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How does P2P lending fit into the consumer credit market?

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Non-technical summary

Research Question

In recent years, we have begun to observe the growth of the internet economy, which has progressively led to "crowd-based" platforms and the direct matching of lenders and borrowers. Via peer-to-peer (P2P) lending platforms the decision process of loan origination is given into the hands of private lenders and borrowers. This paper investigates how the P2P lending market fits into the credit market and specifically aims to answer the following questions: Why do retail consumers look for P2P financial intermediation? Are the interest rates charged by P2P lenders in Germany higher than those of banks? Are P2P loans more risky than bank loans? Are internet-based peer-to-peer loans substitutes for or complementary to bank loans?

Contribution and Results

The paper shows that loans channelled via P2P platforms involve higher interest rates than loans channelled via the traditional banking sector. They are also riskier than those of banks. However, when adjusted for risk, the interest rates are comparable. Moreover, analysis of the different segments of the bank credit market and P2P lending shows that, after having controlled for interest rate and risk differences, the bank lending volumes are negatively correlated with the P2P lending volumes. Our finding suggests that high-risk borrowers substitute bank loans for P2P loans since banks are unwilling or unable to supply this slice of the market.

Nichttechnische Zusammenfassung

Fragestellung

In den letzten Jahren war ein verstärktes Wachstum an Möglichkeiten von Onlinefinanzierungen zu beobachten. In diesem Rahmen wuchsen insbesondere Plattformen, die sich auf „crowdlending“ spezialisiert haben, und somit das direkte Zusammenführen von Kreditgebern und -nehmern vereinfachten. Durch Peer-to-peer (P2P) Kreditplattformen wird der Entscheidungsprozess zur Kreditvergabe in die Hände der privaten Kreditgeber und Kreditnehmer gegeben. Dieses Papier untersucht, wie die P2P-Kreditvergabe in den Kreditmarkt passt und konzentriert sich dabei besonders auf folgenden Fragen: Warum nehmen Privathaushalte P2P-Platformen als Finanzvermittler in Anspruch? Sind die Zinsen der P2P-Kredite in Deutschland höher als die der Banken? Sind P2P-Kredite riskanter als Darlehen der Banken? Sind die auf Internet basierende P2P-Kreditvergabe komplementär oder substitutiv zu Bankkrediten?

Beitrag und Ergebnisse

Unsere Ergebnisse zeigen, dass Kredite von P2P-Plattformen höher verzinst werden als Kredite, die über das Bankensystem vergeben werden, und riskanter sind. Wenn jedoch für die zugrundeliegenden Risikounterschiede bereinigt wird, sind die Zinssätze miteinander vergleichbar. Darüber hinaus zeigt die Analyse, dass die Kreditvergabe durch P2P-Plattformen negativ mit den Banken korreliert, selbst wenn für den Risikounterschied und für die verschiedenen Segmente des Bankensystems kontrolliert wird. Unsere Ergebnisse zeigen, dass für Kreditnehmer mit hohem Risiko die Bankenkredite zu Gunsten der P2P-Kreditvergabe ersetzt werden, da die Banken dieses Marktsegments nicht bedienen wollen oder können.

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Abstract

Why do retail consumers look for P2P financial intermediation? Are internet-based peer-to-peer (P2P) loans a substitute for or a complement to bank loans? In this study we answer these questions by comparing P2P lending with the non-construction consumer credit market in Germany. We show that P2P lending is servicing a slice of the consumer credit market neglected by banks, namely high-risk and small-sized loans. Nevertheless, when accounting for the risk differential, interest rates are very similar. Our conclusion is that P2P lending is substituting the banking sector for high-risk consumer loans since banks are unwilling or unable to supply this slice of the market. Our study serves to show where the institutionalization of credit provision has left a slice of the market unsupplied.

Keywords: P2P lending, financial intermediation, consumer credit.

JEL classification: D40, G21, G23, L86

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1 Introduction

Historically, banks are an institutional solution to the problem of asymmetric information in the credit market between the provider of funds and the receiver of those funds; see Akerlof (1970) and Stiglitz and Weiss (1981). Both *ex ante* (adverse selection) and the *ex post* (moral hazard) asymmetric information can be mitigated by banks because of their expertise in screening and monitoring borrowers at reduced cost compared to individual lenders, as stressed by Leland and Pyle (1977) and Diamond (1984). Therefore, in the hypothetical case of perfect screening and monitoring, banks can extend financing to many firms or individuals who would otherwise not be granted it. No borrower should be rationed and each borrower should pay the right price to obtain the loan. In this case, all "bankable" consumers would have access to credit and there would be no opening for new business models to compete with the banking sector.

However, what we have begun to observe in recent years is the growth of the internet economy, which has progressively led to "crowd-based" platforms which allow for the direct matching of lenders and borrowers. Via the so-called peer-to-peer (P2P) lending platforms the decision process of loan origination is put into the hands of private lenders and borrowers.

In this kind of lending model the mediation of financial institutions is not required, as stressed by Herzenstein, Dholakia, and Andrews (2011) and Galloway (2009) and Morse (2015). Borrowers (either households or firms) post their loan request online and provide information on their current financial situation, e.g. income and open credit lines. On the other hand, lenders look into a pool of credit seekers and search the ones that best fit their risk-return preferences. The final decision in the screening process rests with the lenders.

P2P lending is enjoying considerable success all over the world, and there is a clear positive trend for the provision of credit via P2P platforms. By contrast, at the same time, comparable segments of the credit market via the banking sector are showing a negative trend.

This paper aims to investigate how the P2P lending market fits into the credit market and specifically aims to answer the following questions. First, are the interest rates charged by P2P lenders in Germany higher than those of banks? Second, are P2P loans more risky than bank loans? Third, are risk-adjusted interest rates so different from those of banks? Other studies have been conducted for the P2P lending market in the US, but there are no papers which investigate this question in a developed country other than the US. Moreover, the papers that investigate these issues in the US market have difficulties comparing the interest rates charged by P2P versus banks since there are no official statistics on interest rates on consumer loans. Furthermore, consumer lending in the US is a very diffuse market, which includes non-banking loans as payday loans. In Germany, by contrast, consumer loans are largely provided by banks, and the Bundesbank provides good statistics at the bank level. Fourth, we aim to investigate whether the sensitivity of the volume of loans to interest rates is similar to that of banks. By investigating this issue, we are also contributing to the literature on banking since, to our knowledge, ours is the first paper that investigates the P2P lending market from this perspective. Further, while the transmission mechanism, i.e. how changes in market rates affect retail rates, have been studied in the literature, much less is known about the elasticity of credit demand

with respect to loan rates, especially as they have been characterized in the recent years by low interest rates, non-conventional monetary policies and bank capital requirement constraints.

