



Looking behind mortgage delinquencies



Sauro Mocetti*, Eliana Viviano¹

DG for Economics, Statistics and Research, address: Via Nazionale 91, 00184, Rome

ARTICLE INFO

Article history:

Received 14 January 2016

Accepted 2 November 2016

Available online 10 November 2016

JEL classification:

D12

E51

G01

G21

Keywords:

Mortgage delinquency

Income

Selection

Lending policies

ABSTRACT

Delinquency rates for mortgages originated before and after the financial crisis are examined using a novel and large panel obtained by merging data from tax records and credit registers. First, we estimate the selection into the mortgage market using an exogenous index of local credit supply as exclusion restriction. Second, controlling for selection we estimate the impact of income shocks on the delinquency rate. We find that since 2008 the selection process has led to the halving of the delinquency rate. Conditional on the creation of a new mortgage, job losses nearly double the delinquency risk; estimates uncorrected for selection are severely downward biased.

© 2016 Elsevier B.V. All rights reserved.

1. Introduction

As the U.S. subprime crisis has showed, even a small number of indebted households can produce a considerable turmoil if the sustainability of their debt is in question (Mayer et al., 2009). Thus, understanding and quantifying the determinants of financial difficulties is crucial not only at the microeconomic level, but also for the stability of the financial system.²

In spite of the relevance of the issue, the empirical evidence on the determinants of debt delinquencies is not as wide and it is disproportionately focused on the housing equity (i.e. the difference between the market value of the house and the outstanding

mortgage debt). The relevance of the housing equity channel, however, is lower in those countries (other than the US), where the institutional setting is less favorable to the strategic behavior of borrowers.³ This is a general feature of many European countries where debt-repayment history heavily affects access to credit in the future and the penalty for defaulting are higher. Duygan-Bump and Grant (2009) shows the effects of judicial and financial institutions on households' default behavior. Indeed, many commentators put emphasis on the deterioration of the quality of the pool of the borrowers as one of the main drivers of the increase in the delinquency rate in the 2000s. Moreover, large and widespread income fluctuations as the ones recorded after the Global Financial Crisis of 2008 are plausibly another important driver of financial difficulties of households.

In this regard we address the two following questions: how much do lending policies affect the household delinquency rate? And how much, given banks' selection, do labor shocks impact on the individual financial health? To the best of our knowledge, this is the first paper that tries to address the roles of both selection into indebtedness and income shocks in a unified framework and quantifies the impact of selection and of income shocks (corrected for selection) on the delinquency rate. Our analysis relies on a novel and large dataset obtained by merging data from

* Corresponding author.

E-mail address: sauro.mocetti@bancaditalia.it (S. Mocetti).

¹ We thank David Card, Francesco Manaresi, Paolo Sestito, seminar participants at the University of California, Berkeley and at the Bank of Italy, the participants at the Rimini Conference on Economics and Finance and the AIEL conference and two anonymous referees for very useful suggestions. Paolo Acciari and Elisabetta Manzoli provided excellent help in the construction of the dataset, making this research project possible. Sauro Mocetti is grateful to UC Berkeley's Center for Labor Economics for their generous hospitality during the research on this project. The views expressed in this paper are those of the authors alone and do not necessarily reflect those of the Bank of Italy.

² The microeconomic consequences include credit costs (since delinquent households will suffer worsened credit ratings and larger credit constraints in the future) and non-monetary costs associated with the stigma of default. From a macroeconomic point of view, troubles in the mortgage portfolio of a large bank may lead to a reduction in the domestic credit supply and propagate internationally through the funding markets (Aiyar, 2012).

³ Strategic behavior is commonly referred to the households' propensity to default on mortgages – even if they can afford to pay them – when the value of the mortgage exceeds the value of the house.

the Italian tax records (TR) with information on individual financial situation drawn from the credit register managed by the Bank of Italy (CR). The final merged dataset contains roughly 1 million individuals representing a random sample of the population born between 1950 and 1986 (around 1/30 of the Italian population in the same cohort). These individuals are followed yearly from 2005 to 2011. Thus, we are able to map out – from TR – the evolution of the individual economic conditions and to observe – from CR – those who originated a mortgage and their subsequent repayment behavior (the possible anomalies being past due, substandard loans and bad loans, which are interpretable in terms of increasing degrees of financial bad health).

From the empirical point of view we analyze, for different cohorts of mortgages, the determinants of household delinquencies after two years from the creation of the mortgage using a Heckman probit approach. This estimation strategy has two advantages. First, it allows us to examine the relationship between income changes and debt delinquencies while controlling for unobserved variables that are systematically related to the likelihood of originating a loan and to the subsequent repayment behavior. Second, the replication of the analysis for different cohorts of mortgages allows us directly assessing whether and to what extent selection matters and, more importantly, whether its role has changed across the years here considered which cover the period before and after the Global financial crisis.

To model selection we first derive a quantitative measure of the credit supply at the local level, following an approach which is in spirit very similar to the one proposed by [Greenstone et al., \(2015\)](#). Specifically, we estimate a bank-year fixed effect – interpreted as an indicator of the bank's lending policy in a given year – in a regression where overall household debt at the province-bank-year level is the dependent variable and province-year fixed effects are among the controls. The bank-year indicator of the credit supply is, by construction, nationwide and unrelated to local economic conditions. This indicator has been translated at the local level using the number of branches of each bank in each local credit market as weights. In the selection-corrected main equation we estimate the probability that a borrower faces a deterioration of her/his financial health as a function of the changes in labor income after the creation of the new mortgage.

We find that the probability of originating a mortgage is significantly correlated with the bank lending policies that were characterized, from 2008 onwards, by a remarkable tightening of the standards applied to the approval decision. This led to a weakening of the supply-driven effect in mortgage origination and a strengthening of the (positive) selection of borrowers, thus reducing the probability of delinquencies for more recent cohorts of mortgages. According to our estimates, because of the positive selection, the delinquency rate of the new borrowers has been roughly 50 per cent lower with respect to the rest of the population (i.e. 3.5 points lower with respect to a predicted probability slightly above 6 per cent). Before the crisis, on the contrary, the selection effect was not statistically significant from zero and negligible from an economic point of view. Conditional on selection, the exposure of individual financial health to the labor market shocks is sizeable: a 10 percent drop in earnings is associated to about 5 percent increase in the delinquency rate; in case of job loss the delinquency rate nearly doubles. The correction for sample selection leads to larger negative effects, suggesting that the selection-uncorrected estimates suffer from a severe attenuation bias (roughly one third of the true parameter).

All in all, our findings highlight the importance of a labor market perspective in examining mortgage origination and debt repayment behavior. Moreover, they provide some insights about the role of institutions and policy design. First, the selection mechanism underlying the creation of a new mortgage strongly affects

the quality of the pool of borrowers. Thus the regulatory framework may play a key role in avoiding an improper attenuation of the banks' screening policies.

Second, household financial difficulties are significantly and strongly related to adverse shocks in the labor market. On this respect, institutions – from unemployment insurance to credit market legislation – might mitigate the negative consequences of these shocks and have much wider effects (e.g. financial stability) than those traditionally thought.

Most of the existing empirical evidence – based on loans data – refers to the US mortgage market (e.g. [Deng et al., 2000](#); [Foote et al., 2008](#); [Haughwout et al., 2008](#); [Demyanyk and Van Hemert, 2011](#); [Bajari et al., 2013](#)) and focuses on the evolution of the housing equity. A general finding is that housing equity explains a large part of default behavior of households and that the sharp reversal in house price dynamics observed in the second half of the 2000s was a critical factor in the recent increase of default rates. The drawbacks of these studies are that they refer to a selected sample of the population (those who have a loan) and they have almost no information on the borrower (i.e. if any, they are collected only at the time of the creation of the new mortgage).⁴

A second group of studies – based on surveys – includes [Boheim and Taylor \(2000\)](#), [Fay et al. \(2002\)](#), [Diaz-Serrano \(2005\)](#), [Duygan-Bump and Grant \(2009\)](#), [Guiso et al. \(2013\)](#) and [Gerardi et al. \(2015\)](#). These studies exploit the availability of a richer set of information compared to loan data and (in some cases) explore also the consequences of “trigger events” inside households (such as episodes of unemployment or long-term sickness).⁵ These studies also document that proxies of employment status at the aggregate level (e.g. state or MSA) can lead to a severe attenuation bias that substantially understates the role of unemployment ([Gerardi et al., 2015](#)). However, surveys suffer for some limitations. First, the estimation of low-probability events (like household delinquency) requires sufficiently large sample that indeed are not available.⁶ Second, surveys do not collect data on repayment difficulties or mortgage arrears on a regular basis. Third, like any survey, the willingness of household to participate and/or to accurately answer to the questions may vary significantly with income and the financial situation itself, thus inducing potential severe biases in the estimates.⁷ Finally, the panel dimension of the survey is typically small, thus exacerbating some of the limitations discussed above. Beyond these drawbacks, none of the existing studies have

⁴ Some other papers address the repayment behavior for other types of loans like personal loans and credit cards ([Domowitz and Sartain, 1999](#); [Gross and Souleles, 2002](#); [Adams et al., 2009](#)), focusing on the role of borrowers' financial conditions, adverse selection and default costs.

