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Leonor F. Costa, M. Manuela Rocha,
Paulo Brito

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MONEY SUPPLY AND THE CREDIT MARKET IN EARLY MODERN ECONOMIES: THE CASE OF EIGHTEENTH-CENTURY LISBON

Leonor F. Costa

M. Manuela Rocha

Paulo Brito

GHES

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R. Miguel Lupi, nº 20
1249-078 Lisboa - Portugal
Telf. 213925974
Fax. 213925940
e-mail: ghes@iseg.utl.pt

Abstract

In this paper, we address the partial equilibrium functioning of the short-term credit market in the Eighteenth-century Lisbon and its response to three major events: massive gold inflows from Brazil, a catastrophic destruction of capital caused by the 1755 earthquake and the enactment of a 5% legal ceiling on interest rates 1757. We build a time series for the market interest rate, and a regression shows money stock and real estates as two significant variables. Interest rates were affected negatively by the former and positively by the latter. We conclude that changes in the money stock tended to operate through the supply of loanable funds. The wealth effect, measured by the stock of real estate, operated over demand and tended to be the most significant effect among several other possible countervailing effects (e.g., the impact of wealth effects on supply, the informational effects of collaterals). The inflow of gold clearly generated a liquidity which by itself explained the downward trend in interest rates up until around 1780. However, the huge variations experienced by the stock of capital after the earthquake also explains the steadiness of interest rates in a period when the inflow of money started to recede. For the whole period during which the 5 % ceiling on interest rates was in force we do not find any evidence to confirm the existence of disequilibrium credit rationing: the notional interest rate predicted by our model was very close to the 5% legal ceiling.

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Keywords: Interest rates, credit markets, Brazilian gold, Lisbon earthquake.

JEL: N13, N23, N43

Plan

1. Introduction[1]

"Antónia Margarida Leonor said that she needed one million *réis* and for that reason she asked Luis António da Rocha whether he was willing to lend that amount under her obligation [...]; [since] he agreed, he delivered the said million *réis in gold coins in front of me* notary"[2].

These were common words in short-term loans (obligations) in Lisbon in the 18th century. They were registered in notarial records and document one particular application of the gold that flooded the Portuguese economy after the discovery of the first alluvial samples in Brazil in the 1690s. At this time, an average of close on 3 billion *réis* of gold per year (833,333 pounds sterling), mostly coined in Brazil, entered Portugal through the port of Lisbon, the city where the Brazilian fleets arrived (Costa, Rocha, and Sousa, 2013). Besides an indication of the coins that constituted the loan, obligations systematically provide information about several dimensions of the private credit market, including interest rates as a percentage of the principal contracted.

On November 1st, 1755 this very same city, whose economy was lubricated by the monetary wealth generated by rents of the colonial system, underwent the most calamitous destruction of capital at that time. An earthquake, which must have reached a level of 8 to 9 on the Richter scale (Pereira, 2009) had devastating effects. Recent estimates point to a level of destruction of close to 75% of GDP (Cardoso, 2007). The event was followed by the State's mediation imposing a 5% legal cap on interest rates, which put an end with a legal loophole that had allowed interest rates to vary freely from usury laws.

The combined and contradictory effects of the accumulation of money stock, a sudden destruction of residential stock and a legal cap on interest rates enacted only in 1757 make this case a significant one for analyzing the way in which credit markets worked in a partial equilibrium in early modern economies. We use an extended data base of 2,753 obligations, which support a consistent time series on interest rates.

By analyzing interest rates contracted before a notary, we intend to contribute to the economic history literature that has acknowledged that the price of a loan has many economic and social dimensions (micro or macro, short-or long-term), not all of which drive the remuneration of capital in the same direction. It is a discount factor that is implicit in transactions involving uncertainty about outcomes, when these outcomes are perceived differently by economic agents, who are sensitive to asymmetries of information and moral hazard. Even so, at a macro level of analysis and in the long run, interest rates have shown some trends which are thought of as a temperature chart of a system's social-economic evolution (Homer and Sylla, 2005) and historians agree that this variable displays a downward drift in early modern European

[1] Previous versions and results included in this paper have been presented at APHES 2013, FRESH 2014 and the GHES Workshop 2014. We are grateful for the comments and suggestions made by Michael Burda, Gregory Cark, Rui Pedro Esteves, Regina Grafe, Maria Alejandra Irigoin, Silvia Marzagalli, Larry Neal, Nuno Palma and Jaime Reis. We thank Ofélia Sequeira and Lisbeth Rodrigues for collecting the data. The financial support from national funds provided by FCT (Fundação para a Ciência e a Tecnologia) is gratefully acknowledged. This article is part of the Project EXPL/EPH-HIS/1742/2012.
Corresponding author: leonorc@iseg.utl.pt (GHES/ISEG); Maria Manuela Rocha (GHES/ISEG); Paulo Brito (UECE/ISEG)
[2] Arquivo Nacional da Torre do Tombo (National Lisbon Archive), Notary office n. 2, box 128, book 607, fl.75-76.

economies. Even now, the causes of this trend are still a matter of intense discussion. There is no consensus about why would capital remuneration decreased in first place, and there are doubts as to whether it actually declined or was just submitted to a series of legal caps.

North and Weingast's seminal work (North and Weingast, 1989) initiated a stream of analyses that have focused on the role of political institutions in financial development. The authors claim that a decline in interest rates signaled a fall in overall risk, which had become the main engine of growth in the western economies (North, 1991), particularly in England's leadership of the industrialization process. The importance of political institutions instilling trust and outlining incentives to investment, through the enforcement of property rights and contracts, has not been discredited. It still offers some lessons for developing countries even today (Acemoglu, 2009; World Bank, 2002). However, North and Weingast's conclusions have been submitted to some criticism.

New and more extensive data sets have challenged the view on the primacy of political institutions to explain both long- and short term trends (Clark, 1996; Clark, 2007; Epstein, 2000). International factors, such as the integration of financial markets, contexts of war, and other political events are also significant causes of fluctuations in the interest rates (Neal, 2000; Neal, 1990; Barro, 1987; Sussman and Yafeh, 2006; Edvinsson, 2011). All in all, the constitutional arrangements of the state turn out to be the least substantial explanation, particularly in the case of those political units that had a history of state bankruptcy and which experienced drifts similar to those of political units characterized by parliamentary regimes (Grafe, 2012; Grafe and Irigoin, 2012). And even if we accepted that "good" political institutions can impact on the overall risk, the remuneration of capital may still rise due to a demand shock driven by the consequent upsurge of confidence in the market (Quinn, 2001).

Although the role of political institutions in the functioning of credit markets has been a subject of much dispute, institutional variables matter for micro level analyses, which have documented cases that add new insights to North and Weingast's work. Studies on the mechanisms (either third-party or private-based institutions) that mitigate the lender's risks have motivated diversified methods and researches (Greif, 1989; Fontaine, 2008; Rocha, 1996; Muldrew, 1998).

Among this stream of works, Hoffman et al. (2000) carried out research into notarial deeds, demonstrating that in the eighteenth-century Paris financial intermediation developed in spite of the lack of a banking system (Hoffman, Postel-Vinay, and Rosenthal, 2000) and in spite of financially cumbersome programs of an absolutist regime, such as that of John Law's. The participation of notaries in this market assisted the growth in the volume of credit. Through their own registers of assets, notaries controlled information that helped to monitor the borrowers and decrease the lenders' risk (Hoffman, Postel-Vinay and Rosenthal, 2000). In this work, extensive time series of interest rates are missing, partly because lenders and borrowers did not declare interest on short-term obligations. Anyway, usury laws enacted in France since late 17th century led the authors to consider that interest rates was a variable insignificant in determining credit allocation. Hence, the market is taken as a "priceless" market.

The view that usury laws did not prevent the credit market from developing and assisting economic growth has been emphatically rejected in recent research into the British case (Voth

and Temin, 2005; Voth and Temin, 2008). The authors demonstrated that the main consequence of usury laws was credit rationing. As far as data provided by a single private bank is concerned, Temin and Voth claim that the 5% cap on interest rates in England slowed down the pace of economic structural changes. After all, the cause of the England's first move lay elsewhere, but definitely not in financial intermediation (Voth and Temin, 2013), while the State seems to have been the party mostly interested in a legal cap on interest rates.

Our present knowledge tells us that legal ceilings could have had different effects in the working of credit markets, and that interest rates varied due to a wide range of factors both at a micro and a macro level. In this paper, we contribute to this discussion by calling upon variables that have been less studied or even neglected. We contemplate money stock and collaterals as independent variables. The importance of collaterals in the evolution of credit markets is a topic that has been studied in the economies of developing countries (World Bank, 2002: 40–42) and is turning out to be a theme in financial history literature too (Neal, 2015; Reis, 2011). As for the levels of liquidity, this seems to be a missing variable in the economic history literature that has advanced our present knowledge on financial intermediation.

We conjecture that in pre-modern economies wealth was mostly composed of money balances and real estate. Money was based on precious metals thus, being a store of value, that is, a financial asset. We know that a rise in the money stock occurred in the Portuguese economy throughout the eighteenth century (Sousa, 2006; Costa, Rocha, and Sousa, 2013). As far as the questions dealt with in this paper are concerned, we take money as an exogenous variable and we infer from contracts of obligations that liquidity impacted on the supply side of the credit market. The demand side was a positive function of the borrower's future income (measured by wages) and non-human wealth (measured by real estate). So, an increase in the stock of real estate could have increased the interest rate via the wealth of borrowers. However, real estate pledged as collateral could also have served to reduce the risk of moral hazard for lenders, thus decreasing interest rates via an information role. Hence, by destroying the stock of real estate, the earthquake could have affected this market through those two channels: it contracted the stock of non-human wealth, which either reduced demand or altered the information role of collaterals. These, together with the existing levels of liquidity, determined whether interest rates would have soared after the earthquake or not, despite the reduction of capital stock suggesting that the remuneration of capital would go upwards.