Finally, we investigate why retail consumers borrow on P2P platforms. The last question induces us to investigate several reasons. (a) Does the credit demand, addressed via P2P platforms, come from consumers with limited or no access to the banking sector? (b) Does it come from consumers who want to borrow at better terms and conditions? (c) Or does it come from customers who have a preference for the use of the internet and are looking for other opportunities rather than classical bank products?

The interest in borrowing and lending via web-based platforms has been investigated by looking at the Google Trends database provided by Google. By investigating (a), (b) and (c), we are able to answer the question: Is P2P lending a substitute for or a complement to bank lending?

This paper relates to the literature on P2P lending that is not vast but is growing rapidly. In fact, although P2P lending is a relatively young sector which started in 2005 with the launch of Zopa, an increasing amount of research has been devoted to the topic, especially after Prosper (a competitor of Zopa) made its entire platform's data available in 2007; see, Ravina (2012) and Pope and Sydnor (2011). The information technology nature of P2P lending grants access to granular data on credit provision and the investigation of new questions. On the one hand, scholars ask to what extent consumers' characteristics impact their interest rate. Duarte, Siegel, and Young (2012) evaluates the impact of trustful pictures on interest rates, Lin, Prabhala, and Viswanathan (2013) evaluate the impact of friendship connections on interest rates, and Ravina (2012) evaluates the effect of beauty and skin color on interest rates. On the other hand, researchers ask to what extent information facilitation and institutional design enhance credit provision. Hildebrand, Puri, and Rocholl (2015) investigate to what extent the change from interest rate auction to rates that are pre-determined by the website affects the amount of credit provision. Herzenstein et al. (2011) analyze to what extent investors herd with each other when analyzing which loan to fund.

Our work abstracts from the behavioral aspects of the P2P credit market. Instead, we offer a macro-perspective by analyzing how the P2P market outcome fits into the credit market. In some ways our work is related to Blaseg and Kötter (2015), who analyze why startups prefer equity crowdfinancing over bank credit, while our paper analyzes why consumers seek credit on P2P platforms instead from banks.

The data on P2P lending are provided by Auxmoney, which is the largest and oldest P2P lending platform in Germany for consumer credit. On the other hand, data on bank lending are provided by the Deutsche Bundesbank. Because of differences origination between P2P and bank lending in terms of their origination, we compare the two data sets by controlling for risk and interest rate differences. In this way, we are able to set the same basis for our econometric estimates. As a final note, we aim to stress that our results and inferences are drawn from correlation and not from causation.

The paper shows that loans channeled via P2P platforms involve higher interest rates than loans channelled via the traditional banking sector. They are also riskier than those of banks. However, when adjusted for risk, the interest rates are comparable. Moreover, analysis of the different segments of the bank credit market and P2P lending shows that, after having controlled for interest rate and risk differences, the bank lending volumes are

negatively correlated with the P2P lending volumes. Our finding suggests that high-risk borrowers substitute bank loans for P2P loans since banks are unwilling or unable to supply this slice of the market.

The paper is organized as follows. Section 2 presents the data sets from Auxmoney and the Deutsche Bundesbank. Section 3 compares the interest rates charged by Auxmoney and those of German banks. Section 4 investigates the interest rate elasticity of Auxmoney loans versus that of German banks. Section 6 expands our estimation in the context of internet loans. Section 7 concludes.

2 Data and Descriptive Statistics

The data sources used in our study are (1) Auxmoney for data on P2P lending; (2) the Deutsche Bundesbank (Interest Rates Statistics) for data on bank lending; (3) Schufa for data on credit ratings; (4) the Deutsche Bundesbank (Balance Sheet Statistics) for data on loan loss provisions; (5) the Federal Statistical Office (Statistisches Bundesamt) for data on inflation, unemployment and GDP growth (interpolated quarterly), all by state;[1] (6) Google Trends for data on Google search statistics.

Auxmoney is the oldest and largest P2P lending platform in Germany. According to their website, from the day it begun business in 2007 until the time of writing (late 2015) the total volume of credit provided was EUR 219 million in 39,090 projects, with an average nominal interest rate of 9.65%.

Auxmoney provided us with two different data sets. The first includes all loans provided by Auxmoney divided by cities between January 2010 and August 2014, with no maturity information. The second includes the average amount of loan provision, the average interest rate and the average Schufa score for each state per month.[2] For reasons of data confidentiality, Auxmoney provides records only with at least five loans' worth observations. They also provide us with the statistics of the distribution of their loan maturities provided in the first data set as reported in Table 1.

Maturity	# Loans	Volume
12	1,310	3,688,350
24	2533	9,221,550
36	3,292	15,813,900
48	2,084	16,356,700
60	1,405	16,140,600

Table 1: Distribution of Auxmoney loans per maturity. Data provided by Auxmoney, sample period January 2011 until August 2014.

As Table 1 shows, the largest number of loans provided are the three-year loans, while one-year maturity loans make up the smallest number. On average, the large-size loans

[1] This data will be used as state–control variables in our estimations.

[2] Schufa is a German private credit bureau with 479 million records on 66.2 million natural persons. Schufa provides credit ratings for each person requesting a loan and Auxmoney provides the Schufa score of each credit application.

are the ones with the longer maturities. Loans range from EUR 11,487 for the five-year maturity to 2,815 for the one-year maturity. In terms of total volume distribution, the largest loan volumes are from the four- and five-year maturities.