⁵ [Fay et al. \(2002\)](#) use the Panel Study of Income Dynamics (PSID) and find evidence of the strategic behavior of the households (i.e. households are more likely to file for bankruptcy when their financial benefit is higher). [Guiso et al. \(2013\)](#) find that the strategic behavior is affected also by the social stigma associated with the default. [Diaz-Serrano \(2005\)](#), using the European Household Community Panel (ECHP), finds that income volatility is associated to a higher mortgage delinquency risk. [Duygan-Bump and Grant \(2009\)](#) present a descriptive analysis based again on the ECHP and find that household repayment behavior differs across European countries and that this is related to differences in institutions. [Gerardi et al. \(2015\)](#) use the PSID and find that individual unemployment is a strong predictor of default.

⁶ As [Fay et al. \(2002\)](#) and [Duygan-Bump and Grant \(2009\)](#) acknowledge, an important limitation of their studies is that they are based on a small number of bankruptcy filings and arrears, respectively.

⁷ One reason is that households tend to guard their financial privacy jealously. In [Fay et al. \(2002\)](#) the fraction of households that filed for bankruptcy in the PSID is less than half the national rate. [Duygan-Bump and Grant \(2009\)](#) recognize that in the ECHP arrears are self-reported and, likely, under-reported; the definition of arrears itself is vague, including a wide range of borrowers' behaviors, from bankruptcy to being only a few weeks behind on their payments. [Acciari et al. \(2014\)](#) find evidence of under-reporting in the delinquency rate in the Survey of Household Income and Wealth (SHIW) in Italy.

directly addressed the selection issue. A notable exception is [Mian and Sufi \(2009\)](#) who find more mortgages defaults in areas with a larger share of subprime borrowers, thus highlighting the role of the quality of the pool of borrowers. However, they look at aggregate data while we focus on individual heterogeneity.

Our paper is also related, though to a lesser extent, to the studies that address the strength of credit scoring models in predicting the individual default risk ([Boyes et al., 1989](#); [Jacobson and Roszbach, 2003](#)). Indeed, our results, which explicitly deal with selection, suggest that credit scoring models based on parameters' estimates on the pool of accepted applicants can be severely biased (i.e. their ability to predict the exposure to income risk can be overrated).

The remainder of the paper is organized as follows. In [Section 2](#) we describe the data. In [Section 3](#) we present the empirical strategy. Results and robustness checks are discussed in [Section 4](#). [Section 5](#) briefly concludes.

2. Data and descriptive evidence

We built a large and representative panel of Italian population of tax payers, merging confidential data from TR and CR. The dataset contains information for roughly 1 million individuals, randomly selected among those born between 1950 and 1986 and who filled tax record at least once from 2005 to 2011. Therefore, our sample includes all the employed people in this very large cohort, almost all the unemployed people (i.e. those who experience a transition from employment to unemployment and vice versa) and a fraction of inactive people – for instance, non-labor-income earners (e.g. pensions or rents) and youngsters before they enter the labor market. The sample is followed on a yearly base.

From TR we draw information on after-tax income by income sources and main demographic characteristics (age, gender, country of birth, city of residence, etc.). Income items reported on personal tax returns include salaries and pensions, self-employment and unincorporated business income, real estate income, and other smaller income items. Tax declaration covers capital income incompletely and excludes most capital gains.

The CR is managed by the Bank of Italy and collects data on the (residual) debt and debt repayment behavior from all banks and financial intermediaries operating in Italy. More precisely, CR records all debts of individuals, firms, and public entities above 75,000 euro until December 2008 and above 30,000 afterwards. We focus only on households and, for comparability, on debts larger than 75,000 euro that are mainly (but not necessarily) borrowed to buy a house and this is why we refer, for simplicity, to the mortgage market.⁸ The banks assign the credit “health status” to their clients and each other bank can access to individual data in order to evaluate individual credit risk. Banks have to report changes in debt and health status each month. Credit status, assigned according to official guidelines, can take the following values: “performing loan”; “past due”, “substandard loan” or “bad loan”. Bad loans (*sofferenze*) are loans which are deemed to be uncollectable on the basis of relevant circumstances; substandard loans (*incagli*) are loans with a well-defined weakness and the paying capacity of the borrower is not assured; finally, past due (*crediti scaduti*) are loans whose payments are past due by three months or more.⁹ The consequences of being registered as bad borrowers are severe, as individuals incur in the substantial risk of being excluded from the credit market. In this paper we observe the credit status at the end of each year.

Table 1
Descriptive statistics.

	Mean	St. dev.	25°	75°
<i>Individual variables:</i>				
% of individual with positive income	80.0	40.0	1	1
Income (thousands of euro)	17.3	23.4	9.2	21.5
% of employees	75.1	43.2	1	1
Age	40.0	10.2	32	48
% female	44.7	49.7	0	1
% foreign-born	16.3	36.9	0	1
% dependent children	31.6	46.5	0	1
% of individuals who originate a mortgage	10.6	30.8	0	0
Debt (thousands of euro)	140.5	120.7	95.8	156.7
% bad loans (new mortgages)	2.6	15.9	0	0
% substandard loans (new mortgages)	1.3	11.3	0	0
% past dues (new mortgages)	1.8	13.3	0	0
<i>Local variables:</i>				
Credit supply	0.9	0.4	0.7	1.2
House price (euro per sq. m.)	1683	976	1019	1976
Employment rate	45.7	7.3	39.4	51.5
Population density	1.3	1.9	0.2	1.7

Source: Individual variables are drawn from TR and CR; local variables are drawn from Bank of Italy (the credit supply indicator), OMI (house prices) and Istat (employment rate and population density).

Our dataset has also some drawbacks. First, we do not observe households but individuals. Therefore, when estimating the relationship between income changes and delinquency, we do not take into account the fact that the negative consequences of income losses for individuals might be compensated through intra-household redistribution of resources. This means that, if any, we underestimate the effects of income shocks. Second, from TR we do observe income, while we do not have information on wealth. However, since TR records real estate incomes we can partially control for real assets, which in Italy account for nearly two thirds of total wealth. Third, we do not observe the value of the house and we proxy it – as commonly done – with the average house price at the municipality level.¹⁰

Main descriptive statistics are reported in [Table 1](#). On average, about 80 percent of the sampled individuals fill the tax record with a positive income. Among those, three out of four are in paid employment (i.e. their main source of income comes from dependent employment), 11 and 5 percent are mainly self-employed and renters, respectively. The average after-tax income from labor (paid employment and self-employment income) is about 17,300 euro and the ratio between the interquartile range (the difference between the upper and the lower quartile) and the median is nearly 80 percent, thus suggesting a high heterogeneity in the earning distribution. The remaining 20 percent of the sample includes both unemployed and inactive individuals with zero income. Looking at the main socio-demographic characteristics, the average age is 40 years old. The fraction of female (45 percent) is, as expected, lower than that of males, due to their lower labor market participation. The fraction of foreign-born (16 percent) is higher than the national average, likely reflecting both the higher employment rate of foreigners and the exclusion in our sample of the more aged cohorts. Finally, 30 percent of the individuals have (at least) a dependent child.

In a longitudinal perspective, labor market conditions deteriorated from the financial crisis on, likely weakening the housing demand. The employment rate in our sample (i.e. individuals with strictly positive labor income over population) decreased by one

⁸ In Italy mortgages represent a sizeable part of the credit market, around two thirds of the total loans to the households.

