Bundesbank. Unfortunately, the ECB's interest rate statistics for Monetary Financial Institutions (MFI) are only available beginning in January 2003. In order to extend the observation period to Germany's entire membership in the Euro Area, data from the discontinued interest rate statistics of the Deutsche Bundesbank are used to extend the MFI interest rate time series back to January 1999.⁷ For that purpose, the interest rate levels of the ECB's interest rate statistics are written back with the absolute differences of a similar interest rate from the Deutsche Bundesbank's statistics.⁸ However, owing to methodological differences in data gathering, both statistics are only of limited comparability. The assignment of the respective interest rates is based on the proposals of [Deutsche Bundesbank \(n.p.\)](#). For the policy rate, the main refinance rate of the ECB is used.

⁷ In principle, it is possible to extend the observation period back to the time before Germany joined the Euro Area. In this study it is refrained from doing so because the transition of the monetary policy responsibility to the ECB marked a regime change. Monetary policy instruments and policy rates significantly differ between the ECB and the pre-Euro Bundesbank. With its main refinance rate and its permanent facilities the ECB has three policy rates at its disposal to control money market interest rates and limit their fluctuations. The Deutsche Bundesbank on the other hand used only its Discount rate and Lombard rate, with varying importance, to steer money market interest rates ([Deutsche Bundesbank 1995, pp. 101-110](#)).

⁸ This approach avoids creating a possible structural break in the constant term when shifting from one data source to the other.

2.2. Private clients

Figure 2: Policy, credit and deposit rates (private clients, new business)



Notes: Interest rates in percent, monthly data, scales varying; low interest rate phase shaded.

Source: Deutsche Bundesbank, ECB; own figure.

In this section, the interest rate pass-through to private bank customers is assessed. For that purpose, three different bank interest rates are used: short-term deposit rates⁹, consumer credit rates¹⁰ and mortgage interest rates¹¹. The development of deposit interest rates (figure 2 top),

⁹ Since January 2003: effective annual interest rate of overnight deposits of private households according to the ECB's MFI interest rate statistics (new business, German contribution). Extended back with the mean effective annual interest rate for higher-yield sight deposits of private individuals according to the interest rate statistics of the Deutsche Bundesbank.

¹⁰ Since January 2003: effective annual interest rate of consumer credits of private households according to the ECB's MFI interest rate statistics (new business, German contribution). Extended back with the mean effective annual interest rate for instalment credits of private individuals between 5.000 and 15.000 euro and an agreed maturity of 36-60 months according to the interest rate statistics of the Deutsche Bundesbank.

¹¹ Since January 2003: effective annual interest rate of credits for house purchases with over five and up to ten

indicates that the policy rate and the bank rate have heavily converged right before and at the beginning of the low interest rate phase. The previously existing average margin of about 1.6 percentage points has completely vanished. The drastically reduced policy rate level seems to have been completely passed on to private depositors. Prior to the low interest rate phase, the short-term pass-through seems to have been incomplete as the interest rate margin fluctuated between 0.8 and 2.8 percentage points. In contrast, the already large spread between consumer credit rates and the ECB's main refinancing rate (figure 2 middle) seems to have widened even more in the low interest rate environment. Apparently, banks barely passed on lower refinancing costs to consumer credit customers. However, that seems to have been the case in higher interest rate times as well. In contrast, the relationship between policy rates and mortgage interest rates (figure 2 bottom) appears to be closer. The spread seems to have widened somewhat between 2009 and 2011, but since then it appears to have converged back to previous levels.

Whether these visually observed properties of and changes in the pass-through of policy rates are statistically significant is investigated deploying the approach introduced above. The regression results¹² (table 1) generally confirm the graphic impressions. For all three bank interest rates, changes of the policy rate are only partially translated into altered bank interest rates, as the estimates of β_{Trans} of well below 1 demonstrate. In case of the consumer credits, it was not even significantly different from zero. Thus, changes in the ECB's policy rate had no effect on consumer credit interest rates in the short-run. However, that changed in the low interest rate environment. While the short-term reaction parameter remained unchanged for sight deposits it significantly increased for consumer credits and mortgages. With regard to the interest rate margin, there is a distinct level disparity between the two loan interest rates, with a much higher margin on consumer credits. In both cases, the margin significantly decreased in the low interest rate era, as there are several negative structural breaks detected in the constant term.¹³ By contrast, there is no evidence for significant changes in the long-run equilibrium relationships. For all three bank interest rates of private clients, the Andrews-Plowberger test detected no significant structural breaks in the γ parameter.