The Deutsche Bundesbank statistics used in this study are provided by two different data sets. The first is the Interest Rates Statistics (MIR, Bade and Beier (2016)), which gives the amounts and the interest rates per bank and per month applied to non-construction consumer credit lines (outstanding and new business) for different maturities (credit card/ overdraft, up to one year, and more than one year). The statistics are composed of monthly observations between January 2011 and August 2014. The second is the data set from the Balance Sheet Statistics (BISTA, Beier, Krueger, and Schaefer (2016)), which gives information on write–ups and write–downs, from which we derive the banks' loan loss provisions.

As will become evident later in the study, our analysis is made on the state level. The regional differentiation of bank loans is possible because of a feature of the German banking system: the presence of Sparkassen and Volksbanken. Sparkassen are geographically restricted banks with a legal mandate to provide bank services to all potential costumers.[3] Volksbanken are cooperative banks (also geographically restricted), whose costumers are actually members of an organizational structure that aims at credit facilitation. By focusing on those banks that are more readily comparable to Auxmoney, we therefore avoid the inclusion of large commercial banks or any non-regional banks. Thus, there are 105 banks in our sample, which hold loan portfolios of relatively small size.

Table 2 provides comparative descriptive statistics of the amount of P2P loans and the average bank total of new loans per state with a distribution analysis of the banks new loans by size for each of the different maturities (overdraft/cc, one-year loans, from one- to five-year loans).

	Banks				Auxmoney
	K^o	K^z	K^m	K^b	K^{P2P}
Mean	75,413,940	9,436,381	3177000	99,864,000	109,089
St.Dev.	60,745,630	26,663,760	2737000	76,210,000	119,543
25 Pctl	38,044,000	1,206,000	1,436,000	65,357,000	27,500
50 Pctl	60,411,500	3,099,000	2,566,500	78,324,000	71,200
75 Pctl	92,530,500	7,656,500	3,990,500	103,093,000	141,550
# Obs	4664	4664	4664	4664	397

Table 2: Lending amounts, K, (in Euro) by bank, month and state, where the index o stands for overdraft and credit card, z stands for $[0, 1]y$ loans, m stands for $]1, 5]y$ loans. Source: Research Data and Service Center (RDSC) of the Deutsche Bundesbank and Auxmoney, sample period January 2011 to August. 2014.

Table 2 shows that the average total volume of new loans granted by Auxmoney per state per month is EUR 109,089, which is far lower than the average total loan volume per month of the average total amount of new loans per bank per state, which is EUR 99,864,000.

[3]For further details on the Sparkassen structure, see Puri, Rocholl, and Steffen (2011).

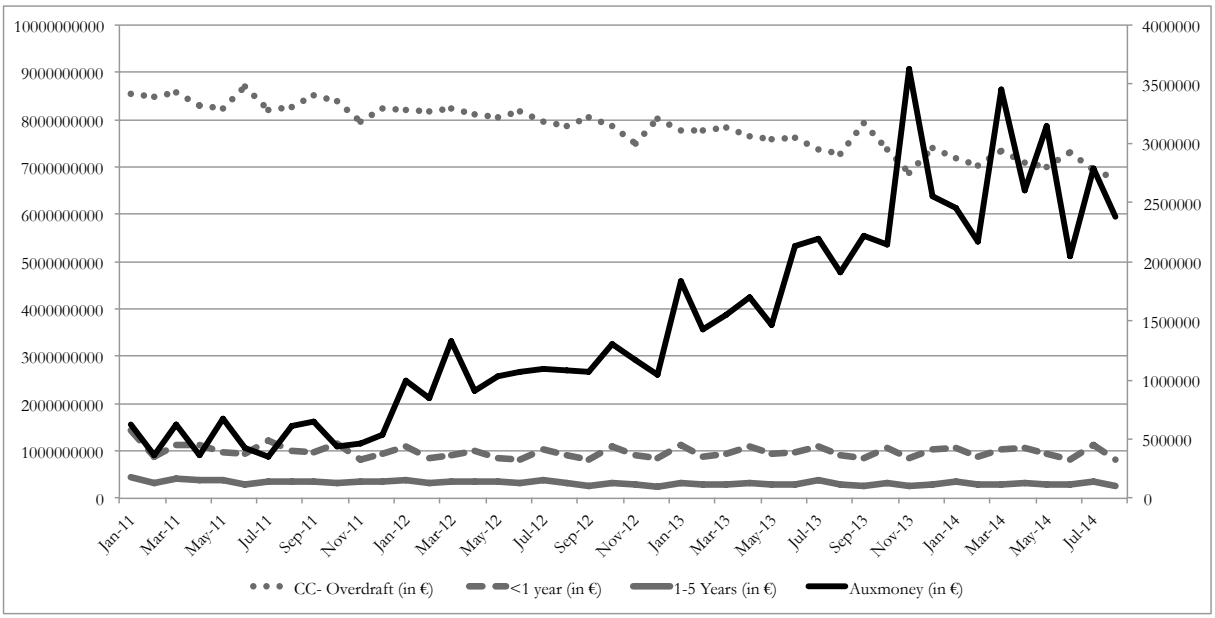

Figure 1: Provision of non-construction consumer loans by maturity structure. Auxmoney represents credit provided through the Auxmoney credit platform, CC-Overdraft represents credit provision through credit cards and overdraft in the banks in our sample, ¡1 year represents credit provision with a maturity below one year in our sample, 1 to 5 years represents credit provision with a maturity between one and five years in our sample. Source: Research Data and Service Center (RDSC) of the Deutsche Bundesbank and Auxmoney, sample period January 2011 to August 2014.

Figure 1 shows and compares the amount of P2P loans with the amount of bank loans. It shows that while bank lending either remains constant or follows a downward trend, P2P lending follows a clear upward trend. On the other hand, P2P lending volume is largely volatile, indicating that we have a far from established market.

Since we use data across different German states, we also verify whether the consumer credit loans are proportionally distributed in each state. If credit provision had been concentrated in one or only a few specific regions, our analysis would have been biased. Figure 2 shows the geographical distribution of credit provision among German states for both the banking sector and P2P lending. Each individual dark bar represents the share of bank credit provided in a specific state in relation to the total amount of bank credit provided in all states (in our sample of banks). Similarly, each single light-colored bar represents the share of P2P credit provided in a specific state in relation to the total amount of P2P credit provided in all states. Although the amount of credit is unevenly distributed among states, Figure 2 shows that bank and P2P loans are proportionally distributed among themselves and across states. To conclude, Figure 2 shows that for some states (Brandenburg, Saarland and Thuringia) there is no information on Sparkassen credit. Those three states are therefore excluded from our sample.