⁹ See [Acciari et al. \(2014\)](#) for more details on the data and for a descriptive analysis on the mortgage market in Italy.

¹⁰ Other than house prices, the dataset has been enriched with other variables capturing local socio-economic conditions, such as the population density in the municipality where the individual resides, and the employment rate in the local labor market (LLM) where the individual lives and work.

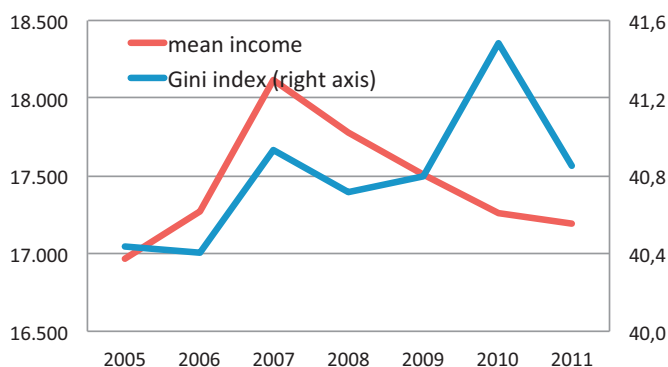


Fig. 1. Income trend, We consider only individual with strictly positive labor income and in the age-bracket 25–54.

Source: authors' elaborations on data from TR and CR.

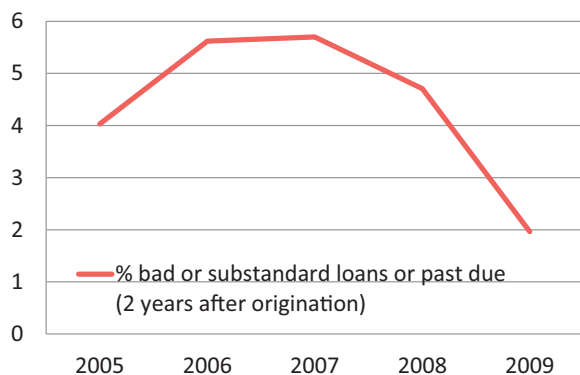


Fig. 2. Mortgage delinquency rate, Delinquency rates for different cohorts of mortgages (years in the x-axis refer to origination).

Source: authors' elaboration on data from CR.

percentage point from the period 2005–2007 (3 years before the crisis) to 2008–2010 (3 years during the crisis). Looking at employment transitions, 73 percent of non-employed individuals remain in the same status in the next year while 7 of the employed become non-employed; the corresponding figures before the crisis were 71 and 6 percent, respectively. Among employed individuals, mean earnings experienced a drop of nearly 5 percent with respect to 2007 in real terms (Fig. 1); moreover, the decrease in labor income has been accompanied by an increase in the dispersion of earnings.

Looking at the debt variables, one tenth of the individuals originated a mortgage between 2005 and 2011. The average (residual) debt for new debtors is 140,000 euro. Among them, the fraction of individuals recording a bad loan, a substandard loan or a past due are, respectively, 2.6, 1.3 and 1.9 percent; relatively to overall population the same figures are 0.4, 0.1 and 0.2 percent. Thus, mortgage household delinquencies are extremely rare events, though they may have large economic consequences.

Taking again a longitudinal perspective, there has been a substantial improvement in the delinquency rates of mortgages originated from 2008 onwards (Fig. 2). Namely, less than 2 percent of mortgages originated in 2009 recorded a delinquency within the next two years while the corresponding figures for mortgages originated before the financial crisis were well above 5 percent.

In Table 2 we report a descriptive assessment about who are the individuals recording (to a greater or lesser extent) financial anomalies. The results are purely descriptive because we are not considering sample selection (we observe delinquencies only for those who originated a mortgage) and we are omitting important variables that may affect individual financial repayment behavior,

Table 2
Individual correlates of mortgage delinquency.

Dependent variable:	Delinquency
Female	–0.285*** (0.006)
Age	0.012*** (0.004)
Age squared	0.014*** (0.005)
Dependent children	0.019*** (0.006)
Foreign-born	0.367*** (0.007)
Log of labor income	–0.188*** (0.005)
Log of income from rents	–0.083*** (0.001)
<i>Main source of incomes:</i>	
Pensions	–1.225*** (0.058)
Self-employment	0.104*** (0.008)
Rents	–1.200*** (0.050)
Observations	611,121

The table reports the marginal effects of a cross-section where the dependent variable is the existence of a debt delinquency; the sample includes individuals who originate a debt, independently from when it was originated; robust standard errors in parentheses.

* mean significantly different from zero at the 10 percent level.

** mean significantly different from zero at the 5 percent level.

*** mean significantly different from zero at the 1 percent level.

like income shocks and/or local variables. Independently from the definition of delinquency that we adopt, males and foreigners have, on average, higher propensity to fail the payments. Among the occupations self-employed have higher likelihood of recording a delinquency than employees, while the reverse is true for rentiers (i.e. those with real estate rents as main source of income). Finally, the delinquency rate is negatively correlated with labor incomes.

The pool of borrowers has changed over the years both in quantity – as can be concluded by looking at the ratio between the number of new borrowers and the reference population – and in quality, as suggested by the predicted probability of recording a delinquency (based on the regression presented in Table 2). According to our data, new borrowers in the mortgage market were about 2 percent of the reference population between 2005 and 2007 and sharply decreased to around 1.5 percent in the subsequent three years (Fig. 3a). As far the quality of new borrowers is concerned, they have, on average, a lower predicted probability of delinquency (Fig. 3b), suggesting that debtors are positively selected with respect to the remainder of the population (e.g. they disproportionately belong to higher income classes). However, the relative quality of new borrowers changed over the years. Namely, after the 2008 crisis the predicted probability of delinquency for the whole population increased, while the same figure for the group of new borrowers progressively decreased. Specifically, looking at the main socioeconomic characteristics, we find that in our data after 2008 there is an increase of the (positive) earning-gap of the borrowers with respect to the rest of the population; moreover they also were relatively older while the fraction of foreign-born among new borrowers decreased from 14.4 percent to 9.0 percent.

Many other variables, that are unobservable for the econometrician and observable for the local bank manager responsible for loan approvals, may have affected selection. They may include additional sources of income not recorded in the tax declarations, fu-

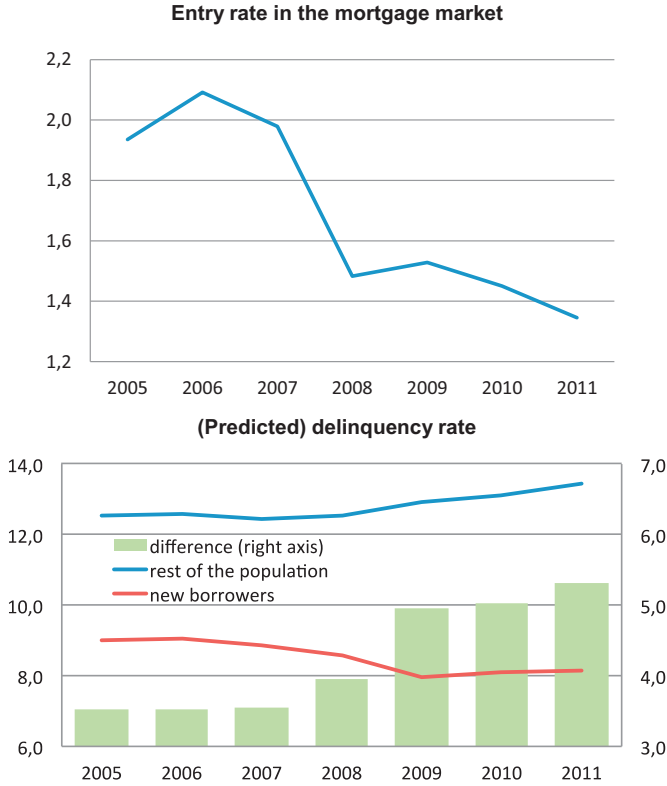


Fig. 3. Quantity and quality of new borrowers.