To test these hypotheses, we setup a model for the market interest rate using as regressors money supply, wages and the number of hearths, as a proxy for the stock of real estate in Lisbon. The estimators were obtained for the period in which the interest rate was freely moving or the interest ceiling was deemed as non-operative. This allowed us to arrive at an estimate of the notional interest rate, for the period in which the ceiling was operative, and to predict the severity of the credit rationing.

We conclude that the level of liquidity stands out in the model as a consistent explanation, even after the earthquake, mitigating the effect of the destruction of capital, and that the legal ceiling on interest rate was quite near the notional interest rate, meaning that rationing was not a consequence of the state's intervention.

2. Short-term credit in Lisbon

Like eighteenth-century France, Portugal also lacked a banking system and any experience of private or public banking cannot be studied until the early nineteenth century (Reis, 1996; Cardoso, 1997; Valério, 2007). But credit practices in the eighteenth century can be known about through the registers of religious orders and brotherhoods, which kept track of their own network of borrowers and lenders. Like these institutions, notaries registered obligations that covered a wider social environment. These contracts have similar articles which provide consistent and homogeneous information to support several time series. Methodological reasons, such as the large number of observations and the quality of information, and not the assumption that notaries played a specific role in this market, led us to check in full the activity of notaries in Lisbon and to define the criteria that would be used for sampling credit dealings[3].

2.1. The data

The number of contracts signed in the city can be identified through a general index of notarial deeds under the management of a *Distribuidor*, an institution that assigned services to the eighteen offices of the corporation. From this index, we chose one office from which to collect data relating to all contracts referring to credit dealings from 1715 to 1800, whose share in the business was assessed by the records of the *Distribuidor*. The benchmarks of the time series of obligations were predetermined by Portuguese monetary history, which provides us with a series of data about the money stock that starts in 1718 and ends before fiat money was introduced during the Napoleonic Wars (Sousa, 2006; Costa, Rocha, and Sousa 2013). This procedure led us to choose the office of the Barbuda family to collect data about all the credit contracts.

The notary of the Barbuda family executed a number of deeds that was close to the average and did not register a sharp decline after the earthquake, contrary to what is detectable among those who were at the forefront of the notarial business in the first half of the 18th century. This office dealt with 5% of the obligations signed in Lisbon, recording an increase of contracts between 1756 and 1770, when it reached 10%. From then on, it returned to the same level as activity as it had had before the earthquake. This provided us with a sample of 2,753 obligations which inform the data set on interest rates and the amounts of money lent that we use in this paper. The credit contracts in the Portuguese notarial books contain a number of important features which differentiate Lisbon from the Paris case[4]. First, long-term loans, such as *perpetuités* and *rentes vergiers* (life perpetuities) were not registered as such by Lisbon notaries. All cases refer to short-term credit known as obligations. This type of agreement involved three

[3] For a full explanation of sampling (the assumptions and procedures that led to the choice of this office, see For a full explanation of sampling (the assumptions and procedures that led to the choice of this office, see Costa, Rocha, and Brito, 2014.

[4] All the references to notarial records and the credit market in Paris are based on (Hoffman, Postel-Vinay and Rosenthal, 2000).

different situations, however. One was contracting of new debt; the other was a formal acknowledgement of an outstanding debt, and the third situation consisted of the acknowledgement of a credit deriving from purchases of services or goods.

A comparison of the amounts allocated by each of these contracts shows that new debt accounted for the vast majority of notarial services. It totaled 1,890 million *réis*, of which 98 million were borrowed as bottomry loans for overseas trade. The second and third type of obligations involved 330 million and 176 million *réis* respectively. Our data base concerns exclusively new debt but neglects bottomry loans because the interest rates charged comprised insurance premium and maritime contingencies. So, the remaining 1,792 million *réis* is the total volume we are analyzing. In the wording of contracts, the principal was physically transferred from the lender to the borrower in gold specie. According to the Portuguese monetary system, gold coins were worth no less than 2,400 *réis* which paid for 10 working days of unskilled labor (data from database Prices, Wages and Rents in Portugal (1300-1800)[5]. This is evidence that gold coins were not used in current transactions. Therefore the increased stock of this kind of money meant the growth of a store of value used as an asset for financial purposes. Thus, liquidity in our model refers to this role played by money.

According to the articles of 2,649 contracts (bottomry loans apart), the borrower was expected to have an asset to be used as collateral. This consisted of real estate (rural and urban property), jewels, public debt bonds, or land rents. In the remaining 134 cases of our sample, this article is omitted. Contracts either determined a fixed term or allowed for its extension (in 80 cases the maturity of the loan is not specified). The maturity of the loan could have been even shorter than one year, although 76% of cases mention one year or one year extendable period. In order to know how prorogation extended credit we made use of a fiscal source referring to an income tax (the *Décima* tax) which considered interest as an autonomous taxable income[6].

From these records, we find that a prorogation could extend the term for the repayment by 43 years, but this was far from common. The mode was in the 5-10 years interval. The market was opened up to the entry of diversified social groups, which supports the general intuition of previous studies suggesting that the market was a socially diversified one (Madureira, 1994; Rocha, 1996; Rocha 1998). In spite of the fact that all social categories are represented both as lenders and borrowers (see Table 1), commerce and professionals stand out as the categories that best describe the supply side, while the members of the nobility participated mainly as borrowers. The customers of the Barbuda office had a social structure similar to the one that we have inferred from shorter samples built up using the records of the *Distribuidor*, which covers all offices and thus guarantees that the selected notary does not have any substantial analytical biases (Costa, Rocha, and Brito, 2014). In any case, and contrary to what has been found in Paris, the credit market intermediated by notaries in Lisbon was not dominated by social elites, which does not, however, deny the fact that in Portugal too the nobility was highly indebted to

[5] http://pwr-portugal.ics.ul.pt/

[6] In 1762 the income tax called Décima, which had been created in 1641, underwent an administrative reform that shortened its operation procedures. The levy on loans, whether or not charged with interest, came to be registered in autonomous books. From 1770 onwards, even loans at zero interest rate were taxed based on the assumption that it was the lenders' risk to charge interest. This research took records of taxable income in four Lisbon parishes from 1763 to 1800 and compared them with credit intermediated by the notary selected for this study (Parishes: S. Paulo; S. Sebastião; Madalena; Mártires, Arquivo Histórico do Tribunal de Contas, Lisbon, Livros de Décimas de Juro; Archive references: DC 700MJ-DC 717J; DC 731J-DC 742J; DC 889J-DC 907J; DC 1128J-DC1147J).

businessmen and to peers (Monteiro 2003)[7]. The institutions that intervened in financing the social elites were brotherhoods (*Misericórdias*) and religious orders (Sá, 2002; Amorim, 2006).

Table 1 – Total credit shares and social ranks (1715-1800)

Social categories	Lenders	Borrowers
Administrative & Clerks	3.4%	6.2%
Commerce	22.9%	12.5%
Craftsmen & Laborers	6.1%	9.6%
Farmers & Fishermen	0.4%	1.2%
Foreigners	3.5%	2.4%
Military	3.6%	6.2%
Nobility	7.5%	14.0%
Professionals	18.8%	10.0%
Proprietors	4.6%	3.9%
Religious institutions	3.1%	9.9%
Services	1.4%	2.1%
Transport	0.2%	2.0%
Women	8.7%	3.4%
(Women-W)	(6.4%)	(7.5%)
Unclassified	9.3%	9.4%

Source: Cartório do Distribuidor, Arquivo Nacional da Torre do Tombo, Lisbon

The social identity of the actors involved seems decisive for the match between borrowers and lenders: the highest share of loans taken out by one social rank corresponds to borrowers belonging to the same rank. This is different from what happened in Paris. According to the argument of Hoffman et al., the diversified social strata of the parties to a contract were evidence of the need for the intermediation of these officers in the financial markets (Hoffman, Postel-Vinay, and Rosenthal, 1992; Hoffman, Postel-Vinay, and Rosenthal, 1998). If we followed the same reasoning, we would not draw the same conclusion from the Lisbon data since the common social ranking would denote the parties' previous acquaintance. However, in a social environment in which prior acquaintance might have been important, religious orders and women were notable exceptions. Women (single, married or widows) did not lend much of their money to other women. While they preferred to invest their money in noblemen's consumption needs, religious institutions put their savings in the hands of professionals.

The issue of the parties' prior acquaintance poses some questions about what notaries did in the Lisbon market. In a sample of 128 contracts, it was explicitly indicated that borrowers were aware of the lender's intention to use his financial wealth for the purposes of lending money, which suggests that borrowers and creditors knew about their mutual interests before going to

[7] All the references to notarial records and the credit market in Paris are based on (Hoffman, Postel-Vinay, and Rosenthal 2000).

the notary. This being the case, these professionals were expected to formalize a private agreement to serve as proof in the event of litigation. The notary's services guaranteed the lender that he would be assisted by a third-party institution, i.e., the courts. It can therefore be said that the contract minimized the lender's risk if the judicial system was effective in executing collaterals, and we know that some decades later, already in the 19th century, the judicial system did not actively encourage the development of credit markets (Reis, 2011). However, the idea that the judicial system was operative in eighteenth-century Lisbon is underlined by the fact that there were many obligations declaring an outstanding debt and a high rollover of debts in which it was explicitly stated that, once judicial proceeding had been initiated, collaterals were in the lenders' possession. The judicial system turns out to be fairly efficient in protecting lenders, thereby making collaterals also an effective device for monitoring borrowers. Moreover, collaterals were a condition for the entry of borrowers into the market, since they were responsible for providing documentary proof relating to their property rights over the collateral. In the case of real estate owned through emphyteusis, the debtor delivered the respective deed to the creditor[8]. Therefore, not only the parties' prior acquaintance but also the information available about the juridical status of collaterals suggests that notaries' involvement was limited to writing down a private agreement in order to provide proof in the event of litigation[9].