From the commercial banks' point of view, their profits with private clients are under pressure from both, the deposit interest rates and the credit interest rates. For one, before the low interest rate era, they were able to (re-)finance themselves at lower costs using customer deposits compared to tapping the money market or the ECB's refinance facilities. Admittedly, banks are currently able to refund themselves interest-free using the ECB's refinance operations but if the previous interest rate differential would have remained intact, deposits rates would be well into negative territory. With respect to bank's credit interest rates, their margins on the policy rate significantly diminished. However, in case of the consumer credits, the margin is nonetheless very large.

years initial rate fixation according to the ECB's MFI interest rate statistics (new business, German contribution). Extended back with the mean effective annual interest rate for mortgage credits of private individuals with up to ten years initial rate fixation according to the interest rate statistics of the Deutsche Bundesbank.

¹² The extension of the ECB's interest rate statistics using the discontinued interest rate statistics of the Deutsche Bundesbank apparently worked smoothly. In none of the cases, the Andrews-Plowberger test detected significant structural breaks when shifting from one data source to the other in January 2003. In case of the consumer credit interest rates, the MFI time series exhibits a seasonal component (significantly lower interest rates in December). That seasonal pattern, which significantly weakened in 2012, was modelled using a seasonal dummy variable.

¹³ Caveat: The structural breaks in the constant term cannot only be the result of economic causes but also be due to the fact that since March 2016 the ECB's main refinance rate exhibited values of 0 for the first time (and almost 0 since September 2014). Hence, the estimates of the constant term prior to the low interest rate era are outside the codomain of the empirical observations.

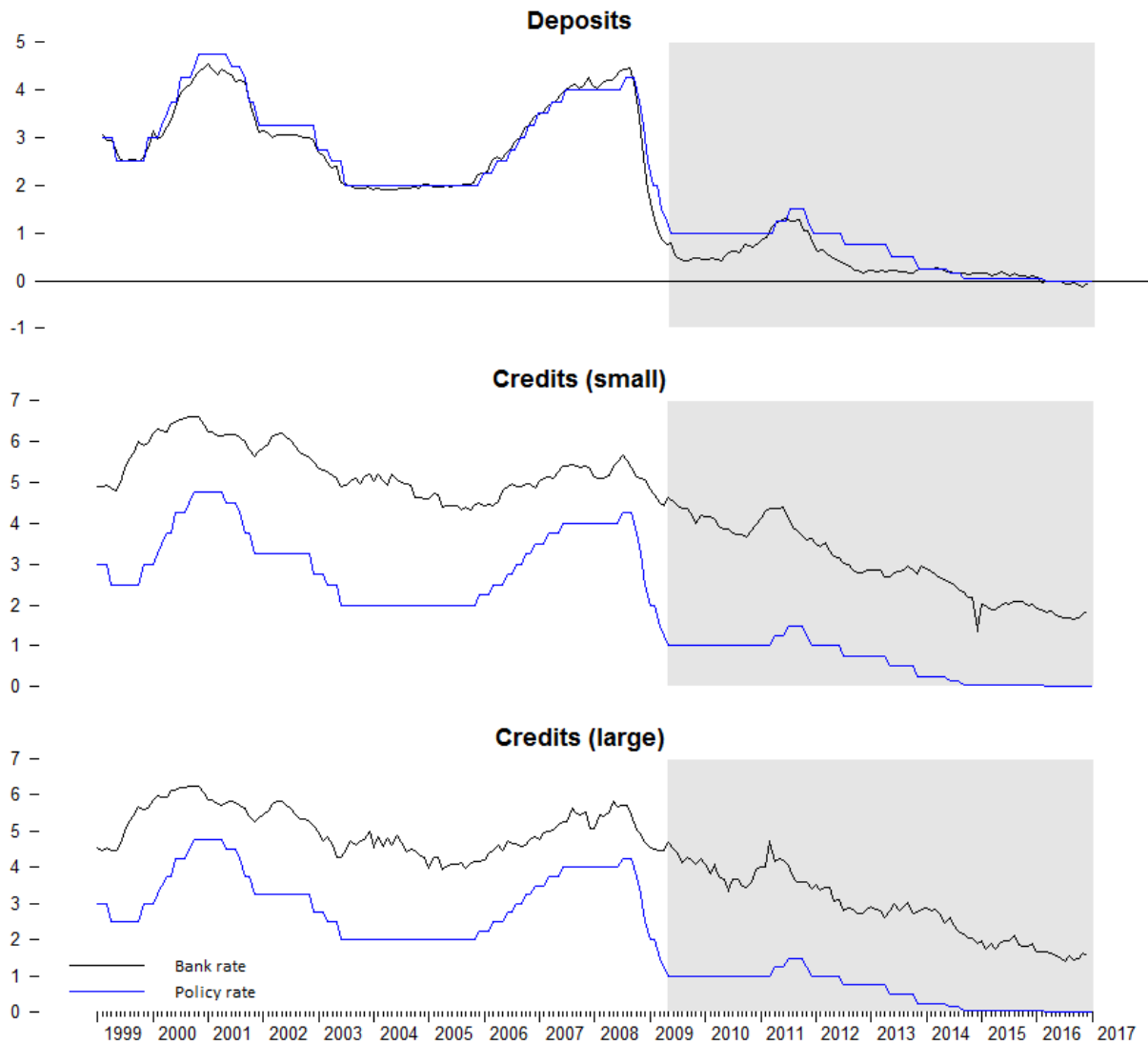
Table 1: Estimation results of the interest rate pass-through to private clients