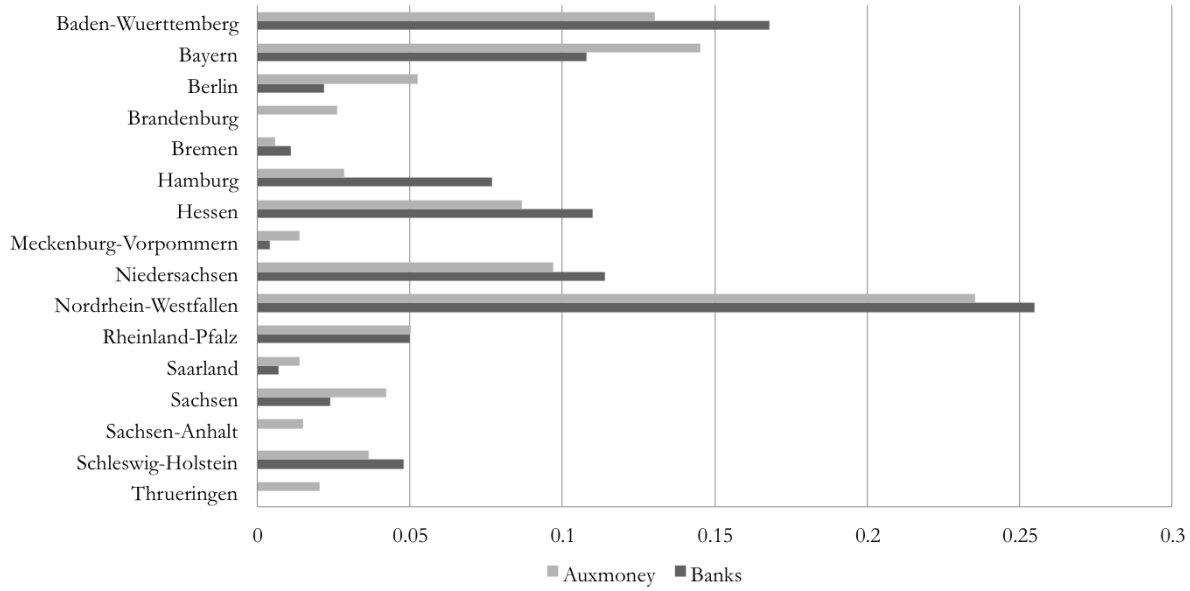

Figure 2: Share of credit provision by state in our sample. Source: Research Data and Service Center (RDSC) of the Deutsche Bundesbank and Auxmoney, sample period January 2011 to August 2014.

In our analysis we also investigate the interest in borrowing and lending via web-based platforms. The Google hits on credit-specific keywords (namely, "Finanzierung" (funding), "Kredit" (loan), "Auxmoney" and "Schufa") are collected and pooled together for each German state for the period January 2011 to August 2014. Google Trends provides a monthly or weekly time series of the volumes of Google hits for each selected keyword. Therefore, in order to have comparable volumes at each point in time, we aggregate the weekly time series to the month resolution. By default, for each time series, Google Trends normalizes the volumes to their highest value, which is set equal to 100, and all the other values are related to it with a precision of one. This normalization allows for comparisons of time series within the same German state but not across them. The results of our analysis are shown in Table 3. Note that the summary statistics are based on 12 German states instead of 16. Brandenburg, Bremen, Saarland and Thuringia are excluded because the volumes of the Google searches, although pooled at the state level, are negligible and do not display enough variation.

	Google Trends		
	Finanzierung	Kredit	Auxmoney
mean	67.42	61.26	32.84
sd	9.3	7.76	27.5
min	39.5	0	0
p25	61.45	61.45	32
p50	67.4	61.5	35
p75	74	66.45	51.5
max	90.75	82.4	100
# obs	440	484	440

Table 3: Descriptive statistics for Google Trends for the words *Finanzierung*, *Kredit* and *Auxmoney* downloaded on October 16, 2014. Google Trend data is normalized to 100 to the highest value. Source: Research Data and Service Center (RDSC) of the Deutsche Bundesbank and Auxmoney, sample period January 2011 until August 2014.

3 Interest Rates and Loan Riskiness

In this paper we investigate first whether the interest rates charged for P2P lending are higher than those charged by banks and, in particular, we investigate how different the riskiness of P2P loans are.

Table 4 shows the interest rates applied to new loans by banks and P2P during the period January 2011 to August 2014.

	Banks			Auxmoney
	i^o	i^z	i^m	i^{P2P}
mean	11.18	2.99	4.59	12.75
sd	1.08	0.98	0.84	0.83
min	8.72	1.23	2.01	10.33
p25	10.37	2.35	3.98	12.2
p50	11.3	2.83	4.56	12.75
p75	12.01	3.33	5.08	13.36
max	13.2	8.13	6.75	14.47
# obs	572	572	572	397

Table 4: Banks' and Auxmoney interest rates, i, (in %) by month and state, where the index o stands for overdraft and credit card, z stands for $[0,1]y$ loans, and m stands for $]1,5]y$ loans. Source: Research Data and Service Center (RDSC) of the Deutsche Bundesbank and Auxmoney, sample period January 2011 to August 2014.

The average interest rates across banks and states are 11.18%, 2.99% and 4.59% for CC/OD, $[0,1]y$ loans and $]1,5]y$ loans, respectively. During the same period, the average interest rate applied for P2P loans is 12.75%.

As one would expect, on average, overdraft interest rates are higher than the other interest rates. In particular, the spread between the average interest rate on CC/OD and the average interest rate on $[0, 1]y$ loans is due to (1) the cost of liquidity provision which is provided "on demand" for CC/OD; (2) differences in the borrowers' risk profile. The comparison between the interest rates charged by banks and by P2P lending indicates that P2P lending is characterized by an interest rate that is higher than that charged by banks. The products closely similar to P2P loans are the CC/OD. However, we need to stress that P2P loans do not provide the same liquidity service provision as CC/OD, therefore, there should be other reasons why P2P lending is at nominal interest rates that are higher than the classical bank loans.