In summary, the bulk of the contracts that we analyze were signed between two parties belonging to the same social rank, with the majority of borrowers claiming that they needed the money for the consumption of durable goods (buying, building or refurbishing houses) or for a rollover of debts (Costa, Rocha, and Brito, 2014). Each contract points to an institutional arrangement designed to minimize information asymmetry.

Our aim is to use the data, whose context was a personal agreement, to extract macro-economic variables, such as a market interest rate. Contrary to what happened in Paris, obligations in Lisbon specified both the principal and the interest (as a percentage of the principal, not as a yield). In some cases, the parties declared their intention to deal at zero interest rates, either because of personal ties or goodwill. Such a situation was found in 292 of the contracts in our sample, which amounted to 6.2% of all the money that was lent. It is a situation that also became more common after 1765. Deals at 0% rate were not unknown, but they did not amount to a general rule. Such dealings have also been recognized for other places and other institutional environments (Fontaine, 2008). Even English banks engaged in this practice (Quinn, 2001; Voth and Temin, 2013).

In the next section we provide the quantities and the interest rates specified in our sample of 2,753 obligations.

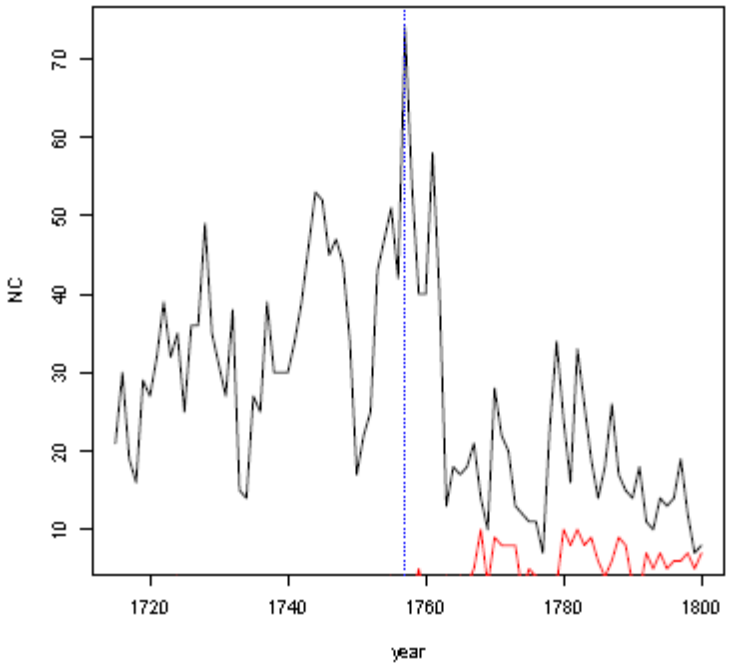
[8] Take the example of the words of one obligation: "mortgage of houses and shops [the borrower] owns which are submitted to emphyteusis by the municipality of Lisbon and he gave the respective legal documents of ownership". In all cases referring to incomplete property rights, the borrowers gave the respective contract to the creditor, suggesting the notary had no control over the documentation needed to enforce the credit deeds and ensure the role collateral played in this market.

[9] These circumstances mean that it makes little sense to conjecture about whether notaries reported actually ineffective deals due to the inefficiency of the institutions that should have assisted the parties. This makes the contracts a reliable documentary source for building several time series that describe the various dimensions of the credit market (interest rates, value of loans, collaterals, the uses made of the credit provided, and maturities of loans).

2.2. The evolution of contracted credit and interest rates

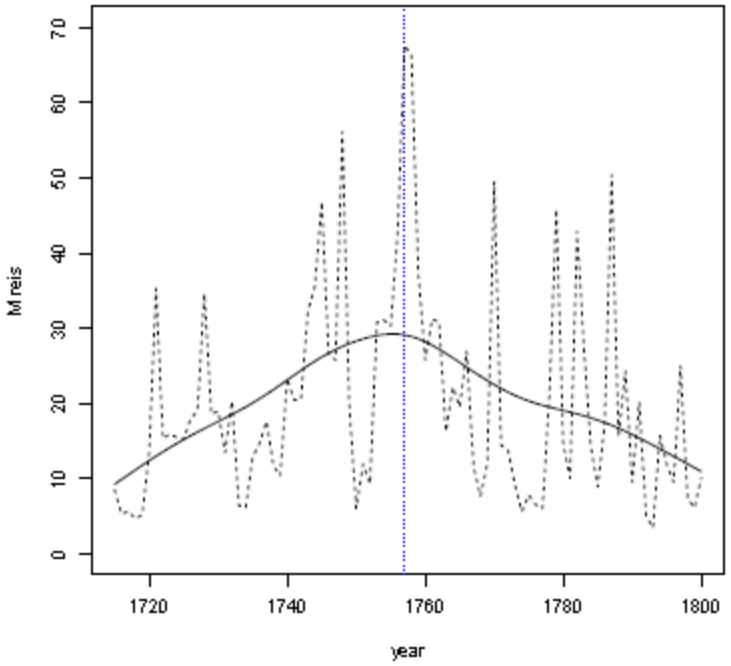
The number of deeds and the amount of the loans were quite volatile (Figures 1-2). However, we find an upward trend in the first half of the century, reaching a peak in 1757 and 1758, and a downturn afterwards, both as regards the number of deeds and the total number of the loans contracted. Inflation-deflated values display similar tends (Figure 3).

Figure 1. Number of contracts with positive and zero interest rates



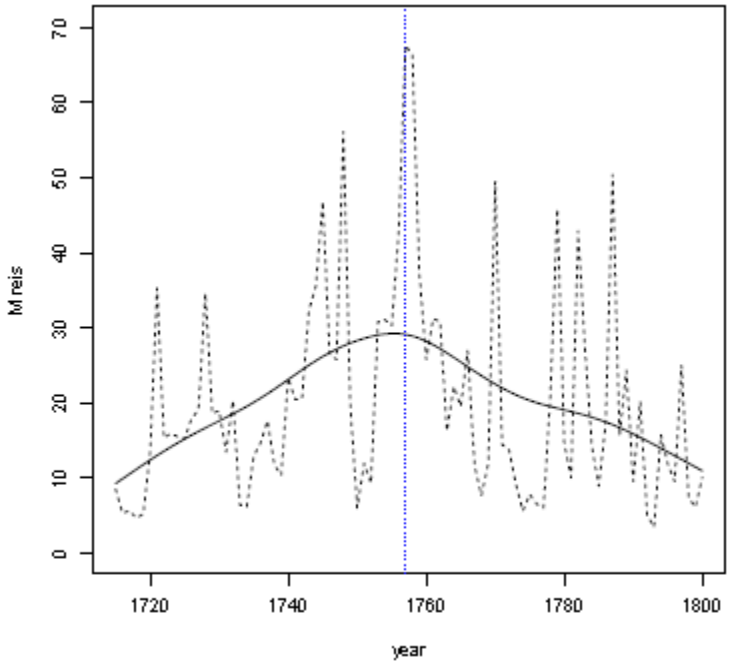
Source: Arquivo Distrital de Lisboa, Arquivo Nacional da Torre do Tombo, Lisbon, Notarial Deeds, 2nd Notary's Office of Lisbon (2º Cartório Notarial de Lisboa, antigo 1º)

Figure 2. Total credit (raw data and HP filtered



Source: see Fig.1

Figure 3. Total real value of the contract (raw data and HP filtered)

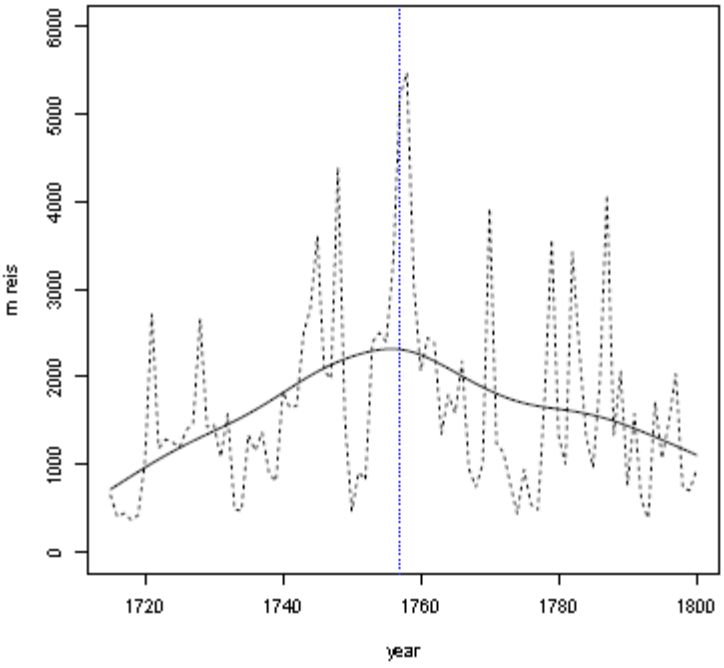


Source: see Fig. 1

It is worth recalling that the notary's office selected as our sample escaped from the destruction caused by the earthquake, and this office obtained a higher share in the market of notarial services from 1755 to 1770. Therefore, the reduction in the number and amount of loans must have been more pronounced in the city as a whole. The representativeness of this declining

trend is also apparent in the fiscal documentation relating to the *Décima* income tax that was referred to earlier. Data on taxable loans supports the idea of a contraction even in a parish urbanized after the earthquake, which underwent population growth and gradually changed its previous rural features, as happened in São Sebastião (Madureira 1992; Pereira, 2009). Negative tax incentives may have played a part in the formal credit market because the tax rate was raised from 4% to 10% after 1762 and in 1771 legislation forced notaries to provide information for fiscal purposes. The deeds were supposed to be compared with the taxpayer's own declaration of earnings. All in all, tax incentives might have interfered with the intermediation of notaries, thus the volume of credit is a variable affected by other factors than those strictly connected to the credit operations. Our sample comprises a large range of amounts from a minimum of 3200 *réis* in a 1719 contract and a maximum of 24,800,000 *réis* dating from 1787. The mean value of a loan is 1,535,992 *réis*.[10] The daily wage of a skilled worker provides a reasonable gauge for assessing the significance of these amounts. A mason's daily wage in Lisbon varied between 200 *réis* at the beginning of the century and 425 *réis* in 1800. Assuming 250 days for a year of work, the annual income of a craftsman in Lisbon would range from 50,000 to 106,250 *réis*. In short, the average value of a loan in this series is about seventeen times the annual income of a craftsman (a social rank that was actually in this market). However, as far as the whole time span is concerned, the average amount per contract follows a similar time path as the total amount (Figure 4). It displays a declining trend after 1760.