	Deposits	Consumer credits	Mortgages
α	0.10*** (7.51)	6.11*** (22.46)	1.04*** (5.91)
γ	-0.19*** (8.22)	-0.85*** (22.40)	-0.24*** (5.99)
β_{Trans}	0.33*** (32.61)	0.03 (1.40)	0.23*** (7.81)
β_{Trans_LI}	-0.01 (0.76)	0.44*** (7.87)	0.17*** (3.43)
α_{LI}	-0.01 (0.32)	-0.57*** (7.57)	-0.17*** (3.40)
<i>additional structural breaks (α) in the low interest rate phase (mm/JJ)</i>	-0.03*** (02/2012) (5.09)	0.73*** (06/2010) (12.81)	-0.11*** (02/2010) (4.75)
	-0.02*** (11/2012) (3.09)	-0.51*** (03/2012) (14.56)	-0.18*** (07/2011) (6.62)
	-0.02*** (02/2015) (4.11)	-0.26*** (03/2015) (6.20)	-0.12*** (01/2015) (4.83)
	-	-0.21*** (08/2016) (7.32)	-0.04*** (05/2016) (3.11)
Σ structural breaks (α)	-0.07	-0.82	-0.62
Observations	216	216	216
adjust. R ²	0.86	0.74	0.61

Notes: *** - 99% significance level; absolute, robust (Newey-West) t-values in parentheses.
Source: own figure and calculations.

2.3. Business clients

Figure 3: Policy, credit and deposit rates (business clients, new business)



Notes: Interest rates in percent, monthly data, scales varying; low interest rate phase shaded.

Source: Deutsche Bundesbank, ECB; own figure.

In this section, the pass-through of policy rates to business clients is investigated. To this end, three bank interest rates are used: short-term deposit rates¹⁴ and credit interest rates for small¹⁵ as well as

¹⁴ Since January 2003: effective annual interest rate of deposits with an agreed maturity of up to one year of nonfinancial corporations according to the ECB's MFI interest rate statistics (new business, German contribution). Extended back with the mean effective annual interest rate for 1-month time deposits of corporations between 0.5 million and 2.5 million euro according to the interest rate statistics of the Deutsche Bundesbank.