The entry rate (top panel) is the ratio of new borrowers over population. The predicted delinquency rate (bottom panel) is estimated from a regression where the dependent variable is equal to 1 if the borrower has a past due or a substandard or bad loans and 0 otherwise and the explanatory variable are age, gender, birth of country, occupation and incomes; the predicted probability of delinquency is computed for the new borrowers and the rest of the population, with histograms measuring the gap between the two groups. source: authors' elaborations on data from TR and CR.

ture income prospects, the stability of the job, the strength of the family ties (representing a source of monetary and non-monetary support to the borrower in case of shocks), the market value of the house and other soft information related to the borrower credit-worthiness that the local bank manager could potentially observe. In the next section we discuss how to address these issues with a more rigorous empirical framework.

3. The estimation strategy

We examine how mortgage delinquencies react to income changes, conditional on selection of individuals into indebtedness. We rely on a standard Heckman approach that has been repeated for different cohorts of mortgages, thus directly assessing changes in the selection process over time.

3.1. Heckman selection models

Let i be an individual who must choose on getting a mortgage (m) at time t and, eventually, on subsequent delinquent behavior (d) between time t and time $t+k$. The propensity to originate a mortgage and to be delinquent (conditional on having originated a mortgage) can be represented by two latent variables:

$$y_{m,i,t}^* = x_{i,t}\delta + \varepsilon_{m,i,t} \quad (1)$$

$$y_{d,i,t+k}^* = z_{i,t+k}\gamma + \varepsilon_{d,i,t+k} \quad (2)$$

They are both expressed as the sum of an observed component ($x_{i,t}$ and $z_{i,t+k}$, respectively) and an unobserved random component ($\varepsilon_{m,i,t}$ and $\varepsilon_{d,i,t+k}$, respectively). Of course, individual propensities are unobservables. However, the creation of the mortgage is observable and can be defined as a binary outcome:

$$y_{m,i,t} = \begin{cases} 1 & \text{if } \varepsilon_{m,i,t} > -x_{i,t}\delta \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

Subsequently, conditional on having got a mortgage, the repayment behavior can be defined as:

$$y_{d,i,t+k} = \begin{cases} 1 & \text{if } \varepsilon_{d,i,t+k} > -z_{i,t+k}\gamma \\ 0 & \text{otherwise} \end{cases} \quad (4)$$

Namely, $y_{d,i,t+k}$ is observed only when $y_{m,i,t} = 1$, i.e. for a non-random sample of the population. We let $y_{d,i,t+k}$ be equal to 1 if the credit status of individual i worsens within 2 years after mortgage origination and 0 otherwise.¹¹ Deterioration means the switch from a status of performing loan to a delinquency (bad or substandard loans or past due). We also assume that the error components $\varepsilon_{m,i}$ and $\varepsilon_{d,i}$ are correlated across individuals and are drawn from a bivariate normal distribution with a correlation coefficient ρ .

The set of variables z_i includes controls for initial conditions (i.e. variables observed at the time of the creation of the new mortgage) and controls for changes in individual variables afterwards. The set of variables x_i includes the same variables observed at the time of mortgage origination included in z_i , and an exclusion restriction. The latter is a variable affecting the probability to get a mortgage but which is unrelated to household repayment behavior in the subsequent years and it is necessary to identify the model.

Among the initial conditions observed at time t (i.e. variables that may affect both the probability of originating a mortgage at time t and the ability to repay it later) we include the log of after-tax labor income, the log of income from rents (a proxy also for individual wealth), dummies for the occupational status (identified with the main source of income), age and age squared, dummies for gender, country of birth (i.e. natives and foreign-born) and the presence of dependent children. The set of initial conditions includes also local level variables, such as the log of house price in the city where the individual resides, the employment rate and the population density at the time of mortgage origination. Finally, dummies for geographical areas capture other unobserved local variables. Standard errors are clustered at the local level.

In the main equation, i.e. the probability of being delinquent within two years, we also include variables capturing changes occurred after the mortgage is created such house price percentage change (that may affect the propensity to repay the debt) and labor income changes (that may affect the capability to repay the debt) as suggested by Campbell and Cocco (2015). Specifically, the labor income change is measured as $(y_{t+2} - y_t)/(0.5 \cdot y_{t+2} + 0.5 \cdot y_t)$. The variable varies within the interval $[-2; 2]$ and captures changes occurred with respect to the mortgage origination year; extreme values -2 and 2 capture transitions from employment to non-employment status occurred within this time interval and vice versa (i.e. a change from positive/zero labor income to zero/positive labor income).¹²

¹¹ We have chosen the 2 years lag because the risk of default is higher in the first few years of mortgages and then it declines. This allows us to observe the evolution of different cohorts of mortgages, before and after the outbreak of the financial crisis.

¹² A virtue of this measure is that it facilitates an integrated treatment of transitions from employment to unemployment and changes in income for those who continue to be employed. Moreover, this variable is related to the conventional income growth rate measure (the two measures are approximately equal for small growth rates), while delivering a variable with a much smoother distribution.

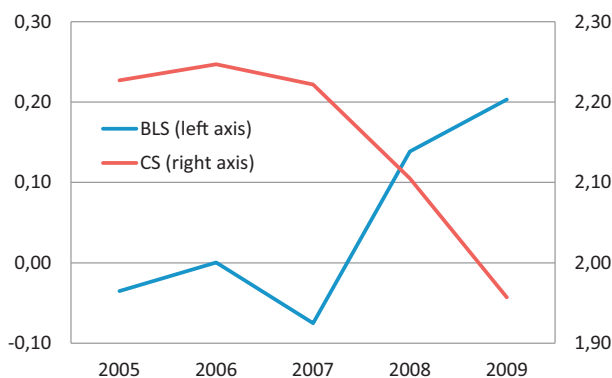


Fig. 4. BLS and the credit supply index.

The blue line represents credit supply conditions as measured by the BLS; positive (negative) values indicate a tightening (easing) of credit conditions. The red line is the credit supply index for the largest Italian banks as estimated from Eq. (5); higher (lower) values indicate more (less) expansive lending policies. Source: authors' elaboration on data drawn from Bank of Italy. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

3.2. The exclusion restriction

Our exclusion restriction is a quantitative index of credit supply at the local level, aimed at capturing the orientation of bank lending policies in the local credit market where the individual lives. In order to identify the credit supply orientation at the local level, we proceed in two steps.

First we run the regression:

$$m_{b,p,t} = \pi_{p \times t} + \pi_{b \times t} + \mu_{b,p,t} \quad (5)$$

where the dependent variable is the log of mortgages by bank b in province p at time t . The set of dummies $\pi_{p \times t}$ is defined for each province-year and captures local economic fluctuations. The variable $\pi_{b \times t}$ is a set of dummies for bank-year, measuring the lending policy of the bank b at time t . This is a pure supply factor since the aggregate mortgage demand is controlled with the province-year fixed effects. Last, $\mu_{b,p,t}$ is the error term. Regression (5) has been run on data drawn from the Bank of Italy Supervisory Report database, containing information on loans of all banks operating in Italy to the household sector. The identification of $\pi_{b \times t}$ is ensured by the presence of multiple banks in each province (i.e. multiple banks exposed to the same local demand shock) and the presence of each bank in multiple provinces (i.e. multiple provinces exposed to the same bank's supply condition).

The bank-year $\pi_{b \times t}$ variable is the main input for the construction of the credit supply index used as exclusion restriction. To check the goodness of our bank-year indicator we have first examined its correlation with the "diffusion index" provided by the Bank Lending Survey of ECB (BLS), which collects qualitative information on euro area main credit supply, by the mean of a questionnaire to the largest banks, and it is used to construct various indices of banks' lending policies.¹³ The correlation between the latter and $\pi_{b \times t}$ for the largest Italian banks estimated through Eq. (5) is reported in Fig. 4. As expected the two lines mirror each other: positive values of the diffusion index suggest a tightening of credit standards applied to the approval decisions and lower values of $\pi_{b \times t}$ indicate less expansive lending policy of the banks.

In Table 3 we perform a statistical test for the predictive power of our bank-year credit supply indicator. Namely, we consider the

Table 3

Credit and supply conditions.

Dependent variable:	Log of loans to the households
Credit supply index	0.843*** (0.010)
Year FE	YES
Bank FE	YES
Observations	3372
R-squared	0.813

The table reports the estimates of a panel where the dependent variable is the log of the loans to the household sector of bank b in the year t (period 2005–2010) and the key explanatory variable is $\pi_{b \times t}$ estimated in equation (5); robust standard errors in parentheses;

*mean significantly different from zero at the 10 percent level.