Figure 4. Average contract (raw and HP filtered)



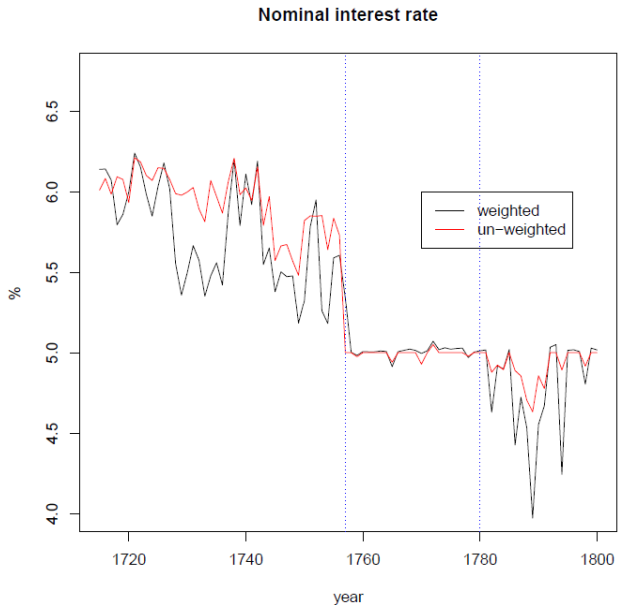
Source: see Fig. 1

If we analyze credit by nominal interest rates, the 18th century can be broken down into three phases. Interest rates (weighted by the value of contracts) declined until 1755 with short-

[10] The silver value of the Portuguese *real* varied during this century. It was worth 31.4 gr until 1733; 33.2 gr, from 1733 to 1746, and subsequently stabilized in 35.6 gr after 1747 until 1836 (Sousa, 2006).

term fluctuations, namely in the first three years of the 1750s, before the earthquake (Figure 5). Contracts at zero interest rates were not very common in this phase, although they became more frequent in the second half of the century. A second and third phase can be identified from 1755 onwards. The second phase coincided with the 5% ceiling on interest rates enacted by the law of January 1757 and lasting until 1779. In this phase, the ceiling seems to have been operative. However, after 1780, and for at least a large part of the period, although the legal cap was still imposed, there was significant number of contracts at rates below 5 % suggesting that the ceiling was no longer operative.

Figure 5. Average nominal interest rate, weighted and unweighted



Source: see Fig. 1

The positive interest rates charged varied from one contract to another within the same year. Rates ranged from 2.5% to a maximum of 6.25%, with 5% and 6.25% being the most frequent cases. In general, the 6.25% rate becomes less frequent from the beginning of the time series and disappears after 1757. The 5% rate displays the opposite trend. In the last two decades of the 18th century, there was a greater variation in the interest rates charged, with several contracts at 3%, 3.5% and 4%. Notwithstanding the multiplicity of interest rate contracted, the overall view provided by a weighted average points to a decreasing trend throughout the eighteenth century (Figure 5).

This series provides irreplaceable information about the working of a credit market in an early modern economy. It is a long-term series of a private market interest rate, dealing with short-term credit. The lack of similar data for other economies prevents us from adopting a fully comparative approach. Information available for private markets and short-term credit that would point to free fluctuations of interest rates have been taken from bills of exchange (Neal, 2015; Edvinsson, 2011) which implied an exchange premium. As for the best studied national cases, such as France or England, private and short-term bank loans operated under usury laws. In any event, there is evidence that in some periods of the 18th century, interest rates could have been

lower than the 5% ceiling, falling below 4% (Voth and Temin, 2008; Hoffman, Postel-Vinay, and Rosenthal, 2000).

From our entirely new series, we learn that interest rates fell 2 % in Portugal throughout the 18th century. In 1715, when there was no legal cap in Portugal, the loans charged a 1.25 percent premium higher than in England or France, where a 5% ceiling had been enacted. However, by the end of the century, all these three markets were operating under the same legal ceiling. Both in Portugal and in England there is evidence that this ceiling was becoming inoperative, which points to some mechanisms of interest rate arbitrage, since exchange rates remained roughly constant. To understand this evolution, we examine the relationship that can be established between monetary variables and a natural catastrophe as two challenges that the Portuguese economy faced in this century. The next section describes the significance of both events, which might have influenced the environment in which the credit market operated.

3. Monetary and economic environment

3.1. Monetary expansion

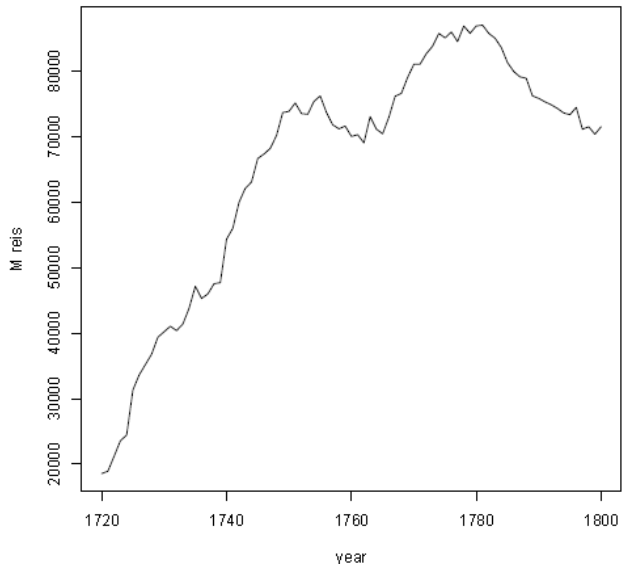
After the discovery of gold mines in Brazil in 1690s, Portugal entered into the world market for precious metals, which were used as money, whether in bullion or coined. Throughout the 18th century, the kingdom imported 557 tons of gold, the equivalent of 271 billion *réis*, (75 million pounds sterling) or 90 times the annual budgetary receipts of the state in 1716. Approximately 1/5 of this amount of gold flowing into the country derived from a tax (the so called fifth) imposed on mining production and thus pertaining to the state. The remaining 4/5 was private property (Costa, Rocha, and Sousa, 2013: 72).

About 77% of the gold came into Portugal in the form of currency since coins were minted in Brazilian Mint Houses. The desegregation of the remittances into the state and private agents shows that the preference for gold-money was stronger among private agents (91% as against 29% in state remittances). Thus, the production of the Lisbon Mint House was mostly dependent on the state's orders, which represented only a minor part of the total stock of monetized gold in the country. By the same token, the systematic study of remittances permits the conclusion that the kingdom was receiving most of the gold already coined, meaning that the main use given to the metal was the issue of money. Therefore, the idea of a waste resulting from the use of gold as an ornamental material must also be discredited. Still, the widespread belief that a large part of this monetary wealth went abroad should guide our approach on the impact of this inflow. About 70% of the gold which arrived tin Portugal spread throughout Europe to finance the deficits of the Portuguese trade balance, which were particularly severe with Britain (Fisher, 2006).

Portugal's economic history literature about the 18th century has focused on the impacts of the gold flows both for a possible “Dutch disease effect” during the upsurge phase and for the critical adjustment effects driven by the downward phase, as far, for example, the case in Spain regarding the impact of silver on the Spanish economy (Costa, Lains, and Miranda, 2011; Drelichman, 2005). The government led by the Marquis of Pombal (1750-1777) is presumed to

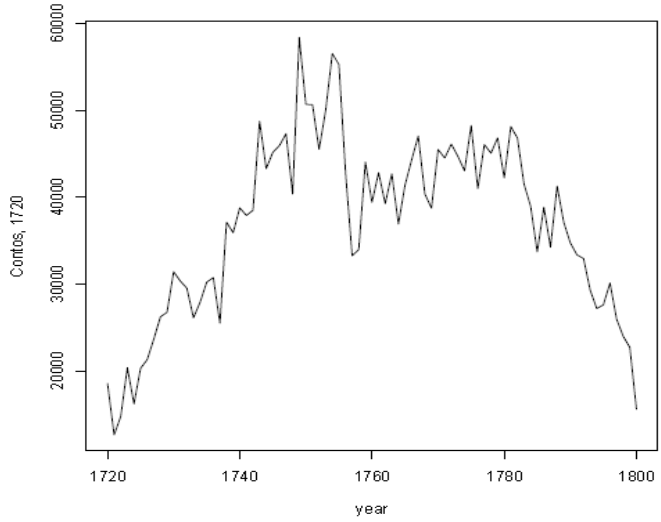
be contemporary to the onset of the less "golden" period. Portuguese historians have predominantly considered that the reduction of gold inflows during Pombal's government triggered a financial crisis which inspired his import-substitution policy to promote manufacturing and erect barriers to foreign capital in the Portuguese colonial system (Godinho, 1955; Macedo, 1982; Pedreira, 1994). A recent study of gold remittances has raised doubts about the onset of the gold downturn (Costa, Rocha, and Sousa, 2013). On the one hand, private agents' remittances peaked in the 1740s. In the period from 1770 to 1774 (the final years of Pombal's government) these remittances were at a level close to that reached in the 1730s. Thus, the postulation that has been made by historians of a financial crisis caused by a slump in gold inflows leads to one of two possible inferences: (1) the crisis must have occurred earlier, in 1740s and not during Pombal's government or (2) there was no financial crisis whatsoever before 1770s. As for the state's remittances, these amounts reached their highest level of the whole century in 1760s, in the middle of Pombal's government. Therefore, there is evidence to dispute the common view of a financial crisis in the middle of the 18th century. New data series on the money stock, which concentrates on stock accumulation instead of flows, paint a different picture. The assessment of the inflows and the exportation of gold to finance current account balances has provided a series that tells us a remarkable stock accumulation of money throughout the whole century until 1780 (Figure 6).