¹⁵ Since January 2003: effective annual interest rate of credits to nonfinancial corporations of up to 1 million Euro and over five years initial rate fixation according to the ECB's MFI interest rate statistics (new business, German contribution). Extended back with the mean effective annual interest rate for nonfinancial corporations and self-employed between 100.000 and 500.000 euro according to the interest rate statistics of the Deutsche Bundesbank.

large loan amounts¹⁶. Examining the history of corporate deposit rates and the ECB's main refinancing rate (figure 3 top) indicates that they are closely correlated. A distinctive spread, as observed for deposits of private customers, existed neither before nor during the low interest rate era and changes in the policy rate seem to be passed on to corporate customers in a timely manner. Since July 2016, the corporate deposit rate even exhibits readings slightly below the lower zero bound. A likely reason for that is the negative overnight deposit rate of the ECB which seems to have been passed on to some extent to business clients. In contrast, the interest rates for small and large corporate credits (figure 3 middle/bottom) have a distinct markup on the policy rate. That markup also seems to be fairly stable indicating that changes in the policy rate are passed through in a timely fashion.

The regression results¹⁷ (table 2) of the interest rate pass-through to corporate clients are similar to that of private clients. Here as well, empirical evidence suggests that the contemporary pass-through is incomplete. However, it is almost one-to-one for deposits¹⁸ and in all cases the short-term pass-through is more complete than for private customers. With respect to the interest rate for corporate credits, the short-term pass-through strengthened significantly in the low interest rate era. By contrast, the short-term pass-through to deposit rates of business clients, as with private clients, remained unchanged. Analogous to credit interest rate for private customers, the margin on business clients' interest rates declined significantly since March 2009. Furthermore, there is no evidence for significant changes in the long-run equilibrium relationships. For all three bank interest rates of corporate customers, the Andrews-Plowberger test detected no significant structural breaks in the γ parameter.

¹⁶ Since January 2003: effective annual interest rate of credits to nonfinancial corporations of over 1 million Euro and over five years initial rate fixation according to the ECB's MFI interest rate statistics (new business, German contribution). Extended back with the mean effective annual interest rate for nonfinancial corporations and self-employed between 0.5 and 5 million euro according to the interest rate statistics of the Deutsche Bundesbank.

¹⁷ The extension of the ECB's interest rate statistics using the discontinued interest rate statistics of the Deutsche Bundesbank apparently worked smoothly. In none of the cases, the Andrews-Plowberger test detected significant structural breaks when shifting from one data source to the other in January 2003.

¹⁸ A χ^2 -Test rejects the null hypothesis $\beta_{Trans} = 1$ on the 99% significance level.

Table 2: Estimation results of the interest rate pass-through to business clients

	Deposits	Credits (small)	Credits (large)
α	0.13*** (10.30)	1.15*** (8.84)	1.31*** (6.30)
γ	-0.46*** (8.60)	-0.31*** (8.61)	-0.41*** (6.29)
β_{Trans}	0.90*** (127.31)	0.44*** (23.88)	0.49*** (16.63)
β_{Trans_LI}	-0.03 (0.99)	0.24*** (4.03)	0.27*** (3.22)
α_{LI}	0.15*** (2.93)	-0.15*** (3.15)	-0.17* (1.82)
<i>additional structural breaks (α) in the low interest rate phase (mm/JJ)</i>	0.15*** (06/2010) (7.46)	-0.10*** (10/2009) (2.60)	-0.23*** (01/2010) (5.25)
	-0.16*** (03/2012) (8.19)	-0.25*** (07/2011) (6.40)	-0.25*** (07/2011) (5.09)
	0.10*** (05/2013) (6.16)	0.09** (06/2013) (2.45)	0.157** (05/2013) (2.35)
	0.13*** (11/2013) (4.56)	-0.12*** (12/2014) (4.83)	-0.20*** (10/2014) (4.27)
	-0.07*** (02/2016) (8.21)	-	-0.13*** (01/2016) (5.99)
Σ structural breaks (α)	0.29	-0.54	-0.82
Observations	216	216	216
adjust. R ²	0.86	0.57	0.29

Notes: *** - 99% significance level, ** - 95% significance level, * - 90% significance level; absolute, robust (Newey-West) t-values in parentheses.

Source: own figure and calculations.

