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Master Thesis Financial Economics

Peer-to-peer lending and regulatory arbitrage: evidence from Europe

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Abstract

This paper investigates the use of P2P lending platforms to circumvent tightening regulations on credit supply. The regulations were introduced in Estonia in March 2015 and apply to licensed credit providers. I find that borrowers lend more and default more often following the introduction of the regulations in Estonia. These findings suggest that borrowers circumvent the credit supply regulations by moving to P2P credit providers. This paper supports prior research that appoints regulatory arbitrage as a driver of the emergence of the P2P lending market. Additionally, the impact of stricter regulation of P2P platforms is studied by investigating the licensing of an Estonian P2P platform as a credit provider in March 2016. The licensing, and the corresponding introduction of the tightening credit regulations, led to a decrease in borrowing on the platform. Stricter regulation of the P2P credit market possibly counteracts circumvention of macroprudential measures on credit supply and enhance financial stability.

Keywords: P2P lending; macroprudential measures; loan-to-value cap; debt-to-income cap; household debt

Contents

1. Introduction

Around 2005 the first P2P lending platforms launched. They quickly gained popularity, and in 2019 the P2P lending market in Europe reached a total transaction value of EUR 2.730 billion (Statista.com). For traditional banks, these new credit providers are a potential threat. P2P platforms connect lenders and borrowers directly, and thereby leave banks and their intermediary roles on the sidelines.

Traditional banks are subject to increasing regulatory burdens. Among researchers, the common belief is that the rise of P2P platforms is, among other factors, driven by regulatory arbitrage (Buchak et al. (2017), De Roure et al. (2019), Braggion et al. (2019), Bertsch et al. (2016), and Tang (2019)). Regulators set capital requirements for banks and compel them to set caps on lending of their customers. P2P platforms are often not subjected to these regulations and thus benefit from almost no compliance costs.

The regulatory burden on banks started to increase severely after the financial crisis in 2008. Regulators all over the world introduced rules to keep the credit market in check. Limits mainly have been set on the maximum amount one can borrow. The same happened in Estonia in 2015. The national bank of Estonia, Eesti Pank, introduced a set of three tightening regulations on credit supply. It set a Loan-to-Value cap, a Debt Service-to-Income cap, and a maturity cap. These new regulations make it harder for borrowers in Estonia to get a loan from a bank. Borrowers could see P2P platforms are a solution for borrowers to still get the desired funding. If so, tighter regulations for traditional financial institutions lead to more traffic to P2P platforms. This paper investigates the introduction of this set of rules in Estonia in a *difference-in-differences* (DID) setting. The Estonian P2P platform Bondora is used to test whether the rise of P2P is due to regulatory arbitrage.[1] The corresponding research question is:

What is the effect of the tightening credit supply regulations on the use of P2P platforms?

The effect is tested on several fronts. First, and foremost, the increase in the use of P2P lending is tested. The use of P2P lending is expressed as the average amount borrowed. The findings indicate

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[1] More information on Bondora is given in section 4

the predicted increased use of P2P lending. The robustness check shows that the effect remains when credit supply is kept constant.

Then, I investigate the impact on loan- and borrower characteristics. The first finding is the increase in default rate on the P2P platform. That is caused by the introduction of a Debt Service-To-Income cap.[2] Since banks cannot accept a high Debt-to-Income ratio, high Debt-to-Income borrowers move to a P2P platform. A high DTI ratio is linked to high default rates (Emetker et al., 2014).

Another effect of the tightening credit regulations is a decrease in the verification of income and expenses of P2P borrowers. Verification is a tool for borrowers to qualify their creditworthiness. As borrowers default on their loans, they have no incentives to share information on their creditworthiness and use the verification tool less.

Then, tighter regulations are associated with longer loan duration for P2P loans. One of the regulations imposes a maximum loan duration for conventional credit providers, which increases loan duration on the unregulated P2P platforms.

To counter the circumvention of regulations by P2P platforms, regulators could include P2P platforms in regular legislation for credit providers. That leads to regulatory compliance throughout the entire credit market. In April 2016, one year after the introduction of the credit supply regulations in Estonia, Bondora was licensed as a credit provider. From then on, the same caps apply to loans from Bondora as to loans from traditional credit institutions. This paper finds that use of the P2P platform diminishes again after April 2016. That adds to the robustness of the main result since borrowers leave the P2P platform again when the regulatory arbitrage benefit disappears.

The data is retrieved from the Estonian P2P platform Bondora. That is the biggest P2P lending platform in Estonia and among the biggest globally. Loan data is publicly available on their website. The data set provides all necessary information on loans, such as interest rates, and borrowers, such as their credit rating. From this data, a panel data set is created. The *difference-in-difference* setting is used to test whether there is a statistically significant positive relation

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[2] A DSTI cap limits the total amount of loan repayments and interest payments to the gross income. Therefore, this cap has a similar effect as a DTI cap, that limits the total amount of loan repayments to the gross income.

between tightening credit supply regulations and the use of P2P lending. The treatment group Estonia is compared to the control group Spain. Spain forms a suitable control group since its economy and demographics are similar to those of Estonia. Besides, Bondora is also active in Spain, and during the treatment period, Spain did not introduce similar regulations. The robustness checks use the same setting, yet a different treatment in the second robustness check. The treatment becomes the licensing of Bondora as a credit provider and with that equal credit supply regulations.

This paper contributes to the literature on drivers of the emergence of the P2P lending market. Researchers in this area often compare P2P platforms to traditional credit providers, like banks. Buchak et al. (2016) appoint disruptive technology and regulatory arbitrage, as the key drivers. The effect of several tightening regulations for conventional banks is examined in prior literature. Most studies look at regulations that constrain the credit supply by traditional banks and the effect on P2P lending platforms.

This paper focuses on constraining regulations for credit demand and therefore, has a setting similar to the study of Braggion et al. (2019). They found that a cap on mortgage loans at traditional banks led to increased use of P2P platforms. This research has similar findings; the tightening regulations on credit supply lead to more traffic to the P2P platform. In extension to their study, this paper finds that the inclusion of the P2P platform in the regular credit provider regulations leads to a decrease in loan sizes. Overall, the inference of the literature on this topic is that P2P platforms benefit from the regulatory burden on traditional banks, whether this affects their credit supply or credit demand.

The results have relevant implications for two key stakeholders. First, the conventional credit providers, mainly banks, for whom the P2P platforms form direct competition. A better understanding of the emergence of P2P platforms makes them more resilient to the new competition.

The second stakeholders are regulators. Newcomers to the lending market, who allow circumvention of regulations, diminish the intended effects of the regulations. Besides, evidence shows that regulatory arbitrage is diminishing, when the P2P platforms fall under the same regulations as traditional credit providers. Therefore, policymakers should incorporate all financing sources when imposing new regulations and license P2P platforms to increase the

effectiveness of credit supply regulations. Regulating the P2P market enhances the stability of a financial system that is resilient to shocks and allows for sustainable economic growth.

The remainder of this paper is structured as follows. Section 2 gives a theoretical background, which discusses the relevant literature. Section 3 explains the implemented regulations and the hypotheses that stem from the literature and the implemented regulations. Section 4 provides the empirical design. The subsections of section 4 provide information on the data set, descriptive statistics, and methodological setting. Next, section 5 discusses the results. And lastly, section 6 concludes and gives potential lanes for further research.

2. **Theoretical Background**

2.1. Motivation borrowers P2P Lending

P2P lending platforms are a relatively new channel for lending, where investors directly lend money to borrowers. The exclusion of an intermediary reduces borrowing costs. (Carignani and Gemmo, 2007). Hence, Philippon (2016) and Morse (2015) argue that P2P lending increases the efficiency in the financial services industry. But to survive competition in the financial industry, there must be reasons for borrowers to choose for a P2P platform.

Several studies research the motivation for borrowers to use a P2P platform. Gibilaro and Mattarocci (2018), Milne and Parboteeah (2016), Buchak et al. (2018) say that P2P loans are used in addition to conventional loans. It is more difficult for borrowers with low income and little collateral to obtain the full desired loan at conventional credit providers. It is exactly this group of borrowers, that they find active on P2P platforms. Moenninghoff and Wieandt (2013) support the theory that P2P loans are a complement to traditional lending and mention the lack of conventional lenders to meet the increasing credit demand as the main reason for the use of P2P platforms. Bulyak (2016) partly agrees. On one hand, she argues that less creditworthy borrowers use P2P lending as a complement to refinance credit card. But on the other hand, she finds that creditworthy borrowers use P2P lending as a substitute. So according to Bulyak, the borrower's objective depends on the type of borrower.