Figure 6. Nominal stock money



Source: Costa, Rocha, and Sousa, 2013

Figure 7. Real stock money (1720 prices)



Source: Costa, Rocha, and Sousa 2013 and Wages and Rents in Portugal (1300-1800) (n.d.)

The fall in remittances after 1756 highlights the effects of the most pronounced deficits in the trade balance after the earthquake. A lot of gold was exported at that time to pay for imports. Once the tragic impact of the catastrophe had dissipated, the stock continued to rise and in 1770s surpassed the level attained in 1755. The definitive downturn began in the early 1780s. In 1800, the nominal money stock was at the level already attained in the mid- 1760s. A comparison of the Portuguese monetary wealth with that of Great Britain underlines the particular features of the Portuguese economy.

Both Portugal and Great Britain attained roughly equal values in terms of their money stock in 1760 (20 billion pounds sterling), despite the fact that in 1688 the latter's money stock had been about 9.5 times the size of the former's. Therefore, the first half of the 18th century was a period of outstanding growth in the monetary wealth of Portugal. However, from 1760 onwards, the money stock in Britain more than doubled while in Portugal it almost stabilized, remaining pegged to precious metals (21, 8 billion pounds sterling). In per capita terms, the comparison shows that, in 1760, the Portuguese money stock was three times that of Britain's, but that, by 1800, its value was only 1.4 times greater (Portugal, (Costa, Rocha, and Sousa, 2013: 106), Britain, (Lindert, 1985)).

The impact of this inflow on prices did not become evident until 1780. However, the price index points to twenty years of inflation (common to the whole of Europe), from 1780 onwards. Therefore the real money stock fell sharply thereafter (Figure 7). The money stock series provides a time frame for the economy which is different from what we would expect from the pace of reconstruction of Lisbon. In fact, data point to a thirty-year period of recovery, which means that, in 1780, when the money stock began to decline, the number of houses in Lisbon has almost returned to the level that had existed on the eve of the earthquake.

3.2. The 1755 earthquake

The phase of relative growth in the credit contracted through our notary's office, where amounts increased and interest rates decreased, coincided with the most pronounced rise in the nominal money stock. The downturn occurred after November 1st 1755. Our present knowledge of the damage caused by the earthquake is based on reports from the time, submitted to historians' heuristic readings. Up to 20% of fixed capital must have been destroyed (Pereira, 2009). No war could have caused such an economic damage at that time. In Lisbon alone about 12,000 houses (10% of the housing stock) crumbled, and 30% became uninhabitable (Serrão, 2007, 161). The cost of the damage exceeded 15, 520 million *réis*, if public buildings are considered (palaces, churches, monasteries and state buildings (Cardoso, 2007: 166). However, one important public building, the Mint House, was spared. Reports of the time commented on the significance of such a fortuitous event, since a great deal of private remittances of gold coins, which had arrived in the last fleets from Brazil, was still stored there. The high level of physical capital depletion was not matched by a loss in money wealth, in the form of gold coins. The abundant descriptions of the tragic event that befell the city and its inhabitants refer to the possibility of recovering personal savings beneath the rubble, namely gold coins, which thereafter circulated bearing signs of the fires that had also contributed to transforming Lisbon into a scenario of destruction.

From the perspective of the credit market the earthquake had several possible consequences: the immediate destruction of wealth, but also the potentially huge need to finance the reconstruction. Unlike other recorded cases (v.e., the 1906 San Francisco earthquake, see (Odell and Weidenmier, 2004) a financial crisis did not ensue because the mechanism generating the inflow of liquidity was spared in the case of Lisbon.

We conjecture that the destruction of wealth had different impacts for lenders and borrowers. For the fortunate survivors (in both the physical and financial sense), the catastrophe offered possibilities for returns, but also involved potentially high risk given the destruction of collateral incurred by the less fortunate people whose houses had been destroyed. Table 2 shows the available date about the number of hearths in Lisbon for the period 1590 to 1800, which makes it possible to build up a time series used as a proxy for the wealth that could have been pledged as collateral.

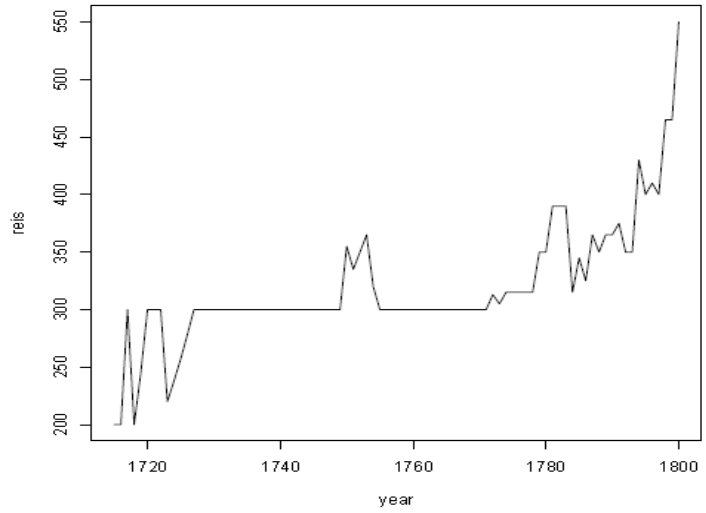
Table 2 – Hearths in Lisbon

year	1590	1700	1755	1760	1780	1800
hearths	30000	31141	33310	22900	33764	44057

Sources: Madureira (1992) and Pereira (2009).

We can see that the earthquake destroyed roughly 30% of houses in Lisbon but that around twenty five years later the housing stock was close to the level that had existed before the earthquake. In fact, in 1757 and 1758, more than 50% of the loanable funds contracted by the notary analyzed in this paper were related to the reconstruction needs of the borrower, making up a "golden age" of investment in residential capital. Construction might have driven the demand for labor. The wages of stonemasons and carpenters rose immediately after the earthquake, showing a pronounced peak, which interrupted the flat trend that had started in the early 1720s. (Figure 8).

Figure 8. Nominal wages (stonemasons in Lisbon)



Source: Database, Prices, Wages and Rents in Portugal (1300-1800)

From 1760 onwards, wages returned to the level prior to 1755 (around 300 *réis* a day). The long-term trend corresponded to the price index stability we mentioned above. A sustained rise in nominal wages can be observed after 1780, when prices also went up. Close to the end of the century, nominal wages were about three times higher than at the the beginning of 1700s, although, in real values, they were quite close to the values of 1720.

3.3. **The legal ceiling on interest rates**

The rebuilding of Lisbon took place at the time when there was a 5% legal ceiling on interest rates. The royal act of 1757 did not mention any catastrophe or demand shock whatsoever. It was claimed that interest rates had been climbing to the point where some businessmen were charging 1% interest per month. We did not find any evidence about this, and it is worth noting that in our series the average interest rate did not reach its peak in 1756. However, the maximum aggregated volume of credit reached in 1757 and 1758 was possibly a response to this cap. Thus, either the legislation anticipated events, foreseeing that rebuilding would push demand, or it had itself caused a demand shock.

The measures imposed by the Marquis of Pombal were in line with the rare previous experiences in Portuguese history of establishing a cap on interest rates. The legislation dating from 1698 fixed 5% interest for perpetual annuities, and 10% or 12% for life annuities[11].In the Iberian market, both perpetual and life annuities (*censos consignativos*) were pegged to farm income. The lender had the right to a share of the output from an estate which the borrower was somehow entitled to. So, the legislation thought to establish a cap on the share of the rent transferred by means of these contracts. It did not include short-term obligations contracted through notarial deeds. Hence, obligations could mention 6.25% interests. Therefore, Pombal's legislation turns out to be different from these prior experiences of interest rates regulation.

The flat line introduced by the Pombal's law extended to 1780, and we question whether the ceiling caused rationing as happened elsewhere in Europe, namely in England from 1714 onwards when the state imposed the same 5% ceiling. In Lisbon, too, the state's intervention could have slowed down the pace of the city's reconstruction by making supply more stringent. But it is also possible that the legal cap was close to the equilibrium interest rate. It might have happened that the fall in demand caused by reduced wealth of borrowers fixed the notional equilibrium interest rate at below the legally imposed 5%.

In the next section, we will use the clauses of contracts to estimate a market interest rate and use this new series to answer the questions posed above about the impact of liquidity, wealth and the legal caps imposed on the functioning of the credit market.

4. A partial equilibrium analysis of the obligations market

So far, our analysis has been guided by the words of contracts drawn up between two individuals, lenders and borrowers, about whose characteristics we have no quantitative information. Our intention, however, is to extract information about the interest rate that is representative of the workings of the credit market, in a partial equilibrium context, from the information available about the contracting parties. For this purpose, we assume that each contract is an instance of a successful (partial) equilibrium matching, in particular the amounts and the interest rates contracted.

We use i_j to denote the contractual interest rate and $l_j = \log L_j$ is the log of the amount of credit, in contract j. The supply and demand behaviors can be generically formalized by functions $l_j = f^s\left(i_j, X_j^s\right)$ and $l_j = f^d\left(i_j, X_j^d\right)$ where X_j^d and X_j^s are exogenous variables affecting demand and supply, respectively. The notional equilibrium pair, denoted as $\left(l_j^n, i_j^n\right)$, is the unconstrained solution of the system coupling the demand and supply equations. If there is no interest rate ceiling, or the ceiling is not operative, then the observed contract pair verifies $\left(i_j, l_j\right) = \left(i_j^n, l_j^n\right)$. If the 5% ceiling is operative, we have $\left(i_j, l_j\right) = \left(5\%, l_j^c\right)$ where $l_j^c = \min\left\{f^s\left(5\%, X_j^s\right), f^d\left(5\%, X_j^d\right)\right\}$ and there is (disequilibrium) credit rationing.