**mean significantly different from zero at the 5 percent level.

*** mean significantly different from zero at the 1 percent level.

period 2005–2010 and we regress the log of loans of each bank to households on $\pi_{b \times t}$; the specification also includes bank fixed effects, to capture time-invariant factors that characterize each bank, and year dummies, to capture common trends. The credit supply indicator enters with the positive sign, as expected, and is highly significant. The impact is also substantial from an economic point of view since one standard deviation in the bank-year indicator leads to an increase of nearly half the standard deviation in the log of loans.

Second, since our aim is to get an index of credit supply at the local level, under the assumption that the individual probability to get a mortgage is affected by the credit policy of the banks located in the place he/she lives, the bank-year dummies $\pi_{b \times t}$ are aggregated at the local level using, as weights, the number of branches of each bank in the local labor market (LLM, since, differently from data on loans we have data on branches with this higher level of detail¹⁴) at time $t - 1$. Formally:

$$CS_{l,t} = \sum_b \frac{\text{branches}_{b,l,t-1}}{\text{branches}_{l,t-1}} \cdot \pi_{b \times t} \quad (6)$$

where $CS_{l,t}$ captures the orientation of the credit supply in the local credit market l at time t and it is expected to be positively related to the likelihood of originating a mortgage in the same local credit market at the same year (i.e. intention to treat). The sources of variability are the substantial heterogeneity in lending policies across banks and the variation of banks' market share at the local level. Italy is an interesting case of study to fully exploit the features of our identification strategy. Indeed, the Italian banking system, in our sample period, was hit by two large shocks (liquidity drought in interbank markets and sovereign debt crisis) and has a highly heterogeneous industrial structure: a large number of small local banks (e.g. credit cooperative banks) co-exist with a few large national players so that banks are differently exposed to exogenous international shocks; moreover the market shares of large banks are markedly different across local markets.

An implicit assumption of the exclusion restriction is that the banks' nationwide lending policies ($\pi_{b \times t}$) are unaffected by unobserved factors at the local level. This assumption might be violated when some province markets are relevant for banks' lending policies. This may happen both when the province is large with respect to the national credit market or when the bank's credit market is very concentrated in a given territory (e.g. in the case of small banks). Moreover, some banks might systematically sort into

¹³ The diffusion index is the (weighted) difference between the share of banks reporting that credit standards have been tightened and the share of banks reporting that they have been eased. See e.g. <http://www.ecb.europa.eu/stats/money/surveys/lend/html/index.en.html>.

¹⁴ LLM is a geographic unit represented by cluster of municipalities and built on the basis of intra-municipality daily commuting patterns. LLMs in Italy are more numerous than provinces and they are arguably closer to the definition of local credit market. However, since we do not have data on loans by LLM we cannot estimate equation 3 at the level of LLM.

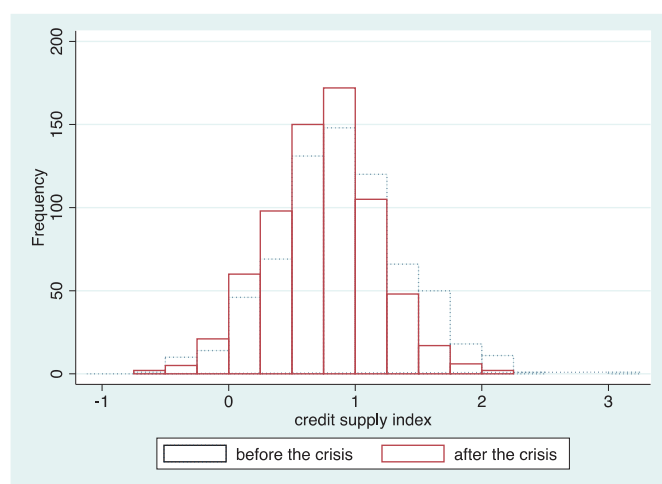


Fig. 5. Credit supply index before and after the crisis.
Source: authors' elaboration on data drawn from Bank of Italy.

Table 4
Entry rate before and after the crisis.

Specification:	I	II	III
Individual controls	YES	YES	YES
Local controls	–	YES	YES
$CS_{i,t}$	–	–	YES
Entry rate in the period 2005–2007	1830	1830	1830
Entry rate in the period 2008–2010	1380	1380	1380
Difference (a)	0450	0450	0450
Explained by covariates (b)	0071	0076	0118
% explained by covariates (b)/(a)	15.8	16.9	26.2

The table reports the Oaxaca-Blinder decomposition of the difference in the entry rate between the periods before and after the financial crisis; individual controls include age, gender, dependent children, country of birth, log of incomes and occupational dummies, local controls include log of house prices, employment rate, population density and geographical dummies.

specific provinces anticipating local future prospects. These violations of our assumption would undermine the validity of the research design. In order to address these issues and to reinforce the exogeneity of the indicator, the bank fixed effects used to build the aggregate indicator for the LLM l belonging to province p are estimated on a regression sample including all provinces but p . This strategy avoids that unobservable shocks in province p affect the lending policies of the banks operating in that province.

It is also worth noting that specialized institutions operating in the subprime market – directly or indirectly supported by the national government or local public entities – are not present in Italian banking system. Thus the selection process examined in this paper reflects market conditions rather than government policies. Moreover, during the period that we consider public interventions in favor of the banking system have been very limited, contrarily to what happened in the U.S. and in other European countries. Therefore, our estimates are not affected by the bias potentially induced by government policies.

Fig. 5 reports the distribution of the credit supply index $CS_{i,t}$ across LLMs and over time. The figure confirms high heterogeneity at the local level: the ratio between the interquartile range and the median is about 70 percent. Moreover, from the financial crisis onwards the distribution of the index shifts towards left, suggesting a tightening of the credit supply conditions. Unsurprisingly, local credit supply explains a significant fraction of the reduction in the entry into the mortgage market before and after the Global financial crisis. Table 4 displays the Oaxaca-Blinder decomposition of this difference. According to our estimates, individual variables

explain about 20 percent of the reduction in the entry rate (column I). The explained fraction of the gap increases only marginally when adding local variables (column II) and significantly when adding $CS_{i,t}$ (column III). Local lending policies, as captured by our proxy, account for roughly one third of the explained gap. Since this index is unrelated by construction to current local conditions, it provides an exogenous source of variation for the probability to get a mortgage, randomizing selection into indebtedness.

4. Results

4.1. Main findings

We consider 5 different cohorts of mortgages, originated from 2005 to 2009, because our dataset is limited to 2011 and these are the only ones that we can re-observe after two years from the mortgage origination. For each cohort, we first model the selection process driving the decision to become indebted, including standard personal characteristics and the credit-supply index described in Section 3. Second, we focus on income changes, i.e. changes occurred after the mortgage origination, and their association with the probability of default. The two steps are estimated simultaneously by maximum likelihood using a standard Heckman probit model. However, for sake of clarity, we comment the two steps separately.

Table 5 refers to the selection equation (first stage) and reports the marginal effects of the probit model. With the exception of the index $CS_{i,t}$, which is exogenous to the individual probability to get a mortgage, the other coefficients are simple reduced-form correlations. The credit supply indicator $CS_{i,t}$ enters, as expected, with a positive sign and it is highly significant in all years, even if in 2008 and 2009 its marginal impact declines, signaling a weaker relationship between the individual propensity to get a mortgage after 2008 and banks' credit supply. Income, observed at the time of the creation of the mortgage, is positively correlated with the probability of indebtedness, suggesting that, on-average, indebted people earn more than the rest of the population. Together with labor income we include also socio-demographic characteristics, which are indeed related to income (as indirectly shown by models used for predicting credit scoring, e.g. Kocenda and Vojtek, 2011 and Nguyen 2015), but may also capture demand factors as well as other non-observable characteristics (e.g. profession, educational attainment, not present in our dataset, but which are very likely to impact on current and future income). The probability of having a mortgage increases also with the number of dependent children probably capturing higher demand for mortgages of young couple (consistently with the findings of Gomez-Salvador et al., 2011, and Magri and Pico, 2011). However, during the period that we consider, its impact declines progressively, suggesting a lower propensity of young couples towards this credit instrument. This interpretation is supported also by the coefficients on age and age squared, which confirm that after the Global financial crisis younger people were less likely to get a mortgage. The same happens to foreign born individuals, who are typically characterized by higher income variability. The elasticity to local house prices is instead roughly constant for all the period.