2.2. Risks P2P Lending

Lenders on P2P platforms directly bear risks as there is no intermediary, such as a bank. The main risks for P2P lenders are liquidity risk, collection risk, and credit risk. The *liquidity risk* is the risk of not being able to withdraw from the investment without a loss. This risk is relevant for P2P platforms, as some platforms now offer a secondary market. Investors can sell their exposure before maturity to another investor on the secondary market. This option relieves investors from the obligation to hold the investment until maturity (Aveni et al., 2015), and thus reduces the liquidity risk.

Collection risk represents the risk that the P2P platform becomes insolvent. The past shows that previously failed platforms stop servicing their investors, and investors lose their entire principal (Aveni et al., 2015). Therefore, investors do well to investigate the platform and the probability of its bankruptcy.

Credit risk is the risk of a loss due to a borrower defaulting on the loan. Credit risk on P2P platforms is an extensively researched topic. Lin and Viswanathan (2009) find that the problem of adverse selection, as mentioned by Akerlof (1970), applies to P2P credit risk. The problem arises as follows. Suppose the platform offers all borrowers the same interest rate. In that case, mainly high-risk borrowers will apply for a loan. As a result, the average quality of the investments goes down for the investors.

2.3. Screening borrowers

To alleviate the adverse selection problem, investors on P2P platforms can screen their peers' creditworthiness themselves. The investor can assess the creditworthiness using data on the borrower, including his credit history. With the gained information about the borrower's creditworthiness, the investors choose the appropriate loans to invest in.

This non-expert screening, combined with the information abundance of P2P platforms, makes it a compelling test case for lending efficiency. Iyerklaff et al. (2016) report that these non-experts are about 45% more accurate in predicting default than the conventional credit scores. They find that the investors rely most on standard financial variables, despite the possibility to use soft and nonstandard information to screen creditworthiness on P2P platforms.

Among the standard financial variables, the debt-to-income ratio is one of the four key variables to screen creditworthiness. In a similar spirit, Klafft (2008) identifies debt-to-income as a primary determinant of interest rates on P2P-lending platforms. Likewise, Emekter et al. (2014) find that the debt-to-income ratio is one of the critical variables in determining loan default.

However, investors do not have to screen borrowers themselves. Many platforms offer an algorithm-generated credit rating of the borrowers. The platforms do not publish how they retrieve the credit ratings exactly, but they indicate the expected loss and the creditworthiness of borrowers. Hence, investors can use the rating to estimate credit risk.

There are conflicting findings of the relative creditworthiness of P2P borrowers. Many studies compare the creditworthiness of P2P borrowers and traditional bank borrowers. Buchak et al. (2017) report more creditworthy borrowers on the P2P platforms, while De Roure et al. (2019) argue the opposite. Relevant for this discussion is the change in borrowers' creditworthiness due to exogenous factors. Bertsch et al. (2016) find that the average creditworthiness of borrowers on a P2P platform increases due to the Federal Reserves (FED) raising trust in borrowers.

2.4. P2P Regulatory Arbitrage

P2P lending is relatively new, and most P2P platforms are much lighter regulated than traditional institutions. The light regulation creates space for regulatory arbitrage. Prior literature often appoints regulatory arbitrage as a driver of the success of P2P platforms in prior literature. (Buchak et al. (2017), De Roure et al. (2019), Braggion et al. (2019), Bertsch et al. (2016), and Tang (2019) find that P2P lending platforms benefit where traditional banks face regulatory and capital constraints. All studies differ in scope regarding the regulatory change, country, and time.

Most studies examine regulatory changes that affect the *credit supply* by traditional banks. De Roure et al. (2019) look at the increase in capital requirements for banks in Germany in 2011 and find that this decrease in credit supply causes a shift to the P2P market. Tang (2019) examines the introduction of FAS 166/167 in the United States in 2010. The FAS 166/167 had a negative effect on bank credit supply and a positive effect on P2P lending.

Buchak et al. (2017) also find that FinTech lending engages in regulatory arbitrage in the United States in the period of 2011 till 2015. They researched the effects of Basel III, which increased capital requirements for traditional banks, the passage of the Dodd-Frank Act, and the formation

of the Consumer Finance Protection Bureau, which both increased regulatory costs of mortgage lending for conventional banks. These regulations again affect credit supply.

Bertsch et al. (2016) studied a regulatory change affecting *credit demand*. They looked at the rise of the Federal Funds Rate by the FED in the United States in 2015. The FED signals confidence in the economy by the liftoff. The liftoff translated into an increase in credit demand, which was also measurable on P2P platforms. Braggion et al. (2019) also researched a regulatory change affecting credit demand. They studied the tightening of mortgage LTV caps in China in 2013. The regulation leads to more difficulties in getting a loan for borrowers, which causes a decrease in credit demand. But on P2P platforms the credit demand increased, as they were not subject to the regulations.

There is consensus in literature that tightening regulations lead to a shift to P2P platforms, but the inference is mainly drawn from studies on regulatory changes affecting the *credit supply* side. This paper contributes to the literature by examining the effect of a decrease in *credit demand* in Europe in 2015.

This paper is mostly in line with Braggion et al. (2019) in terms of regulatory change studied and methodology. Regarding the regulations, Braggion et al. (2019) study the isolated effect of the introduction of an LTV cap. This paper examines a more extensive set of implemented rules, of which an LTV cap is one. The set of regulations investigated in this paper affects non-mortgage loans as well. Therefore, the set of regulations have slightly different consequences on borrower behavior. More details about the Estonian regulatory changes are shared in the next section. Regarding the methodology, Braggion et al. (2019) test the use of P2P platforms by examining the number of loan applications and the average amount borrowed. Since Bondora only publishes data on successfully funded loans, this paper focuses on the effect on loan amount.

3. Regulatory Background

3.1. Regulatory Changes in Estonia 2015

In 2014 Eesti Pank, the central bank of Estonia, published a report on the requirements for the credit market. It says that in ten years' time, household debt doubled to 76 % of disposable income in 2014. More than half of the loans had a maturity of over 25 years. After the financial crisis of 2008, it was time to make some changes to keep the credit market in check and prevent repetition.

At the time, Estonia had not set any limits in the credit market. Banks used to set their own lending standards to minimize risks. As they are self-imposed, these standards are rather loose. The situation changed with the amendment to the Credit Changes institutions Act in May 2014. Eesti Pank was now allowed to establish requirements for the credit market.

Eesti Pank implemented a set of macroprudential measures to reduce risks in the credit supply market in March 2015. All credit institutions, including branches of foreign banks, in Estonia, need to abide by three limits. First, a *loan-to-value (LTV) cap* of 85% is implemented. This cap limits the amount of the loan as a ratio of the value of the purchased asset. In the case of a mortgage, this means the mortgage can maximum be 85% of the value of the house. Secondly, a *debt-service-to-income (DSTI) ratio cap* is placed at 50%, calculated as follows;

$$DSTI\ ratio = \frac{\sum_{i=1}^{n}(principal\ and\ interest\ payments)_i}{borrower's\ net\ income} \tag{1}$$

Debt service stands for the loan repayments plus the interest payments for the outstanding debt. *N* is all the credit agreements of the borrower, including the new loan. Therefore, this cap does not only affect mortgages loans but all of the borrowers' outstanding loans. Hence, the DSTI cap limits the total amount of loan repayments and interest payments to half of the gross income. Lastly, a *maximum of 30 years for loan maturity* is set. This rule simply gives the maximum amount of years the principal is due to be paid.

The overall aim of these tightening regulations is to reduce systemic risks related to lending. The effect of the LTV and DSTI ratio caps, in combination with maximum maturity, is twofold. Firstly, limiting the maximum loan amount increases the resilience of both borrowers and banks. The LTV cap limits the possible loss given default, while the DSTI cap limits the chance of default. Second, by declaring a maximum on the size of loans, the inflation is restrained. Hence, consumption changes are smoother during the entire cycle. Besides, the DSTI cap loan volumes stay in line with household incomes. All in all, the tightening regulations reduce the chances of a credit boom caused by excessive lending.