To investigate this issue, we look at the risk of the P2P loans versus that of bank loans. In fact, the interest rate gap between bank and P2P lending can be potentially explained by the existing different credit risk between bank and P2P borrowers. In order to quantify this spread, we measure the default probabilities of the borrowers by using the Schufa score data set for P2P borrowers and the loan loss provisions for bank borrowers. The Schufa score goes from zero to 1,000, and the higher the value the safer it is.

From the Schufa scores we proxy the default probabilities by using the transformation table provided by Korczak and Wilken (2010), see Table 11 in the Appendix. In this way we were able to carry out a match between the Schufa scores and loan default probability.

Unfortunately, although banks also have access to the Schufa scores of their clients, this information is kept confidential. Therefore, as a proxy for the default probabilities we use the loan loss provisions (π) defined as write–up and write–down over outstanding loans:

$$\pi_{s,t}^{b,i} = \frac{writeupdown_{s,t}^{b,i}}{outstanding_{s,t}^{b,i}} \,, \tag{1}$$

where $i \in \{o, z, m\}$. Whenever banks expect a loan become non-performing (normally, when it is 90 days past due), banks take the precaution of writing them down from their balance sheet and creating a provision which is set aside as an allowance. Similarly, a loan can be written up if it was expected to default but was paid in the end. In the BISTA of the Deutsche Bundesbank, loans are written up/down in full regardless of their recovery rate; see e.g., Memmel, Gündüz, and Raupach (2015).

By using this formula we are able to extract the implicit default probabilities of bank loans as well. The results are summarized in Table 5, which reports the credit risks of bank and P2P loans in terms of the borrowers' default probabilities.

	Banks			Auxmoney
	π^o	π^z	π^m	π^{P2P}
mean	0.12	0.14	0.05	7.27
sd	0.12	0.23	0.33	3
min	-0.11	-1.51	-2.82	0.88
p25	0.05	0.05	0.01	6.25
p50	0.1	0.12	0.03	6.25
p75	0.16	0.21	0.06	8.77
max	0.85	1.86	3.07	24.27
# obs	572	572	572	397

Table 5: Risk, default probability, π, (in %) by month and state, where the index o stands for overdraft and credit card, z stands for $[0,1]y$ loans, and m stands for $]1,5]y$ loans. Risk of Auxmoney clients derived from Schufa score and of banks' clients from loan loss provision llp. Schufa score transformation is reported in Table 11 in the Appendix. Source: Research Data and Service Center (RDSC) of the Deutsche Bundesbank and Auxmoney, sample period January 2011 to August 2014.

As Table 5 shows, during the period under analysis, on average, P2P borrowers exhibit a default probability of 7.27% far larger than the 0.12%, 0.14% and 0.05% for borrowers of CC/DD, $[0,1]y$ and $]1,5]y$ loans, respectively. This indicates that bank borrowers are very different from P2P borrowers. The former are largely less risky, indicating that banks are strictly rationing credit to risky borrowers.

The last question we investigate in this section is whether, by adjusting the interest rate by risk, we still observe a large difference in the interest rate charged by banks versus P2P lending.

Although not directly comparable, as they are derived from different metrics, the default probabilities in Table 5 are used to convert the interest rates in Table 4 into risk-adjusted interest rates as shown in Table 6. The risk-adjusted interest rate is calculated as:

$$1 + r = (1 - \pi) \times (1 + i) + \pi \times RR \,, \tag{2}$$

where r is the risk-adjusted interest rate, i is the risky rate, π is the probability of default that we proxy with the loan loss provision rate frequency and RR is the recovery rate.[4]

[4]RR is set equal to zero for P2P loans in order to match full write–down of banks in the balance sheet statistics.

	Banks			Auxmoney
	r^o	r^z	r^m	r^{P2P}
mean	11.05	2.85	4.54	4.55
sd	1.07	0.96	0.91	3.32
min	8.6	0.51	1.69	-14.55
p25	10.29	2.21	3.89	2.96
p50	11.18	2.64	4.54	5.19
p75	11.86	3.22	5.02	6.48
max	13.12	7.93	8.3	12.61
# obs	520	520	520	397

Table 6: Risk-adjusted interest rate, r, in (%), by month and state, where the index o stands for overdraft and credit card, z stands for $[0,1]y$ loans, and m stands for $]1,5]y$ loans. Source: own calculations.

Table 6 shows that when P2P lending interest rates are adjusted by risk, they are largely in line with those charged by banks for one- to five-year maturities, perfectly in line with the maturities of the P2P loans. This result, even if it comes from several approximations, indicates that P2P lenders apply interest rates that are largely in line with those applied by banks, and that the large difference stems from the fact that borrowers' characteristics are very different: the P2P platform lends to a group of borrowers that are very much rationed by banks because of the high risk.

4 Loan Volume and Interest Rate Elasticity

One of the purposes of this paper is at look to the P2P lending market from a macro-perspective. In this section we investigate, in a partial equilibrium framework, whether the sensitivity of the volume of loans to interest rates is similar to that of banks. We consider a reduced form model of consumer credit from P2P platforms that we then use in the estimation analysis below.

The partial equilibrium reduced form model we consider is the one where P2P credit provision K^{P2P} depends only on interest rate and risk (for a formal derivation, see Freixas and Rochet (2008)):

$$K^h = f\Big(i^h, \pi^h, e\Big), \tag{3}$$

where K^h are the loan volume for Auxmoney, i^h is the interest rate charged by the P2P platform, π^h is the risk profile of P2P's borrowers, and e is the market interest rate that represent the marginal cost of funding.

We investigate the relationship between loan volumes, interest rate, risk and marginal cost of funding by estimating Equation (3) with a panel regression expressed as:

$$\text{Log}[K^h_{s,t}] = \alpha_0 + \alpha_1 i^h_{s,t} + \alpha_2 \pi^h_{s,t} + \alpha_3 e_t + \alpha_4 \Gamma + u_{s,t} + \delta_s \tag{4}$$

where s denotes the state and t denotes the time. The dependent variable $\text{Log}[K^h_{s,t}]$ is

the log of the loan volume per state per month of Auxmoney when h corresponds to P2P and banks when h is equal to b. The other main regressors are the nominal interest rate charged and the default probability. The market interest rate that represents the funding margin cost is proxied with the one-month Euribor rate.