In Tables 6 we report the marginal effects of the main equation, where the dependent variable is a wide definition of financial bad health. More precisely, the dependent variable is a dummy equal to 1 if the mortgage of the i -th individual, becomes a bad loan, a substandard loan or a past due at any time between time t and time $t+2$ (with t indicating, as before, the year of mortgage origination).¹⁵ The table reports two different estimates for each co-

¹⁵ The wide definition is our preferred indicator. Indeed, the latter indicates with certainty the existence of a financial difficulty, while the same is not true for sub-

Table 5
Determinants of selection into the mortgage market.

Dependent variable:	Mortgage origination in year:				
	2005	2006	2007	2008	2009
Log of labor income	0.004*** (0.000)	0.004*** (0.000)	0.004*** (0.000)	0.003*** (0.000)	0.003*** (0.000)
Log of income from rents	−0.002*** (0.000)	−0.001*** (0.000)	−0.001*** (0.000)	−0.001*** (0.000)	−0.000*** (0.000)
Age	0.003*** (0.000)	0.003*** (0.000)	0.002*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
Age squared	−0.004*** (0.000)	−0.004*** (0.000)	−0.004*** (0.000)	−0.002*** (0.000)	−0.001*** (0.000)
Female	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.001*** (0.000)	0.001*** (0.000)
Dependent children	0.008*** (0.000)	0.008*** (0.000)	0.004*** (0.000)	0.002*** (0.000)	0.002*** (0.000)
Foreign-born	−0.001 (0.001)	0.000 (0.001)	−0.002*** (0.001)	−0.004*** (0.000)	−0.007*** (0.000)
Log of house price	0.002*** (0.000)	0.001*** (0.001)	0.001*** (0.000)	0.001* (0.000)	0.002*** (0.000)
Occupational dummies	YES	YES	YES	YES	YES
Geographical dummies	YES	YES	YES	YES	YES
Other local controls	YES	YES	YES	YES	YES
CS _{t,t}	0.163*** (0.051)	0.313*** (0.070)	0.268*** (0.058)	0.122** (0.049)	0.168*** (0.055)
Observations	1013,536	1013,536	1013,536	1013,536	1013,314
Pseudo R-squared	0.058	0.051	0.042	0.039	0.039

The table reports the marginal effects of the selection equation where the dependent variable is entry in the debt market; standard errors clustered at the LLM level in parentheses.

* mean significantly different from zero at the 10 percent level.

** mean significantly different from zero at the 5 percent level.

*** mean significantly different from zero at the 1 percent level.

Table 6
Determinants of mortgage delinquency: baseline estimates.

	Cohort 2005		Cohort 2006		Cohort 2007		Cohort 2008		Cohort 2009	
	Probit	Heckman probit	Probit	Heckman probit	Probit	Heckman probit	Probit	Heckman probit	Probit	Heckman probit
Income change	−0.015*** (0.002)	−0.020*** (0.003)	−0.020*** (0.002)	−0.026*** (0.003)	−0.022*** (0.002)	−0.030*** (0.003)	−0.015*** (0.002)	−0.021*** (0.003)	−0.011*** (0.002)	−0.018*** (0.003)
House price change	−0.014** (0.006)	−0.019** (0.009)	−0.022** (0.009)	−0.030*** (0.011)	−0.000 (0.009)	0.000 (0.011)	−0.003 (0.009)	−0.005 (0.014)	0.005 (0.008)	0.008 (0.013)
Log of labor income	−0.007*** (0.001)	−0.010*** (0.002)	−0.019*** (0.002)	−0.025*** (0.002)	−0.016*** (0.002)	−0.021*** (0.003)	−0.008*** (0.001)	−0.011*** (0.002)	−0.006*** (0.001)	−0.010*** (0.002)
Log of income from rents	−0.000 (0.001)	−0.000 (0.001)	−0.002*** (0.001)	−0.003*** (0.001)	−0.002*** (0.001)	−0.002*** (0.001)	−0.002*** (0.001)	−0.003*** (0.001)	0.000 (0.000)	0.000 (0.001)
Log of house price	−0.014*** (0.004)	−0.019*** (0.006)	−0.016*** (0.005)	−0.021*** (0.006)	−0.010** (0.005)	−0.014** (0.006)	−0.004 (0.004)	−0.007 (0.006)	−0.007** (0.003)	−0.011** (0.005)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
λ		−0.116 (0.825)		−0.335 (0.545)		−0.783 (0.583)		−1.727*** (0.365)		−1.623** (0.725)
ρ		−0.115		−0.323		−0.655		−0.939		−0.925
Likelihood ratio test (Chi-square)		0.045		0.569		1.502		23.903***		11.914***
Predicted delinquency rate		3.5		4.4		4.3		3.2		2.0
Observations	15,276	1011,061	16,778	1010,898	16,703	1011,758	12,781	1012,409	12,658	1011,545

The table reports the marginal effects of a probit and of a Heckman probit model where the dependent variable is, for each cohort of mortgages, the probability of recording a delinquency within two years after mortgage origination. Controls include socio-demographic variables (age, gender, country of birth, dependent children) and local variables (employment rate, population density, geographical dummies).

* mean significantly different from zero at the 10 percent level.

** mean significantly different from zero at the 5 percent level.

*** mean significantly different from zero at the 1 percent level.

hort. The first corresponds to a simple probit of the probability to register an anomaly, which does not include the correction for selection (labelled as λ) and is based only on the subsample of bor-

rowers. The second is based on the Heckman probit model, thus taking into account the selection process into the mortgage market for the whole sample. As before, these estimates are replicated for all the 5 cohorts of mortgages.

The variable of interest is the income change occurred between time t and time $t+2$. The corresponding coefficient varies between 0.1 and 0.2 when selection is not taken into account. When we control for selection we get a higher responsiveness of the probability of delinquency to income changes. In the Heckman probit model a 10 percent negative income change leads to an increase

standard and bad loans that are affected, to some extent, by a subjective evaluation of the lender. For instance, the transition from past due to bad loan can be delayed by internal organizational procedures or because the lender voluntarily allowing the lengthening of the delinquency period. In other words, while the existence of an anomaly unambiguously identifies a financial difficulty, the degrees of anomaly depend also on some external factors that may have little to do with it.

between 0.2 and 0.3 percentage points in the probability of delinquency, which roughly corresponds to a 5 percent increase in the observed delinquency rate. In case of job loss (which, according to our variable, corresponds to a –200 percent decrease in earnings) the consequences are more severe, as the delinquency rate nearly doubles. The estimated impacts could be *prima facie* appear quite small, signaling solid standing of Italian borrowers. This is certainly true, as the lending policies of Italian banks are traditionally viewed as quite prudent, especially when households are involved (Fabbri and Padula, 2004; Jappelli et al., 2013; Magri, 2007). However, without taking into account selection the estimated effect would be smaller. Our estimates are indeed roughly comparable with those presented by Gerardi et al. (2015) who find that in the US households with an unemployed head are approximately three times as likely to default as households with an employed head.

Consider then the coefficient of the selectivity term λ , which is always negative, but it is significantly different from zero only for the two more recent cohorts (2008 and 2009). Also the absolute value of the coefficient increases over time, reaching its peak for the more recent cohorts of mortgages. The sign and the magnitude of the impact of λ depend on the parameter ρ that captures the correlation between ε_i and μ_i . Therefore there are unobserved (to the econometrician) factors positively affecting mortgage origination and negatively correlated with the probability of observing financial difficulties (or vice versa). This evidence, as expected, signals positive selection of the borrowers on unobservables. The relevance of those factors was negligible (both economically and statistically) before the financial crisis and sizeable after the crisis.

According to our estimates (i.e. multiplying the average Inverse Mill's ratio by its marginal effect at the average), the selection process into the mortgage market reduced the probability of default by around 50 percent in the period 2008–2009, which corresponds to a 3.5 points decrease in the delinquency rate. Before the crisis the corresponding figures, though not statistically significant, were much lower in magnitudes (less than 10 per cent and 0.3 points, respectively).