3.2. Regulations on Credit Supply in Spain

As reported by the European Systemic Risk Board (2020), Spain did not set any regulations regarding loans during the entire research period. The situation is similar to the Estonian situation before the changes; banks could set their own limits and rules. Banks set their own limits, such as

a DTI cap. However, these 'soft' limits are dependent on the borrower's characteristics. The bank determines the maximum amount upon every single case independently. Again, banks are not very strict with these self-imposed rules, since lending money is the revenue model of the bank.

3.3. Hypothesis Development

The literature review shows that P2P lending platforms benefit from regulatory constraints for traditional banks. That works as follows: The regulation restricts the maximum loan amount a borrower can get at a bank. Now suppose he wants to borrow more than this maximum amount. The borrower might search for alternative ways of financing the additional credit. A P2P platform could offer the solution to obtain the additional credit, and the borrower can breach the maximum loan amount.

This mechanism applies to the LTV and DSTI cap introduced in Estonia in 2015. When the borrower hits one of the limits at a bank, he can get the additional part on the platform. Therefore, I expect an increase in the amount borrowed on P2P lending platforms due to the shift to P2P platforms. This assumption is formulated in the following hypothesis:

H_1: The tightening credit supply regulations increase the loan amounts borrowed on P2P lending platforms.

An important note is that this event is an exogenous shock to P2P credit demand and not to P2P credit supply. This justifies the use of a difference-in-difference setting and provides a clear interpretation of the hypothesis. The following hypotheses are focused on the change in P2P borrower type and loan performance after the treatment. The hypotheses also discuss the response of lenders to the treatment. They choose loans to invest in and adapt risk exposure.

I expect that tightening credit supply regulations increase the default ratio of loans on P2P lending platforms. This idea stems from the introduction of the DSTI limit of 50% for regular bank loans. Banks can no longer meet borrowers with a high DSTI ratio fully in their demands. Therefore, mainly borrowers with a high DSTI ratio move to P2P platforms (Buchak et al., 2017). As Emekter et al. (2015) mention, borrowers with a high debt-to-income ratio are more likely to default on their loans. That leads to the second hypothesis:

H_2: The tightening credit supply regulations increase the default ratio of loans on the P2P lending platforms.

Next, I predict a decrease in the credit rating of P2P borrowers. Credit rating is a prediction of a borrower's ability to repay his loan and an implicit forecast of the borrower defaulting. As the second hypothesis assumes higher default rates on P2P platforms, credit ratings will decrease accordingly. This thesis is in line with the reasoning of Tang (2019). She argues that lower-quality borrowers particularly face more difficulty accessing bank credit and therefore migrate to P2P platforms. Finally, this results in a decrease in the creditworthiness on P2P platforms.

H₃: The tightening credit supply regulations decrease the credit rating of borrowers on P2P lending platforms.

Then, I expect an increase in the interest rate spread on P2P lending platforms. The interest rate spread is calculated by taking the annual interest rate that is accepted for a loan minus the Euribor rate at the time. The predicted decrease in creditworthiness causes a higher risk for lenders. Therefore, they want to be compensated for bearing higher risk and accept loans with high-interest rates. Hence, the interest rate spread will increase. Prior studies support this assumption. Buchak et al. (2017) found that low credit rating borrowers cause an increase in the interest rate charged. Duarte et al. (2012) also mention that less trustworthy borrowers pay higher interest rates. Therefore, the fourth hypothesis is:

H₄: The tightening credit supply regulations increase the interest rate spread on P2P lending platforms.

The fifth hypothesis is a decrease in the verification ratio after the tighter credit supply regulations. The verification ratio indicates the percentage of borrowers that have had their self-declared income and expenses verified by the platform. Verification is seen as a signaling tool for borrowers with a high credit rating to show their creditworthiness. Because of the influx of new borrowers with a lower credit rating, less borrowers are willing to use this signaling tool of verifying information. The corresponding hypothesis is:

H₅: The tightening credit supply regulations increase the verification ratio on P2P lending platforms.

The last hypothesis states an increase in the loan duration of P2P loans after the introduction of tighter regulations. One of the introduced restrictions for credit supply is a maximum loan

maturity. Therefore, borrowers who want a longer-term loan are no longer served by banks and possibly shift to P2P platforms for longer-term loans.

H₆: The tightening credit supply regulations increase the duration of loans on P2P lending platforms.

The assumption stresses the short-term effect. Over time lenders prefer loans with shorter maturity to mitigate the increased risk. That diminishes the increase in loan duration due to borrowers interested in longer-term loans.

4. Research Design

4.1. Data

The data set is retrieved from *Bondora.com*. Bondora is a P2P lending platform, founded in 2008 in Estonia. Finantsinspektsioon, the Estonian Financial Supervision Authority, licensed Bondora as a credit provider in March 2016. The platform is currently active in three European countries; Finland, Estonia, and Spain. Although the platform in Estonia has been in business since 2009, the launch in Spain and Finland was only in October 2013. In March 2020, the value of total issued loans was more than EUR 366M, invested by over 116,000 investors. The platform targets the general public, as shown by the use of animated characters, vibrant colors, and highly automated services for inexperienced investors.

The data on loans is publicly available on Bondora's website. The data set was retrieved on March 2, 2020. The original dataset has 140,346 loan applications from February 2009 till March 2020. The loan applications come from 69,003 individual borrowers. The data set contains only successful loan applications. The data set is rich in information, with 112 variables on loan and borrower characteristics.

Regarding the data transformation, I take the logarithm of the interest rate spread, the loan duration, and the monetary values, being loan amount and total income. This transformation gives normally distributed variables. Further, the variable *number of previous loans before loan* contains outliers and is winsorized at the 1% top and bottom level.

The sample I use for this research includes data on Estonia and Spain for the period of January 2013 – March 2016. The window runs from the start of the platform in Spain. The window ends a year after the introduction of the new regulations in Estonia. In March 2016, Bondora was granted

a Credit Provider license and from then the Estonian Financial Supervision Authority from regulates Bondora. As a result, from April 2016 Bondora has to adhere to the regulations discussed in this paper. Therefore, the window ends just before Bondora has to comply with the regulations.

Estonia is the treatment group because of the relatively stringent regulations and the data availability on Bondora. (11,092 observations on loan level for the period January 2013 - March 2016). Also, there are no macroprudential regulations on credit supply before 2015. At the time the Estonian banks could choose their own set of rules.

Spain serves well as control group. The same platform operates in Spain, and therefore loans are subject to the same procedures by the platform (such as determining interest rate). Also, there is enough data available on Bondora for this country. (4,495 observations on loan level for the period January 2013 - March 2016). Besides, Spain and Estonia are most comparable in terms of economy, such as GDP per capita (29.5 in Spain and 23.7% in Estonia), interest rates (2.37% in Spain and 2.51% in Estonia). They are also comparable in terms of demographics; borrowers have similar age (about 38 for both countries), employment (about 94% employed for both countries), and their DTI ratios (about 24% for both countries). In section 4.5 the comparison is further justified. Lastly, as mentioned before, Spain did not introduce any loan cap regulations and therefore is perfectly suitable as the control group.

The Organisation for Economic Co-operation and Development (OECD) publishes macroeconomic data for Estonia and Spain. Annual data is available for all the macroeconomic characteristics. That includes information on GDP, population, wages, unemployment, and debt-to-income. As the OECD reports its data in USD, the values are converted to EUR with the use of the annual exchange rates published by the OECD. This conversion to EUR allows the comparison to Bondora's data.

4.2. Descriptive Statistics

After removing observations that have missing values for one of the critical variables for this research 15,404 observations remain.[3] The average loan size during this period was EUR 2,393, and all loan sizes range from EUR 100 to EUR 10,630. An average interest rate of 31.93% is paid,

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[3] The critical values are loan amount, interest rate, debt-to-income ratio, credit score, verification type and loan duration

and the average duration of a loan is almost 3 years and 7 months. Borrowers default on 48.8% of the loans.

These loans are from 8,357 unique borrowers. Of these 5,343 are Estonian borrowers, and the other 3,013 are Spanish borrowers. There are more male borrowers (4,651) than female borrowers (3,553), although some borrowers did not define their gender (152). In line with the requirement to be over 18 years old, borrowers range from 19 years old to 75 years old, with an average age of almost 38 years old. The average debt-to-income ratio is around 24%. Nearly all borrowers are employed (94%), about 26% own a college degree, and 46% own a house. The average number of previous loans is 0.05, and the total amount of the earlier loans is 38.59 EUR. One can portray the average borrower on Bondora as a middle-aged man, who has a job, but no college degree.