Furthermore, the equation includes a constant, a vector of control variables, state fixed effect and a random error term. We consider three control variables – inflation, GDP growth and unemployment – all by state.

The estimated coefficients with fixed effect and standard errors clustered by state are reported in Table 7.

	log(Volume)							
	P2P				Banks			
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
i_{t-1}	-0.2022***	-0.1919***			0.0497***	0.0476***		
	(0.043)	(0.0497)			(0.0113)	(0.0162)		
r_{t-1}			-0.2145***				0.0005***	
			(0.0461)				(0.0001)	
$i_{t-1} - e_{t-1}$				-0.0845*				0.0462***
				(0.0460)				(0.0109)
e_{t-1}				-0.7635***				0.0558***
				(0.0535)				(0.0135)
π_{t-1}	-0.0074	0.0005	-0.2501***	-0.0109	0.0370	0.0294	0.0922**	0.0343
	(0.0167)	(0.0204)	(0.0569)	(0.0141)	(0.0350)	(0.0347)	(0.0414)	(0.0340)
K_{t-1}	0.6293***	0.5658***	0.6317***	0.4256***	0.5413***	0.5576***	0.5413***	0.5188***
	(0.0287)	(0.0424)	(0.0285)	(0.0314)	(0.0583)	(0.0606)	(0.0583)	(0.0664)
State controls	No	Yes	No	No	No	Yes	No	No
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.6337	0.6716	0.6334	0.6729	0.9965	0.9972	0.9965	0.9970
State	11	9	11	11	13	11	13	13
# Obs	385	324	385	385	520	440	520	520
Autocorrelation	0.000	0.000	0.000	0.000	0.0279	0.002	0.028	0.027

Table 7: Comparison of P2P lending and banking sector. Panel data estimation with fixed effects and standard errors clustered by bank. Dependent variable: log of credit provision by Auxmoney. (***) represents significance at the 1% level, (**) at the 5% level, and (*) at the 10% level, standard errors in (), clustered by state. Model I has no state fixed effects, model II takes them into account. State controls include CPI, rent price index, GDP and employment. All explanatory variables are lagged. Risk measured in default probability. Autocorrelation gives the p-value for Wooldridge (2002, 2008) test for autocorrelation in panel data, where H_0 is autocorrelation.

Table 7 reports in the first four columns the results of Auxmoney loans. Column I considers no state control variables, and Column II includes instead state control variables like CPI, GDP growth and unemployment. In both specifications we see that the elasticity of volumes with respect to interest rates is negative and highly significant, indicating that an increase of the interest rates reduces the volume. This means that the volume is largely driven by the demand for loans: when interest rates are higher the demand for loans is lower. The coefficient is similar for both specifications, indicating that it is not largely driven by state economic conditions. We are also controlling for state fixed effect; therefore, our results are not driven by omitted variables related to the state characteristics like size or population.

The same analysis has been performed for banks. The results are reported in Columns V and VI. In this case the elasticity is positive and significant but the coefficient is largely lower than that for Auxmoney loans. This indicates that an increase in the interest rate increases the volume of loans. We could interpret this evidence that the loan supply is largely driving the bank market. On the other hand, we need to be very careful how we read this elasticity coefficient, since the period we consider is largely characterized by major monetary policy interventions to stimulate credit lending.

In Column III we report the estimation of the relationship between loan volume and both the risk-adjusted interest rate and loan risk. The results indicate that loan volume elasticity is driven by both these variables: an increase in the risk-free interest rate reduces the volume, but also loans that are more risky have lower volumes. This is perfectly in line with an equilibrium in which the adjusted interest rate responds to demand for loans; if the rate is too high, demand is lower. Instead, the risk indicates that when loans are too risky, the supply of loans declines in line with credit rationing.

By contrast, the results for banks are difficult to interpret. They are reported in Column VII. In this case the risk-adjusted interest rate is having a positive impact on loan volumes, but the coefficient is very low. Instead, risk is the main driver of the results and the coefficient is also positive and significant at the 5% level. Again, this indicates that loan volumes are largely driven by the supply side; and if we consider that the risk of bank loan is very low compared to Auxmoney loans, it is reasonable to argue that bank supply is driving equilibrium in the bank loan market.

Finally, we investigate the role of the pass-through interest rate effect generated by the changes in the ECB's policy interest rate. We consider the Euribor interest rate as the bank's marginal rate and investigate whether volumes are largely related to external factors, like the bank cost of funding, captured with the Euribor rate.

Column IV reports the results for Auxmoney and Column VIII for banks. The analysis shows that the marginal market interest rate plays a significant role for both Auxmoney loans and banks' loan volumes. In the first case, the reduction in the Euribor increases the volume, while for banks a reduction in the Euribor is related to a reduction of the volume of loans. Again, it is hard to identify whether this effect is supply- or demand-driven. In both cases the coefficient is larger than the spread rate charged by Auxmoney and banks (i-e); therefore, it is clear that market conditions strongly affect the issuance of new loans.

In all regression specifications we added an AR(1) process to avoid possible autocorrelation problems. Also, we run autocorrelation test as proposed by Wooldridge (2002, 2008) in all regressions. We find no evidence for autocorrelation at the 5% confidence interval.

The analysis we have performed so far is partial because it does not consider the impact of the loan volume of the banking sector on the loan volume of Auxmoney. To investigate this, we should include in our analysis the credit supply by the banking sector and Auxmoney.