The vectors X_j^s and X_j^d include idiosyncratic and general magnitudes (i.e., ones that are related to the parties or to the general economic environment) which are actual or expected.

[11] Legislation from May 23rd 1698, which did not alter the rules for such contracts already established by the laws issued on December 13th and October 12th, 1643.

Except for the qualitative information relating to the social categories of the parties, the idiosyncratic variables are completely unobservable to us. "The" market interest rate that both parties could obtain for their savings or pay for alternative debt contracts should be included i8n the information set associated with the aggregate variables. This rate is also unobservable to us given the non-existence, at the time of banks or any organized form of credit. The difference between the contracted and the market interest rate determined the credit premium which was associated with the idiosyncratic characteristics of the parties.

We devise a method for extracting these idiosyncratic characteristics and building up a market interest rate from the contract data in subsection 4.1. In addition to the credit premium, we assume that most of the variability of the idiosyncratic characteristics of the parties should have been absorbed by the volumes of the contracts. This means that the only contractual information that can be extrapolated to the whole credit market in Lisbon is the interest rate. In section 4.2, we use this market interest rate and regress it on the aggregate information presented in section 3.

4.1 Obtaining a market interest rate

Given the nature of our sample, the values of the loans contracted cannot be seen as representative of the credit market in Lisbon in the eighteenth century in a wider sense. However, if we clear them of statistically significant idiosyncratic components, we may expect to estimate a market interest rate from notaries' records.

Let us consider again the socio-economic categorization of borrowers and lenders shown in Table 1. This is the only specific information we can use for characterizing their behavior, for purposes of identifying the supply and demand variables underpinning the obligation contracts. We assume that the behavior of every member within each category is homogenous. That is, they only differ in their wealth or borrowing/ lending capacity, but not in their information.

A specific pair of borrower-lender (b, l), successfully matching in contract j, is characterized by the equations

$$l_j^l = \alpha_0^l + \alpha_i^l i_j + \alpha_X^l X_j + \alpha_j^l \quad (1)$$

$$l_j^b = \alpha_0^b + \alpha_i^b i_j + \alpha_X^b X_j + \alpha_j^b \quad (2)$$

$$l_j = l_j^l = l_j^b \quad (3)$$

where X is the vector of information shared by both parties, unobservable to us, and α_j^l and α_j^b are the idiosyncratic components in the contract j, for borrowers and lenders, respectively. If we solve equations (1)-(2) for X_j and l_j, and pick up the resulting equation for l_j, we get a relationship between the contracted loan and interest rate and the idiosyncratic components of both parties,

$$l_j = \beta_0 + \beta_i i_j + \beta^l \alpha_j^l + \beta^b \alpha_j^b.$$

The parameters affecting the idiosyncratic components, α_j^l and α_j^b can be identified[12] which allows us to consider two types of equilibrium: there is a separating equilibrium involving

[12] Although we cannot identify the other parameters, this is unimportant for our analysis.

borrower b (lender) if $\beta^b(\beta^l)$ is statistically different from zero, and there is a pooling equilibrium involving borrower b (lender) if $\beta^b(\beta^l)$ is statistically equal to zero.

We interpret the first case as an instance in which the other party was able to observe the characteristics of the covenant and tried to establish the contract wording accordingly. If β^b is positive (negative) we interpret this as evidence that borrows higher (lower) amounts than the average in the market, for a given interest rate. In the first case, this can be an indication that the borrower's creditworthiness (which should be directly related to his collateral) is idiosyncratically higher than the average. In the second case it indicates a higher potential for moral hazard assessment. If β^l is positive (negative) we interpret this as evidence that category l lends higher (lower) amounts than the market for every interest rate; in the first case, the level of wealth (in the form of money) of that category should be higher and/or has greater ability to monitor the service payments associated with the credit contract[13] .

For those cases in which β^b and β^l are equal to zero, we can be in the presence of a standard moral hazard problem that we assume can be bilateral[14]. There is usually equilibrium credit rationing in this case, but we cannot observe its extent because of the survivorship bias (our data only contain successful contracting) which can be presented in the data. Nevertheless, we take these pooling equilibria contracts as representative of the equilibrium market conditions and use them to build a market interest rate series.

We run the regression

$$l_j = \beta_0 + \beta_i i_j + \sum_{b=1}^{14} \beta^b D_j^b + \sum_{l=1}^{14} \beta^l D_j^l + \varepsilon_j \qquad (4)$$

where ε_j is the error term, and $D_j^b\left(D_j^l\right)$ is a dummy variable which takes the value of 1 if category $b\,(l)$ is involved in the contract j as a borrower (lender). Table 3 brings together the main results[15].

As borrowers, noblemen and religious institutions tend to borrow higher quantities: that is, for the same interest rate they borrow more or they get a lower interest rate for the same level of borrowing, when compared to the other social categories. Together with proprietors, these categories lend higher quantities as well: that is, for the same interest rate they tend to lend more or they charge a lower interest rate for the same level of credit granted. This indicates that they have higher collateral as borrowers and larger loanable funds (or a higher monitoring capacity) as lenders. Some other categories were in a symmetric situation. Services, which include a large share of domestic servants, and transports tend to contract lower amounts as lenders. As borrowers, those categories, together with farmers, craftsmen and proprietors, participate in contracts in which the idiosyncratic component is negative, indicating lower wealth and/or a negative informational assessment by the covenant.

[13] We neglect the functioning of judicial institutions and the expectations of subsequent court action (Reis (2011) although several cases in our sample refer to judicial actions and the role of collateral to protect the lender in court. We assume that interest rates are higher (lower) than the mean and not riskless interest rates according to the wealth of borrowers and the quality of collateral.

[14] If the lender cannot observe the characteristics of the borrower, we have the case found in Stiglitz and Weiss (1981). However, it is also possible that the borrower cannot observe the characteristics of the lender, in which case the contract offered to him can also be subject to moral hazard in the sense that the borrower is unable to observe the monitoring capabilities of the lender and is charged a higher interest rate.

[15] It is based on the regression results, using three different kinds of estimators, which are presented in table 5 in appendix A.3.

Table 3 – Categories and idiosyncratic components

sign of β^b	
zero	Clerks, Foreigners, Women, Unclassified, Military, Professionals, Commerce
positive	Noble, Religious
negative	Farmers, Craft, Services, Transport, Proprietors
sign of β^l	
zero	Clerks, Farmers, Craft, Foreigners, Women, Unclassified, Military, Professionals, Commerce
positive	Proprietors, Noble, Religious
negative	Services, Transport

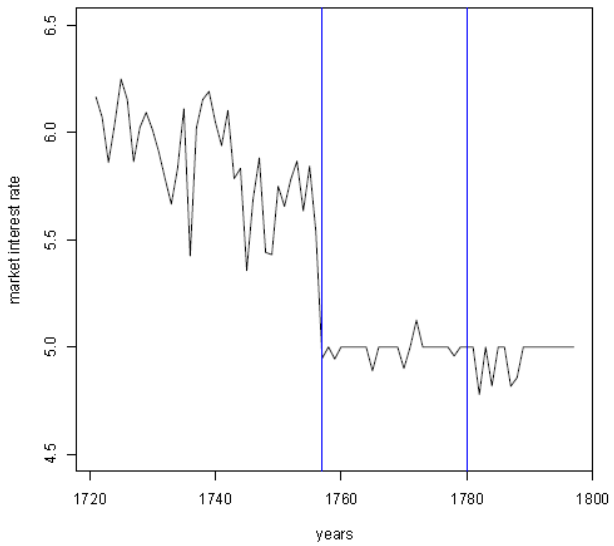
Finally, contracts involving categories of parties such as foreigners, professionals, commerce and military can be considered as instances of pooling equilibrium contracts because we were not able to find statistically significant idiosyncratic parameters. Hence, these categories, which significantly pointed to commerce as being representative, are those that perform the sample to estimate a market interest rate.

We define the annual market interest rate as the weighted average

$$i_t^m = \sum_{k=1}^{n_i} w_k \, , t^i k$$

where $i_k \in \{2.5\%, 3\%, 3.25\%, 3.5\%, 4\%, 4.5\%, 5\%, 5.5\%, 6\%, 6.25\%\}$ are the observed interest rates in all the contracts performed in the period under study, and the weight $w_{k,t}$ is the frequency of the contracts performed by borrowers and lenders having coefficients β^b and β^lstatistically equal to zero (see Table 3) at a rate i_k within year t. This series is illustrated in Figure 9 and is displayed in Table 6 (Apendix A.4).

Figure 9. Market interest rate



In the next section we take this series as a market interest rate, and consider data on the economic environment in eighteenth-century Lisbon from section 3 as representative of the factors influencing the parties involved in the credit market.

4.2 A partial equilibria model for the behavior of interest rate

The information we gathered on the predominant purposes of contracts (roughly 67% for consumption purposes, including 33% for housing, and 23% for other purposes including productive and trade activities, (Costa, Rocha, and Brito, 2014), and the characteristics of the parties involved, led us to the conclusion that the main purpose of contracts was linked to intertemporal consumption smoothing by both lenders and borrowers. That is, we can exclude the financing of productive activities as being the main use of credit and thus exclude corporate finance theory (as in (Tirole, 2006)) as a modelling approach.

Lenders were people with excess liquidity. They were not willing to use their money for immediate consumption, and did not have many ways of applying it other than in (basically) IOU contracts. By doing this, they obtain a prospect of extra income in the future allowing for a higher level of future consumption (including durable goods or real estate). Due to the existence of moral hazard, the income that was pledgeable by borrowers could deviate from the contractual interest rate. This induced lenders to ask for collateral, which in the most cases took the form of real estate. Therefore, the ex-post rate of return for lenders would be higher the higher the contractual interest rate and the collateral. Then, we take the supply of credit function, in year t, as the function $l_t^s = f^s\left(i_{t,}H_t,M_t\right)$, where M_t is the loanable funds and H_t is the real estate of the borrower pledged as collateral. The function $f^s(.)$ increases in all three arguments: the supply of credit increases with the amount of loanable funds and the prospective rate of return.