To put the numbers in perspective, a few variables are compared to the countries' averages of Estonia and Spain in 2015. Starting with the average monthly income on Bondora (EUR 1,095), which is low compared to both Estonia's monthly income (EUR 1,953), and Spain's monthly income (EUR 3,341).[4] This difference adds an essential characteristic to our description of the average borrower; his income is below average. Remarkable is that the average interest rate charged on Bondora is 31.9%. That is way higher than the 12.8% average interest rate on the RenRenDai platform, as reported by Braggion et al. (2019). It is also higher than interest rates for credit card debt, which range from 13-19% according to Morse (2015). Households in Estonia in 2014 had an average of EUR 6,400 of total debt outstanding. In the same year, the average household debt outstanding in Spain was 45,100. On Bondora, the average loan size is EUR 2,393. This difference seems to indicate that most borrowers do not take their full loan with Bondora. But it could also be that Bondora attracts borrowers that lend less overall. For borrowers on Bondora, the average debt-to-income ratio for Bondora borrowers is 23.8%, while in 2015, the average DTI ratio in Estonia was 80.2%, and in Spain 119.1%. A potential explanation for this difference in the DTI ratio could be that borrowers use P2P loans additionally to conventional loans, as also found by several studies.[5]

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[4] Bondora does not state whether this is gross or net monthly income. For the sake of comparison gross monthly income is assumed. Hence, it is compared to the gross monthly incomes of the countries.

[5] Gibilaro and Mattarocci (2018), Milne and Parboteeah (2016), Buchak et al. (2018).

Not only the interest rate is lower on RenRenDai lower, but also the average loan duration (26.62 months on RenRenDai versus 43.50 on Bondora), and the default ratio are lower (1.3% on RenRenDai versus 48.8% on Bondora). The loans on RenRenDai and Bondora show pretty different characteristics, which one should keep in mind when making a comparison.

4.3. Empirical Framework

To test the hypotheses, I use the *difference-in-differences (DID) technique*. This technique aims to measure the differential effect of the treatment on the outcome variable. Therefore, the treatment group is compared to a control group. Simply put, what happened to the control group is what would have happened to the treatment group in the absence of the treatment.

The DID function is a panel method. For a panel data regression model, the data is placed in a matrix of individuals and time. The data thus involves measurements over time for the same individuals. The panel method gives a more accurate inference of the model parameters than other methods. The corresponding function is as follows:

$$y_{it} = \beta_0 + \beta_1(T_i \times P_t) + \beta_2 T_i + \beta_3 P_t + \epsilon_{it} \qquad (2)$$

The first part of equation (2), y_{it}, gives the value of the dependent variable for individual i and time t. The $\beta_j's$ represent the coefficients. T is an indicator variable that denotes the treatment assignment. P is an indicator variable that represents the post-treatment period. Hence, β_1 captures the DID effect. Lastly, ϵ_{it}, captures the residual that is not captured by the model. Fixed effects are added to control for variations over time and location. Next, the standard errors are adjusted for clustering to prevent *autocorrelation*.

The *treatment group* in this study is Estonia. The treatment is the introduction of tightening regulations on credit supply in March 2015. The *control group* is Spain, where no similar changes took place. After validating the use of the DID setting in section 4.5, the hypotheses can be tested. The first hypothesis is that the tightening credit supply regulations on credit supply have an increasing effect on the volume of P2P lending. To test this hypothesis, the effect on loan sizes is measured. By taking the natural logarithm of amount, the model measures the DID effect on a normally distributed loan amount. A balanced panel data set is used for this hypothesis, which means that all individuals have the same number of time-series observations. For the times a borrower did not borrow, the loan amount is equal to zero.

$$Amount_{it} = \beta_0 + \beta_1(Treatment_i \times Post_t) + \beta_2 Treatment_i + \beta_3 Post_t + Controls_{it} + \epsilon_{it} \qquad (3)$$

Equation (3) shows the regression to test the first hypothesis and is based on equation (2). The regression contains an indicator variable *Treatment*, where 1 indicates an Estonian loan, and 0 indicates a Spanish loan. Besides, the regression includes an indicator variable *Post*, where 1 indicates that a loan started in the period after implementation of regulations in Estonia, and 0 before the regulations were implemented. And also, the interaction effect between *Treatment* and *Post* is included. Hence, the expected sign of β_1 is positive, as the DID effect would raise the size of loan applications. *Controls_{it}* is a vector of several control variables. In line with Braggion et al. (2019), it includes country-specific controls, i.e. *GDP per capita, GDP growth rate, population growth rate, houseprice growth rate,* and *natural logarithm of GDP per capita*. Also, borrower controls are included; *age, number of previous loans before loan, use of loan.* The regression is run with month and country fixed effects. No borrower fixed effects are included, as the objective is to research credit demand. Therefore, credit demand should not be held constant, as pointed out by Braggion et al. (2019).

The second hypothesis is that the tightening credit supply regulations increase the default ratio on P2P lending platforms. The corresponding DID function here is;

$$Default_{it} = \beta_0 + \beta_1(Treatment_i \times Post_t) + \beta_2 Treatment_i + \beta_3 Post_t + Controls_{it} + \epsilon_{it} \qquad (4)$$

The dependent variable in equation (4) is an indicator variable, where 1 is the default of a given loan. The expected sign of the coefficient β_1 is positive, due to less creditworthy borrowers on the platform. The rest of the function is the same as explained for the previous function. The third hypothesis is the effect of the regulations on the credit rating of the P2P borrowers. This hypothesis is measured by the following DID function;

$$Credit\ rating_{it} = \beta_0 + \beta_1(Treatment_i \times Post_t) + \beta_2 Treatment_i + \beta_3 Post_t + Controls_{it} + \epsilon_{it} \qquad (5)$$

Credit rating in equation (5) denotes the average credit rating of borrowers, ceteris paribus. As the hypothesis states that the credit rating drops, the expected sign of the coefficient β_1 is negative. The fourth hypothesis is that the tightening of macroprudential policies increases the interest rate spread on P2P lending platforms. The DID function is as follows;

$$Interest\ Rate\ Spread_{it} = \beta_0 + \beta_1(Treatment_i \times Post_t) + \beta_2 Treatment_i + \beta_3 Post_t + Controls_{it} + \epsilon_{it} \quad (6)$$

Where the dependent variable denotes the natural logarithm of the annual interest rate charged on the Bondora loan minus the Euro Interbank Offered Rate. All other parts of equation (6) are equal to equation (3). The sign of the DID effect is expected to be positive due to an expected increase of interest rates charged after the introduction of new regulations. The fifth hypothesis states that the tightening regulations lead to higher verification of borrower's income and expenses;

$$Verification_{it} = \beta_0 + \beta_1(Treatment_i \times Post_t) + \beta_2 Treatment_i + \beta_3 Post_t + Controls_{it} + \epsilon_{it} \quad (7)$$

The dependent variable in equation (7) is an indicator variable, which takes a value of 1 for loans with the borrower's income and expenses verified, ceteris paribus. As the predicted DID effect is positive, the sign of the DID coefficient β_1 is predicted to be positive. The last hypothesis tested is the effect of the tightening regulations on the duration of loans;

$$Loan\ Duration_{it} = \beta_0 + \beta_1(Treatment_i \times Post_t) + \beta_2 Treatment_i + \beta_3 Post_t + Controls_{it} + \epsilon_{it} \quad (8)$$

Where the dependent variable states the natural logarithm of the duration of a loan in terms of months. All other things in equation (8) equal to equation (3). For this regression, the coefficient is again predicted positive, expressing a positive effect of the regulations on the average loan duration.

4.4. Robustness checks: constant credit supply and Bondora licensed as credit provider

Constant credit supply

The first robustness check considers whether the effect remains when keeping credit supply constant. In other words, I want to investigate whether borrowers, who increased lending, borrow more from the same lender than other borrowers. As such, I ensure that the increased use of P2P platforms is not due to increased supply. Examples of increased supply are P2P lending becomes a popular investment strategy in Estonia, or P2P lending simply grows faster in Estonia than in Spain. To observe isolated changes in P2P credit demand, the supply side curve must be fixed.

I use a strategy based on the within-firm estimator of Khwaja and Mian (2008) to construct this setting. They hold credit demand constant by including borrower × year fixed effects. Schnabl (2012), Chodorow-Reich (2014), and Braggion et al. (2019) adopt this strategy in later studies.