Our specification includes also the price changes to capture local aggregate shocks to the housing market (and possibly other aggregate shocks not captured by individual income changes). Before the Global financial crisis the effect of house price changes at the local level are negatively correlated with household delinquency, whereas after 2008 their effect becomes negligible.

Also initial conditions, captured by the log of labor income at time t , and income from rents, all measured at time t , concur to determine individual delinquency. Having an income 10 percent higher at the mortgage origination reduces the delinquency rate by around 0.1–0.2 percentage points. Importantly, the correction for sample selection, with respect to the simple probit model, leads to larger negative effect for not only for income variation but also for the various sources of income and house prices at time t . Concerning the size of the bias for income changes in the two more recent cohorts is between 30 and 40 percent of the true parameter. Therefore, unobserved factors are positively related to income and their omission may severely bias the estimates. Also the size of the coefficient on house prices at the time of mortgage origination increases when selection is taken into account. This evidence suggests that in local labor markets characterized by higher house prices the selection operated by banks is even stronger, as probably also the amount of the loan was higher.

4.2. Robustness

To check the robustness of our findings we enrich the previous specifications along several directions.

In Table 7, we use the same set of variables in both the selection and the main equation (with the exception of the exclusion restriction). Indeed, income and/or house price changes after the mortgage is created can be partly anticipated (at the time of mortgage origination) and, therefore, they may affect selection into indebtedness. According to our findings, income changes are positively correlated with the probability of originating a mortgage. However, and more importantly, the key findings on the substantial role of selection after the Global financial crisis and on the sensitivity of the delinquency rate to income shock are unchanged.

In Table 8, we enrich the specification with further controls. Namely, we add two individual-level variables: the log of the debt hold by individuals at time t and a dummy for debts that are jointly held by at least two individuals (typically members of the same household). Both variables are observed, by definition, only for individuals with a debt and, therefore, may be included only in the main equation. They are plausibly correlated with individual riskiness and, therefore, may capture factors affecting both the probability of recording a delinquency and the probability to get a mortgage. The inclusion of the log of the debt in the main equation, jointly with the house price and income, allows us also to control indirectly for the loan-to-value and the debt-to-income ratios. We also add a variable capturing changes in the delinquency rate at the bank level. Indeed one may argue that easier credit conditions at time t may affect future banks' propensity to report and address household financial difficulties and, consequently, the individual probability of default. Finally, we add local-level variables that are aimed at capturing unobserved features of the local financial development. The first is the density of bank offices (i.e. offices of all banks per square meter), used as a proxy for the accessibility of the banking system. The second is the Herfindahl index, calculated on the share of loans of each bank, which proxies the degree of banking competition at the local level. Both variables may be correlated to both the probability of originating a mortgage and of recording a delinquency and are included in both the selection and the main equation. We find that higher debts increase financial vulnerability while joints debts reduce it. Among the other variables, higher bank concentration and lower branch density reduce the probability of mortgage origination (not reported for sake of brevity, but available upon request) though they are substantially unrelated to individual delinquency rate, suggesting that the structure of the banking system does not show a clear correlation with individual default. As far our key variables, the selectivity term continues to be significant (and with the expected sign) only for the more recent cohorts and the coefficients of explanatory variables in the main equation are qualitatively similar to those of our baseline specification.

Our main estimates, as already mentioned, refer to all loans larger than 75,000 euro, independently from the motivation of the loan. They may also include loans of self-employed people to finance their activities. Moreover, income from self-employment is severely underreported in tax records (Marino and Zizza, 2011). To control for this sources of heterogeneity and mis-measurement, which could affect the analysis of both the selection process and the repayment behavior, in Table 9 we replicate our estimates in a sub-sample which excludes self-employed. The sign and the size of the estimated coefficients are again qualitatively similar.

In unreported estimates (available upon request) we adopted an ordered probit with selection correction, exploiting the fact that different types of repayment delinquencies can be interpreted in terms of increasing degree of financial bad health. Our findings are qualitatively similar, thus suggesting that the results are robust also to different functional forms used to describe the process of individual delinquency.

Table 7

Determinants of mortgage delinquency: balanced equations.

	Cohort 2005 Heckman probit	Cohort 2006 Heckman probit	Cohort 2007 Heckman probit	Cohort 2008 Heckman probit	Cohort 2009 Heckman probit
Income change	−0.020** (0.003)	−0.026** (0.003)	−0.030** (0.003)	−0.021** (0.003)	−0.018** (0.003)
House price change	−0.019** (0.009)	−0.030** (0.011)	−0.000 (0.011)	−0.005 (0.014)	0.008 (0.013)
Log of labor income	−0.010** (0.002)	−0.025** (0.002)	−0.021** (0.003)	−0.011** (0.002)	−0.010** (0.002)
Log of income from rents	−0.000 (0.001)	−0.003** (0.001)	−0.002** (0.001)	−0.003** (0.001)	0.000 (0.001)
Log of house price	−0.019** (0.006)	−0.021** (0.006)	−0.014** (0.006)	−0.007 (0.006)	−0.012** (0.005)
Controls	YES	YES	YES	YES	YES
λ	−0.214 (0.830)	−0.350 (0.540)	−0.816 (0.550)	−1.763** (0.787)	−1.637** (0.688)
ρ	−0.211	−0.337	−0.673	−0.943	−0.927
Observations	1011,061	1010,898	1011,758	1012,409	1011,545

The table reports the marginal effects of a Heckman probit model where the dependent variable is, for each cohort of mortgages, the probability of recording a delinquency within two years after mortgage origination. Controls include socio-demographic variables (age, gender, country of birth, dependent children) and local variables (employment rate, population density, geographical dummies).

* mean significantly different from zero at the 10 percent level.

** mean significantly different from zero at the 5 percent level.

*** mean significantly different from zero at the 1 percent level.

Table 8

Determinants of mortgage delinquency: adding controls.

	Cohort 2005 Heckman probit	Cohort 2006 Heckman probit	Cohort 2007 Heckman probit	Cohort 2008 Heckman probit	Cohort 2009 Heckman probit
Income change	−0.015** (0.002)	−0.019** (0.002)	−0.020** (0.002)	−0.018** (0.003)	−0.018** (0.003)
House price change	−0.017** (0.006)	−0.026** (0.008)	−0.003 (0.008)	−0.007 (0.012)	0.001 (0.012)
Log of labor income	−0.008** (0.002)	−0.021** (0.002)	−0.016** (0.002)	−0.010** (0.002)	−0.011** (0.002)
Log of income from rents	−0.001 (0.001)	−0.003** (0.001)	−0.002** (0.001)	−0.003** (0.001)	0.000 (0.001)
Log of house price	−0.018** (0.004)	−0.020** (0.005)	−0.016** (0.004)	−0.008 (0.005)	−0.013** (0.005)
Log of debt	0.022** (0.003)	0.031** (0.003)	0.034** (0.003)	0.018** (0.004)	0.004 (0.004)
Joint debt	−0.010** (0.003)	−0.025** (0.003)	−0.021** (0.003)	−0.021** (0.004)	−0.029** (0.004)
Bank delinquency rate	0.001 (0.001)	0.001 (0.001)	0.007** (0.001)	0.001 (0.002)	0.002 (0.001)
Bank branch density	0.001 (0.005)	0.000 (0.005)	0.002 (0.005)	−0.007 (0.006)	0.007 (0.006)
Herfindahl index	0.008 (0.047)	−0.016 (0.046)	−0.011 (0.044)	−0.091 (0.060)	0.071** (0.035)
Controls	YES	YES	YES	YES	YES
λ	−0.474 (0.933)	−0.467 (0.667)	−0.620 (0.573)	−1.762** (0.659)	−1.581** (0.564)
ρ	−0.441	−0.436	−0.551	−0.943	−0.919
Observations	1011,058	1010,898	1011,755	1012,407	1011,536

The table reports the marginal effects of a Heckman probit model where the dependent variable is, for each cohort of mortgages, the probability of recording a delinquency within two years after mortgage origination. Controls include socio-demographic variables (age, gender, country of birth, dependent children) and local variables (employment rate, population density, geographical dummies).

* mean significantly different from zero at the 10 percent level.