5 Impact of the Credit Channel on P2P Loans

In this section we investigate the role of the competition in the volume of loans provided by both Auxmoney and the banks. Therefore, we extend Eq. (3) as follows:

$$K^{P2P} = f\Big(i^{P2P}, \pi^{P2P}, D^{P2P}; K^b, i^b, \pi^b\Big), \tag{5}$$

where K^b is the volume of credit provided by the banking sector, i^b is the interest rate applied by the banking sector, and π^b is the risk profile of banks' borrowers.

	log(Volume)			
	P2P		Banks	
	(I)	(II)	(III)	(IV)
i^{P2P}_{t-1}	-0.3435***	-0.4002***		
	(0.0659)	(0.0378)		
$i^{P2P}_{t-1} - i^b_{t-1}$	0.2957***	0.3772***		
	(0.0834)	(0.0418)		
π^{P2P}_{t-1}	-0.1507	0.1041		
	(0.2414)	(0.2985)		
$\pi^{P2P}_{t-1} - \pi^b_{t-1}$	0.1389	-0.1134		
	(0.2515)	(0.3010)		
K^{P2P}_{t-1}	0.2811**	0.1637*	-0.0064	0.0011
	(0.0920)	(0.0832)	(0.0077)	(0.0052)
i^b_{t-1}			0.0467***	0.0474***
			(0.0094)	(0.0098)
$i^b_{t-1} - i^{P2P}_{t-1}$			0.0029	0.0048
			(0.0043)	(0.0046)
π^b_{t-1}			0.0126	0.0056
			(0.0242)	(0.0224)
$\pi^b_{t-1} - \pi^{P2P}$			-0.0002	-0.0002
			(0.0005)	(0.0003)
K^b_{t-1}	-3.988***	-4.318***	0.5346***	0.6042***
	(0.6114)	(0.6781)	(0.0744)	(0.0531)
State controls	No	Yes	No	Yes
State FE	Yes	Yes	Yes	Yes
R^2	0.6789	0.7363	0.997	0.9976
State	11	9	11	9
# Obs	365	313	365	313
Autocorrelation	0.000	0.000	0.000	0.000

Table 8: Comparison of P2P lending against Reference Rate for the banking sector. Panel data estimation with fixed effects and standard errors clustered by bank. Dependent variable: log of credit provision by Auxmoney. (***) represents significance at the 1% level, (**) at the 5% level, and (*) at the 10% level, standard errors in (), clustered by state. Model I has no state fixed effects, model II takes them into account. State controls include CPI, rent price index, GDP and employment. All explanatory variables are lagged. Risk measured in default probability (%). Autocorrelation gives the p-value for Wooldridge (2002, 2008) test for autocorrelation in panel data, where H_0 is autocorrelation.

The first two columns of Table 8 show that P2P loan volumes are still largely related to the interest rate charged by Auxmoney, but they are also related to the difference to the interest rate charged by banks in that state. The larger the difference, the larger the volume. This indicates that the more different they are from the clients of the bank in

terms of riskiness (that is implicit in the interest rate, as we showed above) the larger is the volume of Auxmoney. On the other hand, if we look at the volume of loans already provided by banks, we find that Auxmoney is lending more where banks are lending less (after controlling for interest rates and riskiness). This is in line with what we have already observed cross-sectionally among states from Figure 1. This result indicates that P2P lending is servicing a slice of the consumer credit market neglected by banks characterized by high risk and small size. It is important to stress that Auxmoney is providing this service without extracting a significant return since the risk-adjusted interest rate is in line with that charged by banks. Nevertheless, Auxmoney does not have the cost of the branches that the banks have to face; therefore, it is implicitly earning the profit that derives from having lower fixed costs. Nevertheless, this indicates that there is no evidence of "predatory lending" in the P2P loan market in Germany.

Columns III and IV of Table 8 report the same analysis for banks. In this case, we still see that the elasticity of the loan volume to interest rate is not affected by the introduction of the new variables. The spread between the interest rate charged by banks and that of Auxmoney is not relevant. Instead, the results confirm that the loan volumes of P2P are larger where bank loan volumes are relatively lower. This again indicates that P2P responds (very partially and for a limited amount) to the credit provision left unsupplied by banks.

The last analysis we perform in the next section concerns the general interest of borrowers and lenders in new forms of internet-driven direct credit supply.

6 P2P Loans and the Digital Economy

In this section we investigate the role of the "novelty" factor and interest in new forms of lending and borrowing shown by investors and borrowers. We extend Eq. (3) as follows:

$$K^{P2P} = f\Big(i^{P2P}, \pi^{P2P}, K^b, i^b, \pi^b, D^{P2P};\Big), \tag{6}$$

where D^{P2P} is an "innovation factor" variable that aims at capturing the general interest of borrowers in new forms of internet-driven direct credit supply. Historically, in off-line markets, borrowers used to collect funds indirectly from lenders via brick and mortar banks.

Currently, in the internet age, alternative solutions like P2P lending platforms leverage advanced technology and data analytics to directly match borrowers and lenders *only* via the internet; see e.g., Berger and Gleisner (2009). Thus, *ceteris paribus*, D^{P2P} captures the propensity towards web-based P2P credit solutions.

In order to capture this type of demand, we measure the frequency with which credit-specific keywords ("Finanzierung" (funding), "Kredit" (loan), "Auxmoney") are googled by the general public. For this purpose we use Google Trends, a web facility based on Google Search that shows how often a particular search term is entered in the search engine relative to the total search volume across various regions of the world, and in various languages.

The choice of the keywords is based on two criteria. First, the keywords should intuitively be related to the online consumer credit market. Second, the correlation among

the keywords' queries should be small. Statistics on the terms googled are reported in Table 3.

Table 3 shows that there is a significant variability among states and through time of the "hit" of the different words we have considered. This means that the interest is not the same on this regards.

We also investigate the correlation among the "hits" of these variables. Table 9 presents the correlation among the Google variables.

	Finanzierung	Kredit	Auxmoney
Finanzierung	1		
Kredit	0.306	1	
Auxmoney	0.26	0.258	1

Table 9: Correlation Google Trend variables.

Table 9 shows that the correlation among the four keywords is indeed very low. This means that we were able to include these variables in our analysis. It is very difficult to indicate whether the hits for these words are highly related to investors or borrowers. However, we could expect that the word "Finanzierung" (funding) refers more to investors and "Kredit" (loan), to borrowers' interest. The word "Auxmoney", on the other hand, could be referred to the interest of both investors and borrowers.

Table 10 indicates that the results regarding loan elasticity to interest rates and the substituting relationship between banks and Auxmoney loans are confirmed.