Only the latter research adjusted the strategy to hold not credit demand, but supply constant. That adjustment serves the objective of this study as well. The supply side curve stays constant by including county × year fixed effects in equation (3). As such, the robustness check addresses the empirical concern that changes in P2P lending might be due to changes in credit supply.

Bondora licensed as a credit provider in 2016

For the second robustness check, the treatment is changed. In 2015 Bondora had a different position than regular credit providers. They did not have to comply with the regulations introduced for conventional credit providers. When Bondora got licensed as a credit provider in April 2016, they did have to comply and lose the regulatory arbitrage opportunity. Borrowers can no longer circumvent the legislation by using Bondora.

This robustness check is performed on the main equation, equation (3). The treatment changes to the licensing of Bondora as a credit provider in April 2016. The rest of the equation is equal to equation (3). The hypothesis is that the results are opposite of the results of the original regression, i.e. the DID coefficient takes a reversed sign. That outcome confirms that P2P platforms benefit from regulatory arbitrage and contributes to the robustness of the original findings.

The magnitude of the DID estimate is expected to be larger than the DID estimate in the original setting. Because the incentive for borrowers to use P2P lending to circumvent regulations disappears. Then if they can choose between a bank and Bondora to borrow the maximum allowed loan size, the lowest costs probably play an essential role. Bondora clearly does not win the race of the lowest interest rate. Hence, borrowers prefer to take out their entire loan at a traditional credit provider.

Besides, borrowers potentially prefer a P2P platform because of its anonymity. But the credit provider license also obliges stricter customer identification. This obligation can harm the attractiveness of P2P lending and thus, amplify the DID effect. This robustness check has far-reaching consequences and is rather an extension of the primary research and should be interpreted with caution.

4.5. Comparison treatment & control group

In the pre-treatment period, a parallel trend must be present for the dependent variable between the treatment group and the control group. If this can be proven, the use of the DID method is

justifiable. The dependent variable loan amount is plotted around the date of the treatment for the treatment group and the control group to see if a parallel trend exists in the pre-treatment period. When the plot shows a similar trend before the treatment, it indicates that the groups are not substantially different from each other. Hence, the DID setting is appropriate to use.

For this study, the graph is plotted for 2014Q1 – 2016Q2 (Figure 1). The samples are the treated group and the control group, Estonia and Spain, respectively. The samples are normalized for GDP per capita in these countries to control for differences in resources between borrowers of the two groups.

Before the introduction of the tightening regulations in 2015Q1 the two samples follow a similar trend. After 2015Q1, the treated group increases until the end of the sample. The control group slightly grows until 2015Q3, though certainly not as strong as for the treated group. From then, the amount of the control group plummets and decreases relative to the treatment period, and this decrease persists until the end of the window.

The plot shows that borrowers in Estonia and Spain borrow similar amounts and follow the same trend before the introduction of tightening credit regulations in Estonia. After the introduction, Estonian borrowers increase the borrowing amount, especially when compared to the borrowers in the control group. The plot in Figure 1 confirms the use of the DID setting for this study.

5. Empirical Results and Analysis

5.1. Pearson Correlation Matrix

Table 3 presents the Pearson Correlation Matrix. The matrix gives an overview of the correlation between variables. A high correlation between two variables means that including both variables in the model has little added value. They would explain the same effect on the dependent variable. The stars provide the statistical significance of the values at the 1% level. In general, a correlation coefficient above 0.7 is a candidate for omission (Ratner, 2009). Therefore, all the absolute values over 0.7 are bordered to help the reader focus on the strong correlation.

The highly correlated variable sets are *wage growth and GDP per capita, country DTI ratio and population growth, unemployment rate and GDP per capita, unemployment rate and country DTI ratio, house price growth and population growth, house price growth and country DTI ratio, and house price growth and unemployment rate.* Remarkably, the variables showing correlation are all

country-specific variables. That is not surprising since it is plausible that these values are related to each other. For instance, with an increase in prosperity, both wages and GDP are likely to increase.

Some of the mentioned variables can be omitted, including all variables would have little added value. I choose to leave *wage growth* and *unemployment rate* out as control variables for macroeconomic characteristics. With this selection, I kick out redundant variables but keep enough variables to control for macroeconomic characteristics.

5.2. Panel regressions

Tables 4 and 5 show the regression coefficients for the panel regression using the DID technique. Table 4 shows the effect of the introduction of tightening credit supply regulations in Estonia on the size of P2P loans. All columns measure this treatment effect on the natural logarithm of the average amount borrowed per month per borrower. All columns include country fixed effects. The columns (2-5) control for borrower characteristics (*age, number of previous loans before,* and *use of loan*) and macroeconomic characteristics (*GDP per capita, GDP growth rate, population growth rate, average debt-to-income ratio, house price growth rate, natural logarithm of GDP per capita*). The Columns (3-5) include month fixed effects as well.

The treatment effect of the tighter regulations appears to have a statistically significant effect, at least at the 5% level, on the total loan amount per borrower per month for all the specifications. Specification (1), included as a benchmark, shows the effect without controlling for the borrower- and macroeconomic characteristics. In specification (2) and (3) the coefficient of *Treated × Post* tells us that the log-transformed total loan amount per borrower per month increases by 9.6% monthly due to the treatment, which means a 10.1% monthly increase when corrected for the log-transformation.[6] As this is a monthly effect, which takes place over 12 months, the overall increase is 121%.[7] With the average loan amount being 2,393 EUR, the treatment leads to an average annual increase in the borrowed amount of 2,900 EUR.

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[6] This is calculated by the exponentiation the 9.6% of log-transformed variable, which gives 10.1%.

[7] This is calculated by multiplying the monthly effect by the number of months in the researched period, which is 10.1% × 12 months = 121%.

In 2015 the average Estonian apartment of 70 square meters costs 72,240 EUR. The LTV cap restricts the maximum mortgage for such an apartment to 61,404 EUR, so the other 10,836 EUR now have to be funded alternatively. The average increase in P2P loan sizes accounts for 27% of the alternative funding portion.[8]

The findings also show economic relevance for the DSTI cap. The average annual income in Estonia in 2015 is 14,186 EUR. The DSTI cap states that no more than half of the yearly income may go to loan repayments and interest repayments. This means that the remaining 7,093 EUR cannot be used for loans at traditional credit providers. The estimated average increase in P2P loans, to 2,900 EUR, accounts for 41% of the income that cannot be used for traditional loan purposes. The findings are economically meaningful for both caps.

The effect for the *intensive-* and *extensive margins* are tested separately to find out whether new borrowers or existing borrowers drive the found estimate. These two subsamples are regressed on the same settings as specification (3) of the full sample. The intensive margin includes borrowers that are active (at least borrowed once) on Bondora both before and after the introduction of the tighter regulations. The extensive margin includes borrowers that are active on Bondora only before or after the introduction of the tighter regulations. Both margins show a significant increase in loan amounts due to the tighter regulations on credit supply. The estimate for the intensive margin is 0.15, and the estimate for the extensive margin is 0.094. The coefficient of the extensive margin is relatively closer to the DID coefficient of specifications (2) and (3). Therefore, the inflow of new borrowers after the treatment drives the effect of the main regression. In other words, the tightening credit regulations attract new borrowers to the P2P platform.

All in all, the tightening regulations on credit supply in Estonia increase traffic on P2P lending platforms. Hence, the findings confirm the relative increase for the treated group in Figure 1. The results suggest that the average amount borrowed on P2P platforms increases due to the regulatory burden the conventional credit providers face. The null hypothesis can be rejected, and the following holds:

H_1: The tightening credit supply regulations increase the loan amounts borrowed on P2P lending platforms.

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[8] This is calculated by dividing the increase of the P2P loan by the part of the mortgage that has to be funded alternatively; 2,393/ 10,836 = 27%

Next, Table 5 shows the effect of the treatment on loan- and borrower characteristics. These findings also provide insights into the lenders' responses. The effect of the regulations is tested on the default rate, credit rating, interest rate spread, verification rate, and loan duration in the regressions of Table 5.

All specifications of Table 5 include country- and month fixed effects and the same control variables as in Table 4. Specification (1) looks at the treatment effect on loan default. The tightening regulations increase the default rate of loans by 4.6 percentage points, significant at the 10% level. That means the average default rate on Bondora, which is as high as 48.8%, increases to 53.4%. Hence, relatively the default rate increases by 9.4%. That is much lower than the relative increase of 46% in the default rate on RenRenDai (Braggion et al., 2019), but the difference in initial default rates on the platforms (1.3% on RenRenDai and 48.8% on Bondora) explains the difference in the increases. With these results, the following hypothesis can be accepted:

H₂: The tightening credit supply regulations increase the default ratio of loans on the P2P lending platforms.