** mean significantly different from zero at the 5 percent level.

*** mean significantly different from zero at the 1 percent level.

5. Conclusions

Why some indebted individuals stop repaying debt? In institutional settings where there is limited room for strategic behavior and the consequences of being registered as delinquent are severe, other factors may play a relevant role.

On this respect, our paper sheds light on two important and almost neglected issues: selection into the mortgage market and income changes after the mortgage is created. According to our

findings, the impact of labor market income changes is sizeable, as an episode of unemployment more than doubles the individual delinquency rate. Second, the tightening of the selection process from the Global financial crisis onwards largely explains the trend in delinquency rates of the most recent cohorts of mortgages. Neglecting selection mechanisms may severely bias the estimates of individuals' credit risk.

The huge impact of selection and job loss that we find in a country like Italy, traditionally characterized by prudent lending

Table 9

Determinants of mortgage delinquency: excluding self-employed individuals.

	Cohort 2005 Heckman probit	Cohort 2006 Heckman probit	Cohort 2007 Heckman probit	Cohort 2008 Heckman probit	Cohort 2009 Heckman probit
Income change	−0.013*** (0.002)	−0.016*** (0.002)	−0.018*** (0.002)	−0.016*** (0.003)	−0.012*** (0.003)
House price change	−0.017** (0.007)	−0.022*** (0.009)	−0.002 (0.008)	−0.008 (0.012)	0.009 (0.012)
Log of labor income	−0.008*** (0.002)	−0.019*** (0.002)	−0.016*** (0.002)	−0.009*** (0.002)	−0.009*** (0.002)
Log of income from rents	−0.000 (0.001)	−0.003*** (0.001)	−0.002** (0.001)	−0.004*** (0.001)	0.000 (0.001)
Log of house price	−0.017*** (0.005)	−0.023*** (0.005)	−0.014*** (0.005)	−0.010* (0.006)	−0.013** (0.005)
Controls	YES	YES	YES	YES	YES
λ	−0.733 (0.730)	−0.206 (0.809)	−0.673 (0.563)	−1.589*** (0.537)	−1.595** (0.767)
ρ	−0.625	−0.203	−0.587	−0.920	−0.921
Observations	891,012	887,008	885,788	897,251	900,696

The table reports the marginal effects of a Heckman probit model where the dependent variable is, for each cohort of mortgages, the probability of recording a delinquency within two years after mortgage origination. Controls include socio-demographic variables (age, gender, country of birth, dependent children) local variables (employment rate, population density, geographical dummies) and additional controls introduced in the previous robustness checks (log of debt, joint debt, bank delinquency rate, local branch density, Herfindahl index).

* mean significantly different from zero at the 10 percent level.

** mean significantly different from zero at the 5 percent level.

*** mean significantly different from zero at the 1 percent level.

policies and strong employment protection for permanent workers calls for further scrutiny of these channels also in other countries, where both institutional characteristics are less tight. Our results also suggest that instruments designed to absorb the consequences of income shocks, like for instance the unemployment benefit, tax cuts and in general any policy which relaxes household financial constraints, may have positive effects not only on household consumption, but also on financial stability as they reduce the probability of default. Finally, our results suggest that credit risk models as those typically used by lenders may systematically underestimate the relationship between income and the probability of default, thus leading to mispricing and sub-optimal risk composition of borrowers: it is important that those models are revised accounting for selectivity issues.

References

- Acciari, P., Manzoli, E., Mocetti, S., Viviano, E., 2014. La vulnerabilità finanziaria: un'analisi per classi di reddito. *Moneta e Credito* 67, 401–428.
- Aiyar, S., 2012. From financial crisis to great Recession: the role of globalized banks. *Am. Econ. Rev.* 102, 225–230.
- Adams, W., Einav, L., Levin, J., 2009. Liquidity constraints and imperfect information in subprime lending. *Am. Econ. Rev.* 99, 49–84.
- Bajari, P., Chu, S., Nekipelov, D., Park, M., 2013. A Dynamic Model of Subprime Mortgage Default: Estimation and Policy Implications NBER working paper 18850.
- Boheim, R., Taylor, M.P., 2000. My home was my castle: evictions and repossessions in Britain. *J. Hous. Econ.* 9, 287–319.
- Boyes, W.J., Hoffman, D.L., Low, S.A., 1989. An econometric analysis of the bank credit scoring problem. *J. Econom.* 40, 3–14.
- Campbell, J.Y., Cocco, J.F., 2015. A model of mortgage default. *J. Finance* 70, 1495–1554.
- Deng, Y., Quigley, J.M., van Order, R., 2000. Mortgage terminations, heterogeneity, and the exercise of mortgage options. *Econometrica* 68, 275–307.
- Demyanyk, Y., van Hemert, O., 2011. Understanding the subprime mortgage crisis. *Rev. Financ. Stud.* 24, 1847–1880.
- Diaz-Serrano, L., 2005. Income volatility and residential mortgage delinquency across the Eu. *J. Hous. Econ.* 14, 153–177.
- Domowitz, I., Sartain, R.L., 1999. Determinants of the consumer bankruptcy decision. *J. Finance* 44, 403–420.
- Duygan-Bump, B., Grant, C., 2009. Household debt repayment behavior: what role do institutions play. *Econ. Policy* 24, 107–140.
- Fay, S., Hurst, E., White, M.J., 2002. The household bankruptcy decision. *Am. Econ. Rev.* 92, 706–718.
- Fabbri, D., Padula, M., 2004. Does poor legal enforcement make households credit-constrained. *J. Bank. Finance* 28, 2369–2397.
- Foote, C., Gerardi, K., Willen, P., 2008. Negative equity and foreclosure: theory and evidence. *J. Urban Econ.* 64, 234–245.
- Gerardi, K., Herkenhoff, K.F., Ohanian, L.E., Willen, P.S., 2015. Can't Pay or Won't Pay? Unemployment, Negative Equity, and Strategic Default NBER working paper 21630.
- Gomez-Salvador, R., Lojschova, A., Westermann, T., 2011. Household Sector Borrowing in the Euro Area – A Micro Data Perspective. European Central Bank, Frankfurt Occasional Paper 125.
- Greenstone, M., A. Mas and H.L. Nguyen (2015), Do Credit Market Shocks Affect the Real Economy? Quasi-Experimental Evidence from the Great Recession and 'Normal' Economic Times, working paper.
- Gross, D.B., Souleles, N.S., 2002. An empirical analysis of personal bankruptcy and delinquency. *Rev. Financ. Stud.* 15, 319–347.
- Guiso, L., Sapienza, P., Zingales, L., 2013. The determinants of attitudes towards strategic default on mortgages. *J. Finance* 68, 1473–1515.
- Haughwout, A., Peach, R., Tracy, J., 2008. Juvenile delinquent mortgages: bad credit or bad economy. *J. Urban Econ.* 64, 246–257.
- Jacobson, T., Roszbach, K., 2003. Bank lending policy, credit scoring and value-at-risk. *J. Bank. Finance* 27, 615–633.
- Jappelli, T., Pagano, M., Di Maggio, M., 2013. Households' indebtedness and financial fragility. *J. Financ. Manag. Markets Institutions* 1, 23–46.
- Kocenda, E. and M. Vojtek (2011), Default predictors in retail credit scoring: evidence from czech banking data, *Emerg. Markets Finance Trade*, 47: 80–98.
- Magri, S., 2007. Italian households' debt: the participation to the debt market and the size of the loan. *Empir. Econ.* 33, 401–426.
- Magri, S., Pico, R., 2011. The rise of risk-based pricing of mortgage interest rates in Italy. *J. Bank. Finance* 35, 1277–1290.
- Marino, M.R., Zizza, R., 2011. The personal income tax evasion in Italy: an estimate by taxpayer's type. In: Pickhardt, M., Prinz, A. (Eds.), *Tax Evasion and the Shadow Economy*. Edward Elgar Publishing.
- Mayer, C., Pence, K., Sherlund, S.M., 2009. The rise in mortgage defaults. *J. Econ. Perspect.* 23, 27–50.
- Mian, A., Sufi, A., 2009. The consequences of mortgage credit expansion: evidence from the U.S. mortgage default crisis. *Quart. J. Econ.* 124, 1449–1496.
- Nguyen, H.T., 2015. Default predictors in credit scoring: evidence from France's retail banking institution. *J. Credit Risk* 11, 41–66.