3. Summary and state of research

In this paper, it is shown that the ECB's policy rate, measured by various Taylor interest rates, is by far too low for Germany's macroeconomic situation for over six years now. That entails risks to Germany's macroeconomic stability and the stability of its financial system. How strong these risks materialize in Germany's bank based financial system depends on the extent to which commercial banks pass on the ultra-low policy rates to their customers. The empirical evidence unearthed in this study suggests that the pass-through, even though incomplete, was significantly stronger and timelier in the low interest rate era than before. Moreover, the empirical results indicate that interest rate margins on credits to both, private and corporate customers, dropped in the low interest rate environment with negative consequences for banks' profits. By contrast, there is no evidence for structural changes in the long-run relationship between the ECB's policy rate and banks' interest rates. While the stable long-term relationship might be soothing for monetary policy makers, the stronger short-term pass-through as well as the decreased interest rate margins are reasons for concern as they increase the risks emanating from the long and ultra-low interest rate environment.

The results of this study integrate well into the existing research body. For one, the incomplete pass-through of policy rate changes is, regardless of the econometric methods utilized, a well-documented phenomenon in the economic literature for Germany (Beckmann et al. 2013; von Borstel 2008; Cottarelli and Kourelis 1994; Ehrmann and Worms 2001; Toolsema 2001 and Weth 2002), the Euro Area (Aristo and Gallo 2014; Beckmann et al. 2013; von Borstel 2008; De Bondt 2005; European Central Bank 2009; Hristov et al. 2014; Hülsewig et al. 2009; Karagiannis et al. 2010; Kleimeier and Sander 2004; Kleimeier and Sander 2006; Kwopil and Scharler 2010; Leroy and Lucotte 2016) and other countries and currency areas (Cottarelli and Kourelis 1994; De Graeve et al. 2007; Egert et al. 2007; Gambacorta 2008; Humala 2005; Karagiannis et al. 2010; Kwopil and Scharler 2010; Toolsema 2001). Moreover, the existence of heterogeneity between different interest rate categories and customer groups, in particular the more incomplete pass-through to private households, as well as stable long-term relationships between central bank and commercial bank interest rates are common results in earlier research.

Diminished interest rate margins for private and corporate loans, as found in this study, are also well-known in the existing literature. The Deutsche Bundesbank (2016) in its 2016 financial stability report ascertained that the interest rate margin¹⁹ of Germany's savings and loan associations and mutual banks trended downwards since 2010 and reached its lowest value in 20 years (excluding the crisis year 2008) in 2015. Busch and Memmel (2015) show empirically, that there is a positive, medium-term to long-term relationship between the level of the policy rate and the interest rate margin. Hence, the longer the low interest rate phase continues, the more compressed banks' margins are likely to become. Demary and Matthes (2014) state overcapacities and strong competition in the German banking sector as additional reasons for declining interest rate profits. Gropp (2016) cites stricter regulation and the lack of structural reforms as further causes of declining profit margins, in particular for smaller banks. In contrast, von Borstel et al. (2016) find no evidence for a drop in banks' interest rate markups caused by monetary policy measures. And Illes and Lombardi (2013) see interest rate markups close to pre-crisis levels.

With respect to changes in the interest rate pass-through in the past years, there are a number of previous studies. However, the majority of research focuses on changes during the financial crisis between 2007 and 2010 rather than during the low interest rate phase. Aristo and Gallo (2014)

¹⁹ The Deutsche Bundesbank defines the interest rate margin, unlike in this study, not as difference between banks' interest rates and the central bank's policy rate but as the overall interest profits in percent of total assets. The interest rate margin measured by the concept of the Deutsche Bundesbank is affected by changes in term transformation and changes of the sources of refinancing as they both determine the amount of the overall interest profits.