As borrowers default more on their loans, a lower average credit rating is expected. Specification (2) does show a negative effect of 2.5% of the treatment on the credit rating. But since the estimate is insignificant, the hypothesis cannot be accepted;

H₃: The tightening credit supply regulations decrease the credit rating of borrowers on P2P lending platforms.

As the default rate increases, so does the risk for lenders. More risk means a higher interest rate. And so is tested in specification (3). Again, a negative but insignificant effect is found. The fourth hypothesis is rejected;

H₄: The tightening credit supply regulations increase the interest rate spread on P2P lending platforms.

Given that the credit rating did not significantly change, it is not surprising that this hypothesis was rejected as well. Bondora does not share exactly how the loan pricing is determined, but credit rating is likely used as one of the components. Next, the effect of the treatment on the verification ratio was tested. Specification (4) gives a decrease of 17 percentage points in the verification ratio, significant at the 1% level. The economic meaning of this is a decrease in the verification rate from

52.2% to 35.2%. The relative decrease of 32.6% appears to be economically substantial. The hypothesis can thus be assumed;

H_5: *The tightening credit supply regulations increase the verification ratio on P2P lending platforms.*

The decrease in verification rate is due to the following. The verification option is seen as a signaling tool of creditworthiness by the borrowers. After the treatment borrowers with fewer resources and higher default rates show up on Bondora. They are less likely to verify their income and expenses as they do not want to signal their creditworthiness.

Loan maturity is one of the areas curtailed by the new regulations. Therefore, the last specification (5), measures the effect of the treatment on loan duration. A 5.9% increase in log-transformed loan duration is found, significant at the 10% level, which translates to a 6.1% increase in loan duration. The average loan duration on Bondora is 43.5 months, i.e., 3 years and 7.5 months. Due to the treatment, the average loan duration increases with 2.7 months to 46.2 months, i.e. 3 years and 10.2 months. The increased loan duration is not exceeding, or even coming close to, the imposed maturity maximum of 30 years, so the economic significance of the change is small. But it does indicate that for loans with a longer maturity, borrowers shift to a P2P platform. And so, the last hypothesis can be accepted;

H_6: *The tightening credit supply regulations increase the duration of loans on P2P lending platforms.*

Table 5 shows evidence that after the tightening regulations, borrowers default more, verify information less, and loan duration increases. For credit rating and interest rate spread, the estimates are insignificant, though one might expect these two factors to be strongly related to the others.

There are a few possible explanations for the deviation of the predicted results for credit rating and interest spread. One explanation could be a delay in the reaction of lenders. It may take some time to detect the increased default rates and respond accordingly. That would explain why the estimates only demonstrate the shift in borrower behavior.

Another explanation is the high volume of automated investing on Bondora. Many investors pursue a rather passive investment strategy on Bondora by using the *Go & Grow* service. This

service is the most popular one on the platform has more than 85,000 users. Bondora designed Go & Grow to make investing accessible to inexperienced investors. Bondora fully manages the investments for investors using the Go & Grow service. Investors do not have to investigate the loans themselves and are therefore unaware of the increased risk. Hence, they do not demand higher interest rates, do not prefer verified loans, and do not decrease loan duration to mitigate the increased risks.

If that is the case, this phenomenon also shows the lack of adaptive power of Bondora. The system that determines credit rating and interest rate did not adjust according to the higher default rate.

5.3. Robustness checks

Constant credit supply

To give more profound insights into the findings, the main regression on loan amount is run with county × year fixed effects. This addition keeps credit supply constant. In Table 6, specification (1) – (3) run the regression on the full sample, specification (4) on the intensive margin, and specification (5) on the extensive margin. The other settings are the same as in Table 4.

From specification (1) – (3) it appears that the estimate is positive and significant, at least at the 5% level. The estimate is between 9.1% and 9.9% when including control variables. Correcting the midpoint 9.5% for the log-transformation gives a 9.9% increase monthly and a 118% increase annually. That means the average borrower increases his borrowing by 2,843 EUR over a year due to the treatment.

Moreover, specification (4) and (5) test whether the results are driven by the extensive margin when keeping the credit supply constant. Both the margins show a significant positive estimate, 0.156 for the intensive margin, and 0.0970 for the extensive margin. The estimate of the extensive margin is closer to the estimates of the full sample, 0.091 in specification (2) and 0.099 in specification (3), than the estimate of the intensive margin. Thus, when including year country fixed effects, the results are still driven by in the inflow of new borrowers.

Hence, the inclusion of year × county fixed effects supports the main findings. The shift to P2P platforms due to tightening credit regulations for conventional credit providers is robust to keeping credit supply constant.

Bondora licensed as a credit provider in 2016

The second robustness check is of a different nature. The treatment is changed. In April 2016 Bondora was officially licensed as a credit provider. From then on, the P2P platform falls under the same regulations as other credit providers in Estonia. And so, the tightening credit supply regulations of 2015 also apply to Bondora from April 2016. Hence, for April 2016, I expect the opposite of the effect in the main regression on loan amount. Because from then on, the P2P loans are included in the credit regulations and can no longer be used to circumvent such regulations.

In Table 7, the *Treated × Post* variable represents the treatment effect of the licensing of Bondora as a credit provider. Besides the different treatment, the setting is identical to the setting of Table 4. All columns include country fixed effects, columns (2)-(5) include borrower and macroeconomic controls, and columns (3)-(5) include month fixed effects.

In the interpretation of these results, I make one essential assumption based on the main results. That is that from March 2015 there are borrowers active on Bondora to circumvent the credit regulations that were introduced at the time.

The effect of the licensing is statistically significant at the 1% level for all specifications. The regressions for the full sample in specifications (2) and (3) show a decrease of 32.7%. That translates to a 37% monthly decrease in loan amount due to the treatment. On an annual basis, this means a 444% decrease. That says that borrowers decrease their loans to -10.626 EUR, which is impossible, but possibly indicates that borrowers are leaving the platform.

The intensive margin of borrowers, who borrow both before and after the licensing, shows a decrease of 40.4%. The extensive margin of borrowers, who borrow only before or after the licensing, shows a decrease of 38.2%. Hence, the effect of the treatment seems to stem from both margins, but mostly the extensive margin. Put differently, on average borrowers reduced their loan sizes, and some borrowers stopped borrowing after the licensing.

These results are in line with the hypothesis that the licensing of Bondora, and the introduction of corresponding regulations, reduce the loan sizes on the P2P platform. The DSTI cap of 50% prescribes a maximum of principal and interest payments of all the loans the borrower has. Now that Bondora loans are included in the cap, borrowers have to decrease their loan sizes to comply.

As expected, the size of the effect is larger than in the original setting. That is because the benefit of regulatory arbitrage disappears and mandatory customer identification is introduced. Borrowers prefer to take the entire maximum amount they can borrow for an advantageous rate at a bank. And borrowers who chose P2P lending because of its anonymity leave the platform as well. Hence, the licensing comes with more causes of a negative effect. That explains the relatively large magnitude of the effect.

The findings for this robustness check indicate a symmetric effect. Therefore, the result of this robustness check supports the prior findings that the regulations set for credit providers influence P2P borrowing behavior. It confirms that regulatory arbitrage increases in P2P loan sizes because the effect is symmetric when the regulatory arbitrage disappears.

6. Conclusion

This paper studies regulatory arbitrage by P2P lending platforms. I investigate the introduction of a set of tightening credit supply regulations in Estonia in 2015. These regulations include an LTV, DSTI, and loan maturity cap. I use the P2P platform Bondora to test the effect of the regulations on P2P lending platforms. This platform has publicly available data sets on its loans and borrowers. Bondora is active in Estonia, Spain, and Finland. With this data set the research question is answered:

What is the effect of the tightening credit supply regulations on the use of P2P platforms?

I use a difference-in-difference setting to answer the research question, where activity on Bondora in Estonia and Spain are compared around the time of the tightening regulations in Estonia. The results show that the hypothesis is accepted; The tightening credit regulations increase the use of P2P platforms. The use of P2P platforms is measured in terms of the loan amount per borrower. This result is robust to shocks in credit supply.