The Google trend variables we considered are only significant for loan volumes of Auxmoney and not for lending banks. This is in line with what we may expect: the majority of bank clients are not interested in finding bank loan opportunities on the internet (at least, so far). Instead, these variables are significant for Auxmoney loan volume. We find that the number of hits of the variable "Finanzierung" is significant and positively related to Auxmoney credit provision, which means that the interest for finding financing opportunities is related to larger volumes of Auxmoney loans. Instead the large amount of interest associated with the hits for "Kredit" are related to a smaller amount of loans. This result could be explained by the fact that when the number of people looking for credit grows larger, adverse selection problems arise.

The hits for "Auxmoney", on the other hand, do not lead to a larger volume of loans, indicating that there is no connection between the interest in these platforms and the actual providers of credit. However, we are aware that these are just proxy variables that capture several dimensions of the behaviors of investors and creditors.

	log(Volume)			
	P2P		Banks	
	(I)	(II)	(III)	(IV)
i_{t-1}^{P2P}	-0.3507***	-0.4102***		
	(0.0707)	(0.0367)		
$i_{t-1}^{P2P} - i_{t-1}^{b}$	0.3095***	0.3995***		
	(0.0844)	(0.0335)		
π_{t-1}^{P2P}	-0.1204	0.1561		
	(0.2283)	(0.2847)		
$\pi_{t-1}^{P2P} - \pi_{t-1}^{b}$	0.1045	-0.1693		
	(0.2381)	(0.2860)		
K_{t-1}^{P2P}	0.304***	0.1968**	-0.0056	0.0014
	(0.0934)	(0.0834)	(0.0076)	(0.0049)
i_{t-1}^{b}			0.0465***	0.0465***
			(0.0090)	(0.0095)
$i_{t-1}^{b} - i_{t-1}^{P2P}$			0.0028	0.0047
			(0.0043)	(0.0045)
π_{t-1}^{b}			0.0136	0.0056
			(0.0248)	(0.0220)
$\pi_{t-1}^{b} - \pi_{t-1}^{P2P}$			-0.0002	-0.0001
			(0.0005)	(0.0003)
K_{t-1}^{b}	-3.907***	-4.115***	0.5434***	0.6164***
	(0.788)	(0.6810)	(0.0801)	(0.0620)
Hits(Finanzierung)$_{t-1}$	1.434**	1.514**	0.0211	0.0755
	(0.5763)	(0.4877)	(0.0594)	(0.0581)
Hits(Kredit)$_{t-1}$	-1.7829**	-2.433***	0.0072	0.08769
	(0.6928)	(0.55854)	(0.0631)	(0.0503)
Hits(Auxmoney)$_{t-1}$	0.3487	-0.0055	0.0042	0.0121
	(0.2367)	(0.1083)	(0.0237)	(0.0244)
State Controls	No	Yes	No	Yes
State FE	Yes	Yes	Yes	Yes
R^2	0.6852	0.7435	0.997	0.9976
State	11	9	11	9
# Obs	365	313	365	313
Autocorrelation	0.000	0.000	0.000	0.000

Table 10: Comparison of P2P lending against Reference Rate for the banking sector and Google Search for Market Variables. Panel data estimation with fixed effects and standard errors clustered by bank. Dependent variable: log of credit provision by Auxmoney. (***) represents significance at the 1% level,(**) at the 5% level, and (*) at the 10% level, standard errors in (), clustered by state. Model I has no state fixed effects, model II takes them into account. State controls include CPI, rent price index, GDP and employment. All explanatory variables are lagged. Risk measured in default probability (%). Autocorrelation gives the p-value for Wooldridge (2002, 2008) test for autocorrelation in panel data, where H_0 is autocorrelation.

7 Conclusion

This paper studies the impact of a new competitor in the credit market. By empirically investigating several questions, we shed light on a new credit channel that financial innovations and technologies have allowed to rise. In the paper we highlight that Auxmoney, the largest P2P loan provider in Germany, is charging interest rates that are higher than those of banks, but that the borrowers are largely more risky that the banks' borrowers.

However, if we control for risk, the risk-adjusted interest rate is in line with the interest rate charged by banks for one- to five-year loans. Moreover, if we look at the distributions of loans of Auxmoney and their dynamics, we find that Auxmoney is lending relatively more where and when banks are lending less. Combining these two elements – riskiness and geographical distribution – we could conclude that Auxmoney is serving borrowers largely considered not "bankable" by banks, that is a segment of borrowers that banks are unwilling (or unable because of bank capital requirements, for example) to supply.

Information technology allowed a previously neglected segment of the consumer credit market to be served by market newcomers. This slice of the market is characterized by high-risk consumers and small credit lines.

The immediate question raised is why banks are not serving these costumers. If credit were like any other good, one would expect that if prices increase in line with risk there should still be actors willing to provide it. However, the institutionalization of credit provision for small loans may have adverse effects, as this paper describes. Even banks with a clear legal mandate to accept all customers (and therefore the lower cost of accessing a broad spectrum of retail costumers) are not willing to provide credit to this slice of the market.

There are several reasons for that behavior. First, banks with a high default rate may incur reputation costs, which might impact negatively on other more profitable business areas. Second, high default rates force banks to increase their loss provisions and, with that, higher capital requirements. Third, the marginal costs of an extra loan provided by banks with brick and mortar branches are certainly higher when compared with the provision of loans through the internet. Thus, banks might be refusing to provide loans for which banks' profit is smaller than their costs, whereas these loans may still be profitable for P2P financial intermediation. Fourth, banks' lending procedures are very complex and paper intensive. P2P lending is faster and easy.

However, each of these reasons indicates that so far, regular financial institutions are still leaving part of the demand for credit unsupplied.

Appendix

Rating	Score	% of the pop.	Default prob.
A	672-1000	ca 20%	0.88%
B	569-671	ca 20%	1.85%
C	520-568	ca 10%	2.72%
D	466-519	ca 10%	3.69%
E	406-465	ca 10%	4.81%
F	336-405	ca 10%	6.25%
G	243-335	ca 10%	8.77%
H	175-242	ca 5%	12.95%
I	137-174	ca 2%	16.64%
K	112-136	ca 1%	19.78%
L	79-111	ca 1%	24.27%
M	0-78	ca 1%	37.83%

Table 11: Schufa scores for different credit qualities and equivalent default probability measures. The higher the score, the lower the default probability. Source: Korczak and Wilken (2010).

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