empirically investigate changes in the pass-through in the Euro Area using a Markow-switching vector autoregressive (VAR) model. They find that, the pass-through to private households and nonfinancial corporations has weakened. Their results are confirmed by [Hristov et al. \(2014\)](#) using a panel VAR approach and [Blot and Labodance \(2011\)](#) using an error-correction model. By contrast, evidence of [von Borstel et al. \(2016\)](#) using a factor-augmented VAR suggests, that the interest rate pass-through was not impaired during the financial crisis. Other studies also include the first years of the low interest rate era. [Paries et al. \(2014\)](#) analyze the interest pass-through in the Euro Area during the sovereign debt crisis using error-correction models. They estimate those until the beginning of the low interest rate phase and compare interest rate forecasts of those models with actual bank interest rates until the end of 2013. For deposit rates, they find that their model forecasts are well below the actually observed interest rates which indicates a weaker pass-through to deposit rates. They suspect that this is the result of banks' reluctance to pass on lower policy rates close to the lower zero bound. With respect to private and corporate credit interest rates, [Paries et al. \(2014\)](#) find that the pass-through followed historical patterns in France and Germany. By contrast, in Spain, Italy, Ireland and Portugal their evidence suggests a weaker pass-through. The authors suspect that this heterogeneity is caused by deviating risks emanating from the diverging macroeconomic developments of these countries and the different risks of sovereign defaults. [Illes and Lombardi \(2013\)](#) also find significant heterogeneity in the interest rate pass-through of Euro Area member states. While, despite the ultra-low policy rates, in Italy and Spain interest rates for nonfinancial corporations only slightly subsided, interest rates in France and Germany decreased much stronger. Research done by the [ECB \(2013\)](#) also finds a weaker pass-through in Italy and Spain compared to France and Germany. In addition, the ECB's estimations also account for sovereign default risks, the default risks of the respective banks and that of the banks' credit portfolios. The estimation results indicate, that these factors explain a large part of the heterogeneity between Euro Area member states. However, the effects of these factors are small in Germany.

The research presented in this paper significantly adds the existing literature that finds significant heterogeneity within the Euro Area. Previous studies identified a weaker pass-through in the so-called crisis countries as the primary source of the observed heterogeneity. This study points to the conclusion, that the heterogeneity is also a result of a strengthened short-term pass-through in Germany. However, the reasons for that are not investigated in this paper. One explanatory approach could be that the drastic drop in the yields of German government bonds, as an alternative investment form for banks, put pressure on credit interest rates. That hypothesis fits to the results of previous studies that find that the interest rate pass-through weakened just in these countries that suffered the most from the sovereign debt crisis while Germany experienced just the exact opposite. Furthermore, this is the first study that investigates changes in the interest rate pass-through in Germany in the low interest rate environment and the first one that makes use of the discontinued interest rate statistics of the Deutsche Bundesbank to obtain data for Germany's entire membership in the Euro Area. Earlier research only made use of the ECB's MFI interest rate statistics beginning in 2003 and only used data until the end of 2013. Data of the time when the policy rate got even closer to and ultimately hit the lower zero bound were so far not included. Moreover, this study investigates the actual transmission of policy rates to bank interest rates. Earlier studies usually use the (by monetary policy strongly controlled) money market rates as explaining variable. Using the actual policy rate instead has the advantage of avoiding that the money market stress during the financial crisis impairs the econometric estimations.

As the low interest rate era is likely to continue for the foreseeable future, the evidence presented in this paper is of high relevance to policy makers and regulators. As the (hard) zero lower bound was hit not before March 2016, the number of observations for this extreme case of low policy rates is still limited. Future research could therefore investigate if that caused further changes in the interest rate pass-through. Moreover, the existing research has barely investigated the role of other special factors that might have affected the pass-through in Germany in the low interest rate era such as

stricter regulation, the effects of unconventional monetary policy measures, capital flight into German government bonds and structural factors in the German banking sector.