As real estate was a significant form of wealth. In this economy, real estate has several functions, as a component of the financial wealth, as a signaling device as a collateral in the credit transaction, and as the main application of the borrowed funds. It would also be possible to consider that it could positively influence the supply of credit, although during this historical period we may regard these assets as being essentially illiquid and generating other forms of income. However, the sign of the eventual wealth effect originating from housing owned by lenders would be symmetric to the sign of the real estate owned or purchased by borrowers. Having no quantitative data assigning the stock of houses to each type of participant, we cannot distinguish between two symmetric wealth effects. We use the stock of hearths constructed in section 3 as a proxy for the sum of the stock of houses owned by both borrowers and lenders.

Borrowers were people in a symmetric situation. At the moment they signed the contract, they wished to consume a higher level than their current income would allow them to purchase and were willing to forego future consumption after paying the loan interest and principal. Conceptually we have the same case for both non-durable and durable goods: buying a house, financed by a loan, allows for consumption smoothing because it generates a steady stream of sheltering services for the borrower and thus avoids having to pay a rent to secure them.

A loan taken out to finance a purchase of a house represents an increase in the existing wealth of the real estate owned by a borrower: in this case we have roughly $H_{t+1} = l_t^d + H_t$. However, if a borrower already had some real estate, this meant that he could save part of the future costs in sheltering services, which in turn meant that he could finance a larger immediate increase in present consumption. Then, there is the positive wealth of the real estate the borrower already had at the time when the contract was signed. There is also the additional wealth effect associated with what economists call "human capital": the present value of future wages. If we assume wages are expected to be constant in nominal terms, we can proxy the borrower's capacity for servicing the loan by the ratio between his wages and the contractual interest rate, W_t / i_t. Thus, we can write the demand for credit function as $l_t^d = f^d(i_t, H_t, W_t)$, where W_t is the wage rate and H_t is the real estate owned by the borrower. The demand function, $f^d(.)$, decreased in the contractual interest rate i_t and increases in the other two arguments.

If we solve for the market equilibrium, where demand equals supply for credit, the notional interest rate is a function of the stock of money, the stock of houses and the wage rate, $i_t = F(M_t, H_t, W_t)$,where we expect that the effect of M_t is negative, the effect of M_t is non-negative and the effect of H_t is ambiguous. As we have already seen, from the several functions of money (means of exchange, means of payment and reserve of value), given the denomination of the monetized gold from Brazil, the financial characteristics tended to be the dominant one. Therefore, our conjecture is that expansions in the money stock through an increase in loanable funds should reduce the interest rate. The final effect of changes in the stock of hearths has an a priori ambiguous effect on interest rates: the stock of hearths of borrowers increases demand and therefore the interest rate; however, an increase in the collateral reduces moral hazard and therefore tends to reduce the cost of credit, just as an increase in the stock of houses by lenders increases the supply of credit. Human capital of borrowers, measured by their expected future wages, plays a similar role to the stock of houses (proxied by number of hearths).

The former theory can be tested if the behavior of both parties is not directly determined by the 5% ceiling, that is, for periods in which it is close to the "notional" interest rate. To do this, we estimate the parameters β of the equation

$$i_t^m = \beta_0 + \beta_M \log(M_t) + \beta_H \log(H_t) + \beta_W \log(W_t) + \varepsilon_t \qquad (5)$$

where M_t is the stock of gold, H_t is the number of hearths, W_t is the wage rate, ε_t is the error term[16]. As we only have a proxy for the total stock of houses, if the sign of β_H is positive, this means that the wealth effect on credit demand is dominant, and if it is negative, then the informational role is dominant (or the wealth effect for lenders is dominant, although we find this case to be less likely).

We used the following method:

[16] We also considered the case in which all the variables are expressed in real terms, but we obtained inferior results. This is not surprising because the price series displays a much higher volatility than both the nominal interest rate and the other explanatory variables, even in the case in which we consider 3-year moving averages.

1. we ran the regression using the period in which there was no ceiling (1719-1756) and when it was not operative (1780-1797). To test for structural change we introduced a dummy variable associated with the 5% ceiling (essentially it has the value of 0 before 1757 and 1 from 1757 onwards).

2. then we used the estimated parameters to predict the interest rate for the period in which the ceiling was operative: 1757-1779. This provides both a check on the predictive power of the estimated equation and an assessment of the deviation of the 5% ceiling from the notional interest rate.

Regressing equation (5) with annual data for the years 1719-1756 and 1780-1797 and using robust least squares regression, we find

$$i_t^m = 5.86^{***} - \underset{(0.6)}{0.34^{***}} \log(M_t) + \underset{(0.07)}{0.38^{**}} \log(H_t) - \underset{(0.11)}{0.22^{***}} D_{c,t} \underset{(0.02)}{\log(H_t)} \qquad (6)$$

where *** and ** refer to *p*-values $p < 0.001$ and $p < 0.01$, and D_cDc is a dummy variable denoting the Marquis of Pombal's ceiling on interest rates which takes the value of 1 after 1757. The time series for stock of houses hearths and wages are highly correlated (the correlation coefficient is around 70% for whole sample period), but our regression results indicate that the first lead to better results[17].

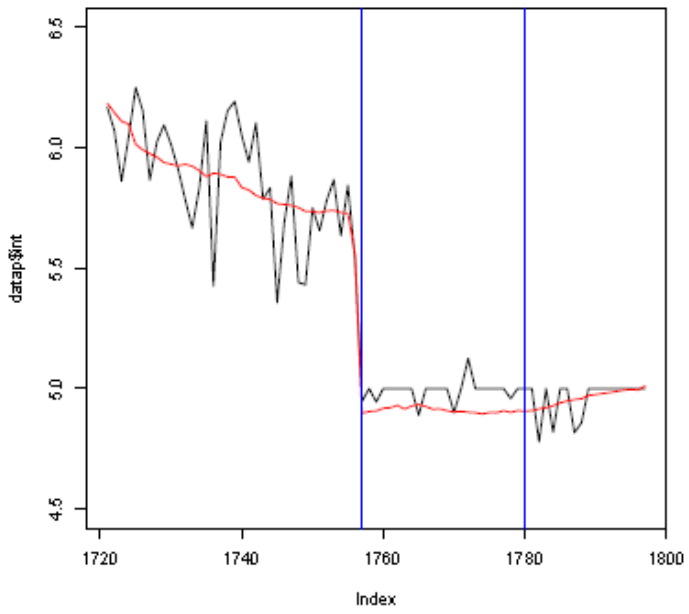
The results from the regression feature: (1) a negative, robust[18] and time-invariant negative effect of the money stock on the interest rate; for a 1% increase in the money stock the rate of interest was reduced by around 0.34 percentage points; (2) a positive but time-varying effect of changes in the stock of housed on the interest rate; an increase in 1% in this stock increased the interest rate by 0.38 p.p before the ceiling (or the earthquake) and by only 0.16 p.p afterwards. Thus, the wealth effect on borrowers' demand dominates in all of the sample period, but the significant reduction in the coefficient after the introduction of the ceiling (and the earthquake) indicates a higher sensitivity to the informational aspect (and less likelihood of being influenced by the wealth effect for lenders). This could have been a consequence of the fact that there was a significant amount of loans collateralized by the houses financed by them and an increase in the share of housing loans in the total amount of contracts.

The interest rate predicted by the model for the period in which the 5% ceiling was operative can be seen in Figure 10. We observe that it is statistically indistinguishable from the ceiling indicating that it was very close to the notional interest rate. We see this as a good empirical corroboration of our equation (5).

[17] See alternative regressions in appendix A.2.

[18] If we consider alternative specifications and regression methods, the coefficient for money is always significant and lies within an interval between -0.33 and -0.38 p.p..

Figure 10. Actual data and in and out-of sample forecasts for the interest rate for model 1



According to our model, the driving force behind the slow reduction in the interest rate before the earthquake was monetary expansion, which was less than offset by the increase in the stock of houses. The sharp decrease in interest rates that immediately followed the earthquake can be explained by the contraction in the demand for credit that resulted from the destruction of houses and the consequence operation of the wealth effect. In this period, the reduction in the stock of gold was not enough to counter the destruction of capital. The period after the earthquake, and the imposition of an interest rate ceiling, was influenced both by that ceiling and by the fact that there were contradictory developments in the money and housing' stocks.

The reduction in the stock of gold may have induced an increase in the interest rate (and disequilibrium rationing) but the slow reconstruction from a much reduced stock of houses (and the increase in their informational role) may have implied the opposite. However, the reconstruction operated by increasing demand for credit tended to make the ceiling operative again closer to the end of the period. In this period this effect was hampered by the increased informational role of the stock of houses as collateral.

5 Concluding remarks

The historical evidence relating to Portugal's enduring growth in liquidity, granted by its South American imperial economy, shows a 2% annual rise in the stock of monetary gold throughout the 18th century. That rate of growth was certainly higher than the rate of growth of the country's GDP per capita. Thousands of notarial contracts relating to short-term obligations allow us to document the consequent effect of that inflow on the workings of the credit market in Lisbon. This market was affected by two other major events: a sudden and significant destruction

of real estate brought about by the 1755 earthquake, together with a different legal framework resulting from the enactment in 1757 of a usury law that imposed a 5 % ceiling on interest rates.

A partial equilibrium model has been put forward for the determination of the market interest rates consistent with those three events. In particular, interest rates should decrease with the supply of loanable funds and should incorporate the wealth and informational role resulting from variations in the stock of real estate (measured by the number of hearths) and pledged as collateral. An assessment of the severity of the (disequilibrium) credit rationing generated by the 5% ceiling imposed on interest rates should be a corollary of the model.