Further, default rates on Bondora rise and verification rates drop. These findings indicate that borrowers have more difficulty meeting their loan obligations. Borrowers do not want to send bad signals to investors and hence use the verification tool less. Besides, the duration of loans increases. The longer duration could be explained by the regulations restricting the maximum maturity of the loans.

Credit rating and interest spread do not significantly change, albeit the increased risk of default. Either, it is due to the high volume of passive investing on the platform, the lenders are simply unaware of the higher risk exposure and therefore do not respond adequately. Or, there is a delay in lenders' response, and they did not yet change their investment choices.

I validate the findings of increased loan sizes by testing for the licensing of Bondora in April 2016. There is no more regulatory arbitrage opportunity from then, as Bondora falls under the same regulations. Therefore, borrowers can no longer use P2P lending for circumvention of regulations. The disappearance of this opportunity results in a decrease of P2P borrowing, and thus supports the main finding that P2P platforms benefit from regulatory arbitrage.

This research also has some key limitations. The first limitation is that the data of Bondora does not provide information on the lenders' loan portfolios. Including this information would give a richer characterization on the supply side of the effect. The second limitation is that the data is solely on provided loans. Information on all loan applications would provide more insights into the changing credit demand.

The findings of this study contribute to the existing literature in several ways. First, this research supports the theory that regulatory arbitrage is one of the drivers of P2P lending's success. This study looks at the credit demand side, whereas most other studies are examining regulatory arbitrage on the credit supply side. Besides, the setting for this research is European, where other studies on P2P platforms focus on the United States and Asia for research on P2P platforms.

Second, this paper adds a new aspect to research on regulatory arbitrage by P2P platforms. It examines the consequences of regulations for P2P platforms. It turns out that these regulations lead to a decrease in P2P lending and confirms that regulatory arbitrage was a motivation for borrowers to use a P2P platform. That is a valuable addition to the prior research, as it gives insight into the consequences of regulating and supervising P2P platforms more strictly.

The main take away is that the unregulated P2P lending affects the credit supply market. Policymakers should think about regulations and dealing with regulatory arbitrage. The findings of this study combined with the size of the P2P market, highlight the importance of policies for P2P lending platforms.

However, little is yet known about policies for P2P lending. This study briefly touched upon the implications of such regulations by studying the licensing of Bondora in April 2016. This research does not address the loss of benefits, such as serving competition for banks and serving the unbanked. Therefore, future research needs to be done into the forms and effects of policies for P2P platforms. Such research would help policymakers shape regulations for the yet largely unregulated market of P2P lending. New regulations possibly counteract circumvention of macroprudential measures and enhance a stable financial system.

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Table 1: Overview research on P2P regulatory arbitrage

Research	Credit supply / Credit demand	Regulation researched	Period	Country	Findings
De Roure et al. (2019)	Credit supply decrease	Capital requirements increased for banks	2011	Germany	Increase P2P lending
Tang (2019)	Credit supply decrease	FAS 166/167	2010	United States	Increase P2P lending
Buchak et al. (2017)	Credit supply decrease	Basel III, Dodd-Frank Act, formation Consumer Finance Protection Bureau	2011-2015	United States	Increase P2P lending
Bertsch et al. (2016)	Credit demand increase	Federal Funds Rate increase	2015	United States	Increase P2P lending
Braggion et al. (2019)	Credit demand decrease	Tightening of LTV caps	2013	China	Increase P2P lending

Table 2: Descriptive statistics

	(1)	(2)	(3)	(4)	(5)
VARIABLES	N	mean	sd	min	max
Panel A - Loan characteristics					
Amount	15,404	2,393	2,032	100	10,630
Interest	15,404	31.93	13.32	6	92.69
Interest rate spread	15,404	31.41	13.32	5.46	92.37
Loan duration	15,404	43.50	18.71	1	60
Verification	15,404	0.522	0.499	0	1
Default	15,404	0.488	0.500	0	1
Use of loan	15,404	3.651	2.797	0	8
Panel B - Borrower characteristics					
Total income	8,357	1,095	719.5	283	24,300
Age	8,357	37.58	11.23	19	75
Male	8,357	0.557	0.497	0	1
Debt-to-income ratio	8,357	23.79	15.40	0	72.88
Home owner	8,357	0.460	0.498	0	1
College	8,357	0.256	0.436	0	1
Employed	8,357	0.944	0.229	0	1
Number of previous loans before loan	8,357	0.0413	0.310	0	4
Amount of previous loans before loan	8,357	44.02	370.1	0	10,600

Table 3: Pearson Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Amount	1.000											
(2) Age	0.005*	1.000										
(3) Log(total income)	0.030*	0.112*	1.000									
(4) Number of previous loans before loan	0.051*	-0.012*	0.040*	1.000								
(5) DTI ratio (borrower)	0.036*	0.005*	-0.135*	0.139*	1.000							
(6) GDP per capita	0.678*	-0.009*	-0.029*	0.096*	0.029*	1.000						
(7) GDP growth	0.019*	0.003	0.003*	0.082*	0.016*	0.045*	1.000					
(8) Population growth	0.052*	0.005*	0.008*	0.143*	0.031*	0.110*	0.681*	1.000				
(9) Wage growth	-0.063*	0.041*	0.070*	0.157*	0.011	0.100*	0.969*	0.655*	1.000			
(10) DTI ratio (country)	-0.488*	0.004*	0.018*	-0.149*	-0.038*	-0.718*	-0.561*	-0.732*	-0.045*	1.000		
(11) Unemployment rate	-0.113*	0.095*	0.357*	-0.178*	-0.186*	-0.983*	0.127*	-0.108*	-0.066*	0.997*	1.000	
(12) House price growth	0.220*	-0.000	-0.007*	0.110*	0.026*	0.310*	0.685*	0.780*	-0.235*	-0.827*	-0.728*	1.000

* shows statistical significance at the 1* level

Table 4: Effect of the tightening regulations on P2P lending volume

This table reports the treatment effect of the tightening regulations on credit supply for credit institutions in Estonia in March 2015 on the use of P2P lending in Estonia ("Treated × Post"). The dependent variable for all columns is the natural logarithm of the total loan amount granted per borrower per month. Columns (2)-(5) control for borrower characteristics *(*age, *number of previous loans before loan, use of loan*)* and macroeconomic characteristics (*GDP per capita*, *GDP growth rate, population growth rate, annual wage growth rate, average debt-to-income ratio, house price growth rate, natural logarithm of GDP per capita*). All columns include country fixed effects and columns (3)-(5) include month fixed effects. The sample period is from Jan 2013 to April 2016. In column (1)-(3) the full sample is used, in column (4) the subsample of borrowers active both before and after the regulation change and in column (6) the subsample of borrowers active only before or after the regulation change is used. Observations are defined at the borrower-month level. The standard errors are in parentheses and clustered at the borrower level.

	Full sample			Intensive margin	Extensive margin
VARIABLES	(1)	(2)	(3)	(4)	(5)
Treated × Post	0.301***	0.096**	0.096**	0.152**	0.094*
	(0.028)	(0.044)	(0.044)	(0.069)	(0.055)
Controls	NO	YES	YES	YES	YES
Month FE	NO	NO	YES	YES	YES
Country FE	YES	YES	YES	YES	YES
Observations	15,490	15,490	15,490	4,021	11,469
R-squared	0.02	0.10	0.12	0.07	0.14

*** , ** , and * show statistical significance at the 1%, 5%, 10% level, respectively.

Table 5: Effect of the tightening regulations on loan and borrower characteristics

This table reports the treatment effect of the tightening regulations on credit supply for credit institutions in Estonia in March 2015 on P2P borrower characteristics in Estonia ("Treated × Post"). The dependent variable is the default indicator (column (1)), the borrower's credit score((2)), the natural logarithm of the interest rate spread of the loan ((3)), the verification indicator ((4)), and the natural logarithm of the duration of the loan in months ((5)). All columns control for the borrower- and macroeconomic characteristics (age, *number of previous loans before loan, GDP per capita, GDP growth rate, population growth rate, annual wage growth rate, average debt-to-income ratio, house price growth rate, logarithm of GDP per capita*) as control variables. All columns include country fixed effects and month fixed effects. The sample period is from Jan 2013 to April 2016. Observations are defined at the borrower-month level. The standard errors are in parentheses and clustered at the borrower level.