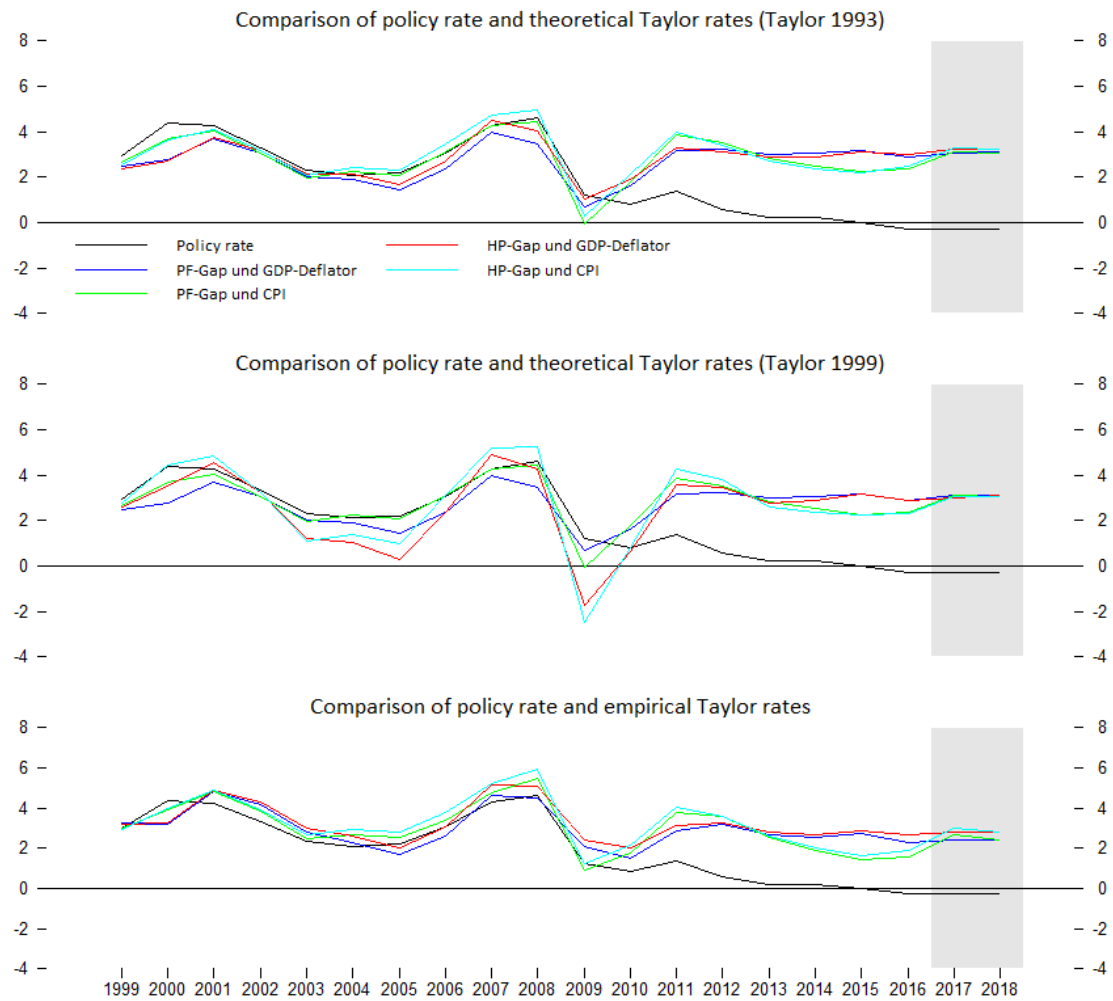
Annex

Table 3: Estimation results Taylor rules

	Model 1	Model 2	Model 3	Model 4
Constant	5.61*** (11.52)	5.88*** (13.47)	6.11*** (15.43)	6.25*** (16.80)
Smoothing parameter	0.40*** (4.21)	0.31*** (2.96)	0.35*** (3.55)	0.27** (2.72)
Inflation gap (HCPI)		1.11*** (3.61)		1.03*** (3.37)
Inflation gap (GDP-Deflator)	0.94*** (3.60)		0.86*** (3.57)	
Output gap (HP-Filter)			0.72*** (3.72)	0.57*** (2.65)
Output gap (Production function)	0.79 *** (3.26)	0.60** (2.32)		
structural break (1992 in constant)	-1.24*** (2.68)	-1.85*** (4.51)	-1.72*** (4.06)	-2.18*** (6.34)
Observations	25	25	25	25
adjust. R ²	0.85	0.83	0.86	0.87

Notes: *** - 99% significance level, ** - 95% significance level; absolute, robust (Newey-West) t-values in parentheses.
Source: own figure and calculations.

Figure 4: Comparison of policy rate and Taylor rates



Notes: Interest rates in percent, annual data, scales varying; policy rate: main refinancing rate of the ECB.
Source: European Commission (AMECO, data version: 13th of February 2017); own figure.

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