Our sample of market interest rates (based on a sample of around 2,700 contracts) pointed to a decline of 1.25 percentage points throughout the 18th century. As conjectured, liquidity was a statistically significant and robust explanatory variable: for every 1 % increase in the stock of money, interest rates declined by 0.34 percentage points throughout the sample period. The evolution of other forms of wealth took place through several different channels, in particular wealth effects and informational effects (as collaterals). Our statistical model shows that the net effect on the demand for credit was the predominant one, although there is evidence of structural change after the earthquake making the collateral role played by housing role more important.

According to our model's prediction for the notional interest rate, the 5% legal cap enacted in 1757 did not generate a significant credit rationing. This allows us to conjecture that the credit ceiling did not have a significant effect on the pace of Lisbon's reconstruction. AS far as the relative speed of this process is concerned, the existence of liquidity may have been instrumental. The process lasted two decades, and was reflected in a 1.96 percent annual rate of growth of residential capital (as compared to a rate of 0.12 percent from 1700 to 1755). The stock of residential capital kept rising thereafter at a rate of 1.34 percent. However, the earthquake might have led to a contraction in the demand for credit due to the reduction in borrowers' capital. Therefore, in the 1780s the legal cap was not operative, i.e., interest rates negotiated in the presence of notaries were lower than 5 percent in many instances. In the 1790s, the notional interest rate again reached the level of the legal cap, which shows how it was affected by the relative variation in the money stock, which displayed then a contracting trend.

Our conclusions highlight the role played by monetary variables in the functioning of credit markets in early modern economies. The non-existence of a central bank and the lack of a monetary policy in the modern sense, provide us with an actual example of a non-sterilized money shock experiment. This is the closest we can get to a textbook example of the impact of liquidity changes on interest rates, which is harder to perceive when the money supply is controlled in accordance to monetary rules or other macroeconomic stabilization policies.

Although liquidity is a central variable in the economics of financial intermediation, the economic history literature has ignored it as a variable that is closely related to interest rates trends in the long run. Our study showed that the money stock must be included within (or studied together with) the range of long-term factors that affected interest rates in Europe: at least, the whole of the early modern period features regular inflows of financial wealth, in a monetary form, coming from either Spanish or Portuguese South American colonies which contributed to the rise in the stock of precious metals used as stores of value all across the continent. For similar reasons, this case study contributed to the discussion on the role of colonial

empires in the growth and macroeconomic performance of European economies in the early modern era, since the rise of the money stock derived from rents generated in the colonial system.

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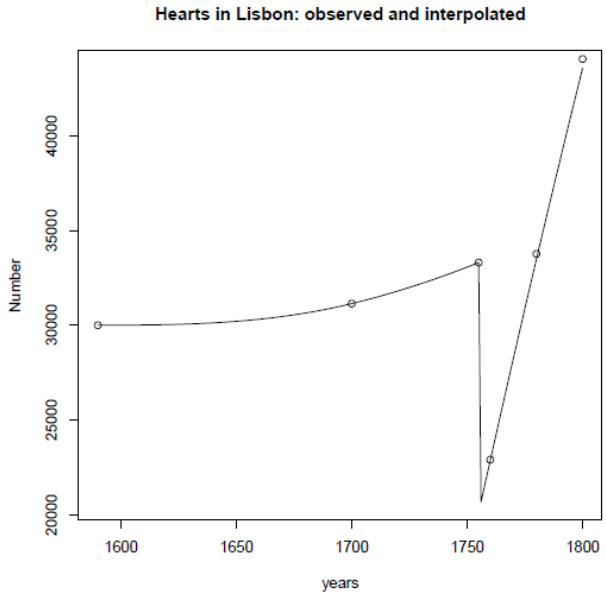
A Appendix

A.1 Building the houses series

We took the raw data in Table 2. We interpolated the data from the period 1590 to 1755 and the data from the period 1755 to 1800 separately. The result is shown in Figure 11.

Figure 11



A.2 Interest rates regression

Results for the regression of equation (6) Using OLS and a Newey-West HAC covariance matrix estimator in Table 6

Table 4. Market Interest rate regressions performed with a Newey-West HAC covariance matrix estimator

	model 1	model 2	model 3	model 4
(Intercept)	5.86 (0.60)***	5.36 (0.72)**	4.75 (0.67)*	4.18 (0.96)·
log(M)	−0.34 (0.07)***	−0.39 (0.08)***	−0.38 (0.09)***	−0.39 (0.10)***
log(H)	0.38 (0.11)**		0.32 (0.18)·	0.36 (0.15)*
I(ceil * log(H))	−0.22 (0.02)***		−0.26 (0.26)	−0.16 (0.28)
log(W)		0.36* (0.15)	0.26 (0.20)	0.35 (0.26)
I(ceil * log(W))		−0.13 (0.01)***	0.02 (0.15)	−0.21 (0.30)
I(ceil * log(M))				0.22 (0.21)
R^2	0.88	0.88	0.88	0.88
Adj. R^2	0.87	0.87	0.87	0.87
Num. obs.	54	54	54	54
RMSE (1957-1979)	0.09	0.09	0.11	0.11

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\cdot}p < 0.1$

A.3 Contract regressions

Results for the regression of equation (4) using OLS, robust LS, and 2SLS (using the year and the dummy categories as instruments) are shown in Table 5.

Table 5. Contract regressions

	OLS	RLS	2SLS
intercept	15.46 (0.23)***	15.37 (0.23)***	16.50 (0.34)***
interest rate	−0.48 (0.04)***	−0.47 (0.04)***	−0.67 (0.06)***
borrower(Farm)	−1.09 (0.14)***	−1.05 (0.12)***	−1.04 (0.14)***
borrower(Craft)	−0.72 (0.11)***	−0.70 (0.11)***	−0.70 (0.11)***
borrower(Foreign)	0.37 (0.23)	0.56 (0.30)	0.38 (0.23)
borrower(Women)	−0.07 (0.11)	−0.06 (0.12)	−0.08 (0.11)
borrower(Non class)	−0.24 (0.12)*	−0.26 (0.14)	−0.20 (0.13)
borrower(Serv)	−0.64 (0.16)***	−0.67 (0.18)***	−0.64 (0.17)***
borrower(Transp)	−0.70 (0.21)***	−0.78 (0.24)**	−0.65 (0.21)**
borrower(Milit)	−0.05 (0.14)	−0.06 (0.14)	−0.06 (0.14)
borrower(Prof)	−0.02 (0.12)	−0.01 (0.12)	−0.03 (0.12)
borrower(Prop)	−0.42 (0.13)**	−0.40 (0.13)**	−0.40 (0.13)**
borrower(Commerce)	−0.07 (0.12)	−0.03 (0.12)	−0.06 (0.12)
borrower(Nobl)	0.64 (0.13)***	0.69 (0.13)***	0.67 (0.13)***
borrower(Relig)	0.53 (0.22)*	0.57 (0.18)**	0.25 (0.23)
lender(Farm)	−0.32 (0.22)	−0.38 (0.18)*	−0.28 (0.22)
lender(Craft)	−0.18 (0.13)	−0.16 (0.11)	−0.16 (0.13)
lender(Foreign)	0.28 (0.21)	0.27 (0.21)	0.33 (0.21)
lender(Women)	0.21 (0.12)	0.20 (0.11)	0.20 (0.13)
lender(Non class)	0.04 (0.13)	0.04 (0.12)	0.08 (0.13)
lender(Serv)	−0.46 (0.17)**	−0.44 (0.16)**	−0.43 (0.17)*
lender(Transp)	−0.70 (0.30)*	−0.69 (0.24)**	−0.69 (0.30)*
lender(Milit)	0.06 (0.16)	0.08 (0.13)	0.06 (0.16)
lender(Prof)	0.20 (0.12)	0.21 (0.11)	0.18 (0.12)
lender(Prop)	0.30 (0.15)*	0.27 (0.14)*	0.32 (0.15)*
lender(Commerce)	0.17 (0.12)	0.16 (0.11)	0.17 (0.12)
lender(Nobl)	0.34 (0.15)*	0.35 (0.14)*	0.35 (0.15)*
lender(Relig)	0.57 (0.20)**	0.54 (0.23)*	0.50 (0.20)*
R^2	0.26		0.25
Adj. R^2	0.25		0.24
Num. obs.	2345	2345	2345

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

A.4- Computed market interest rates

Table 6. Market interest rate in Lisbon

Table 6: Market interest rate

year	interest rate	year	interest rate
1715	6.250	1758	5.000
1716	6.023	1759	4.944
1717	6.111	1760	5.000
1718	5.833	1761	5.000
1719	6.042	1762	5.000
1720	5.911	1763	5.000
1721	6.167	1764	5.000
1722	6.071	1765	4.889
1723	5.861	1766	5.000
1724	6.042	1767	5.000
1725	6.250	1768	5.000
1726	6.154	1769	5.000
1727	5.865	1770	4.900
1728	6.024	1771	5.000
1729	6.094	1772	5.125
1730	6.014	1773	5.000
1731	5.911	1774	5.000
1732	5.786	1775	5.000
1733	5.667	1776	5.000
1734	5.833	1777	5.000
1735	6.111	1778	4.958
1736	5.425	1779	5.000
1737	6.023	1780	5.000
1738	6.154	1781	5.000
1739	6.192	1782	4.778
1740	6.050	1783	5.000
1741	5.940	1784	4.818
1742	6.103	1785	5.000
1743	5.786	1786	5.000
1744	5.833	1787	4.817
1745	5.357	1788	4.857
1746	5.688	1789	5.000
1747	5.882	1790	5.000
1748	5.441	1791	5.000
1749	5.431	1792	5.000
1750	5.750	1793	5.000
1751	5.656	1794	5.000
1752	5.781	1795	5.000
1753	5.867	1796	5.000
1754	5.635	1797	5.000
1755	5.844	1798	5.000
1756	5.537	1799	5.000
1757	4.947		

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Rua Miguel Lupi, 20
1249-078 Lisboa
Tel. +351 213 925 974
E-mail: ghes@iseg.utl.pt