	Default	Credit Rating	Interest rate spread	Verification	Duration
VARIABLES	(1)	(2)	(3)	(4)	(5)
Treated × Post	0.048*	-0.025	-0.024	-0.17***	0.059*
	(0.026)	(0.082)	(0.022)	(0.024)	(0.033)
Controls	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES
Observations	15,490	15,487	15,490	15,490	15,490
R-squared	0.13	0.46	0.43	0.38	0.12

*** , ** , and * show statistical significance at the 1%, 5%, 10% level, respectively.

Table 6: Robustness Check: Effect of the tightening regulations on P2P lending volume, Constant Credit Supply

This table reports the treatment effect of the tightening regulations on credit supply for credit institutions in Estonia in March 2015 on the use of P2P lending in Estonia ("Treated × Post"). The dependent variable for all columns is the natural logarithm of the total loan amount granted per borrower per month. The credit supply curve is kept constant by including County × Year fixed effects in all specifications. The rest of the specifications of the regressions are identical to the specification of the regressions in Table 4. Observations are defined at the borrower-month level. The standard errors are in parentheses and clustered at the borrower level.

VARIABLES	Full sample			Intensive margin	Extensive margin
	(1)	(2)	(3)	(4)	(5)
Treated × Post	0.300***	0.091**	0.099**	0.156**	0.0970*
	(0.029)	(0.044)	(0.044)	(0.070)	(0.058)
Controls	NO	YES	YES	YES	YES
Month FE	NO	NO	YES	YES	YES
Country FE	YES	YES	YES	YES	YES
County × Year FE	YES	YES	YES	YES	YES
Observations	15,320	15,320	15,320	4,020	11,296
R-squared	0.04	0.11	0.13	0.10	0.15

*** , ** , and * show statistical significance at the 1%, 5%, 10% level, respectively

Table 7: Robustness Check: Effect of credit provider license for Bondora in 2016 on P2P lending volume

This table reports the treatment effect of the same tightening regulations on credit supply for Bondora in April 2016 on the amount borrowed in Estonia ("Treated × Post). The dependent variable for all columns is the natural logarithm of the total loan amount granted per borrower per month. Except for the different treatment, the regressions are identical to the regressions in Table 4. Observations are defined at the borrower-month level. The standard errors are in parentheses and clustered at the borrower level.

	Full sample			Intensive margin	Extensive margin
VARIABLES	(1)	(2)	(3)	(4)	(5)
Treated × Post	-0.309***	-0.327***	-0.327***	-0.404***	-0.382***
	(0.035)	(0.038)	(0.038)	(0.067)	(0.052)
Controls	NO	YES	YES	YES	YES
Month FE	NO	NO	YES	YES	YES
Country FE	YES	YES	YES	YES	YES
Observations	15,186	15,186	15,186	4,299	10,887
R-squared	0.04	0.07	0.08	0.05	0.10

*** , ** , and * show statistical significance at the 1%, 5%, 10% level, respectively.
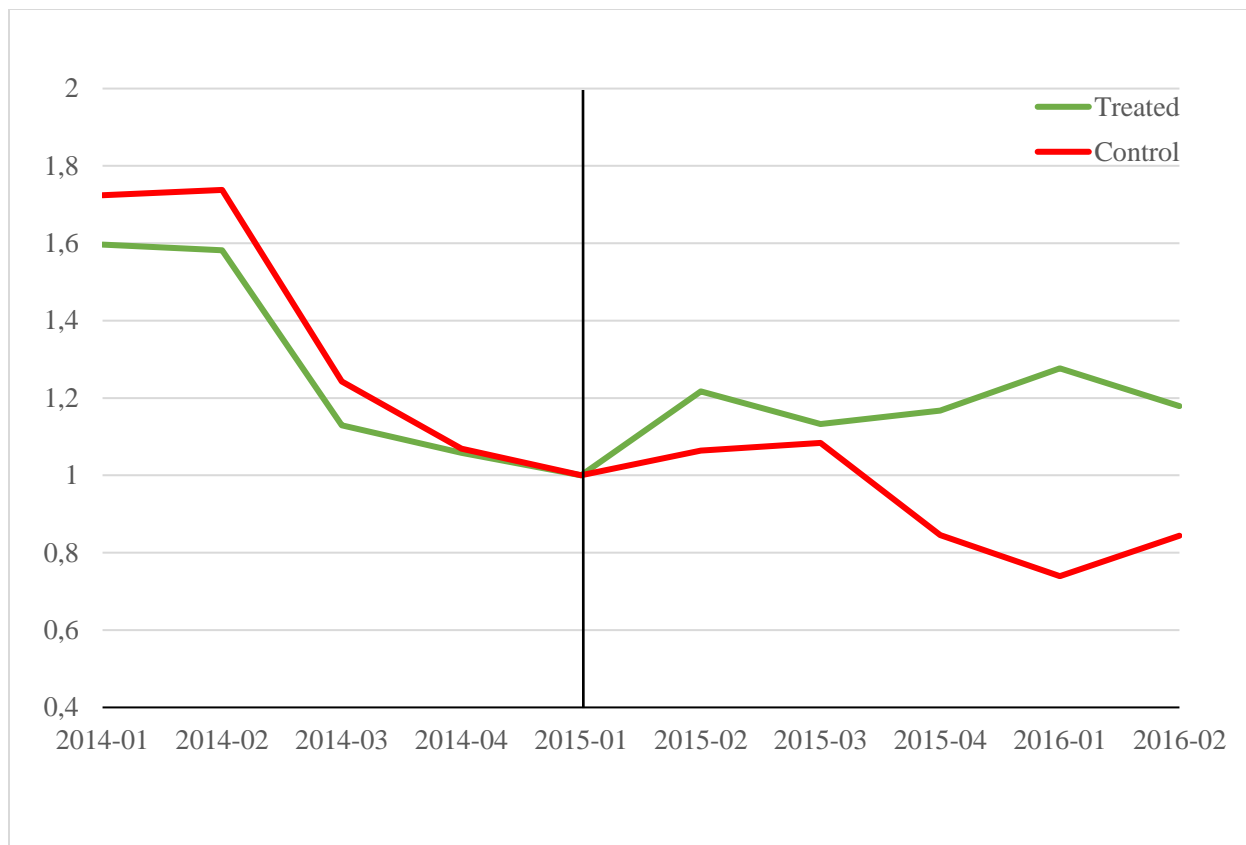
Figure 1: Total loan volume per borrower on Bondora around the introduction of tightening regulations on credit supply in 2015

The graph plots the total volume (EUR) of loans per borrower on Bondora on borrower-quarter-level, normalized for the country's GDP per capita. The average is taken across the treated country, Estonia, and the control country, Spain. The graph is normalized to 1 on the first quarter of 2015, the period of the introduction of the tightening regulations on credit supply for credit providers in Estonia. Hence, the vertical axis shows the change in loan volume relative to this date.

Appendix A: Variable definitions

Variable	Definition
Loan characteristics	
Loan amount	Amount the borrower received.
Loan duration	Current loan duration in months.
Verification	Indicator variable; 1 if income and expenses of borrower were verified by the platform.
Default	Indicator variable; 1 if loan was defaulted, and 0 otherwise.
Interest rate	Annual interest rate accepted for the loan.
Interest rate spread	Annual interest rate accepted for the loan minus the Euribor rate at the time.
Use of loan	Categorical variable; loan purpose as indicated by the borrower.
	(0 Loan consolidation 1 Real estate 2 Home improvement 3 Business 4 Education 5 Travel 6 Vehicle 7 Other 8 Health 101 Working capital financing 102 Purchase of machinery equipment 103 Renovation of real estate 104 Accounts receivable financing 105 Acquisition of means of transport 106 Construction finance 107 Acquisition of stocks 108 Acquisition of real estate 109 Guaranteeing obligation 110 Other business)
Borrower Characteristics	
Income	Borrower's total monthly income in euro's.
Age	The age of the borrower when signing the loan application.
Male	Indicator variable; 1 for male borrowers and 0 for female borrowers.

Debt-to-income ratio	Ratio of borrower's monthly gross income that goes toward paying loans.
Homeowner	Indicator variable; 1 if the borrower owns house and 0 otherwise.
Education	Indicator variable; 1 if the borrower has a college degree and 0 otherwise.
Employed	Indicator variable; 1 if the borrower is currently employed and 0 otherwise.
Credit rating	Bondora rating issued by their rating model.
Number of previous loans	Number of previous loans.
Amount of previous loans	Value of previous loans.