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Abstract

I investigate whether cash thresholds that forbid cash payments on big transactions are effective at reducing tax evasion. I find that the 1000 euros threshold implemented in Italy in 2011 induced a bigger cash expenditure reduction for the households with self employed members, and the more so in case they work in cash intensive sectors. With the help of a simple model, I show that this empirical evidence suggests a tax evasion reduction, and I compute the tax revenue increase implied by the empirical estimates. Calibrating the model, I also perform a counterfactual exercise to quantify the potential effects of lower thresholds.

JEL classification: H26, E42.

Keywords: Self-employed, Transactions, Payments

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1 Introduction

Cash significantly facilitates tax evasion: credit cards and wire transfers leaves a trail that can be traced by the tax authorities, so that any tax evasion attempt can be easily detected. Any policy that fosters cashless payments can therefore reduce tax evasion. Examples include: a subsidy to offset the cost of payment cards; a tax rebate proportional on the card balance; a lottery whose tickets are the card receipts; a tax on cash withdrawals charged at ATM machines and bank tellers; the elimination of high denomination bills; a periodic phase out of banknotes based on a random extraction of the last digits of the serial numbers. In the limit, cash payments could also be forbidden, but this would hard to justify on efficiency grounds and it would significantly change the way monetary policy is thought and implemented (Buiter 2009; Rogoff 2014 and 2016). A close alternative could be a ban on cash transactions of big amount only, the so-called "cash threshold", the rationale being that when cash is used for big transactions it is mostly for illegitimate purposes (Fischer Kohler and Seitz 2004; Rogoff 2014 and 2016). According to this argument, a cash threshold will stem evasion, together with money laundering and terrorist financing, without imposing any cost on most honest taxpayers, who would not have used cash for big transactions anyway. Some individuals, however, will bear a significant cost, if unfamiliar with cashless technologies, like the elderly, or if unwilling to use them for privacy reasons, and those individuals might oppose all cash restrictions, alongside the evaders and the criminals. Some of those individuals might also reduce consumption, perhaps inducing a recession. From a political economy perspective, cash thresholds are therefore fragile, both because they are difficult to implement and difficult to sustain in the long run.

Italy is a good example of this fragility: a heavily indebted country with high levels of tax evasion and a widespread use of cash (Rinaldi 2007; Hesselink and Fernandez 2017), trying to find consensus around anti-evasion policies. Cash thresholds have been in place since 1991, but the threshold itself has been adjusted 10 times, ranging from 12500 euros (from May 1991 to April 2008 and from July 2008 to May 2010) to 1000 euros (from December 2011 to December 2015), mostly according to the political orientation of the majority, either raising it, as requested by the self-employed, evasion prone, voters, or lowering it, to target instead

the requests of the employees and pensioners looking for more equity in tax contributions, especially in midst of macroeconomic distress and austerity measures. Within Europe, the countries that implemented cash thresholds include[1] France (1000 euros in 2015), Spain (2500 euros in 2012), Portugal (1000 euros in 2017), Belgium (3000 euros in 2014) and Greece[2] (500 euros in 2016).

In this paper I estimate the effect on evasion of the smallest, 1000 euros, cash threshold established in Italy in 2011. To do it, I look at the difference in cash expenditure, before and after the threshold implementation, between two groups of individuals: the potential tax evaders, whose income is the result of direct transactions and who earn part of their income in cash, and the employees and pensioners who are subject to tax withholding. The idea is that the total cash expenditure of the first group should have decreased more if the threshold was effective at reducing evasion. A binding threshold reduces in fact the number of cash transactions of big amount and, reducing the amount of cash earned and stored by the potential evaders, will also lower the amount of cash they spend. In addition, since tax evasion is possible only in case of cash transactions, the threshold will also decrease the evaders' income and, therefore, their total expenditure, thereby lowering also their cash expenditure. Both effects should be more pronounced in cash intensive sectors, like retail trade, hospitality and services, where a bigger fraction of the transactions is typically in cash. Moreover, both effects imply also a less frequent cash use on small transactions even if the ban applies only to transactions of big amount.

I propose a model that illustrates the effects of the threshold and that, later in the paper, I use to perform counterfactuals on tax evasion. The model features several buyers of goods and services, with exogenous income, and a seller whose income is the result of the transactions with the buyers. Transactions can be settled in cash, who carries a linear cost, or with a

[1] Cash thresholds are effective in many more countries like, among others, Bulgaria, Romania, Czech Republic, Slovakia and Switzerland, but, in some cases, they are too big to be binding for most transactions and citizens, like the 100 thousand francs threshold in Switzerland or the 15 thousand Euros in Poland and Croatia. Germany, Austria, Slovenia, The Netherlands, Finland and Sweden do not have thresholds. The threshold is absent in Germany, most likely because of a strong preference for cash use, although, recently, there has been a debate on its introduction to prevent criminals from other European countries from laundering money in Germany. The threshold is also absent in Austria, again for a strong preference for cash. In Sweden and Finland, on the other hand, cash is almost never used.

[2] All citizens are also required to spend a fixed fraction of their income with cashless payments and setting steep sanctions in case the quota is not reached.

cashless instrument, whose cost is fixed. Thus cash is used on small transactions only. Tax evasion for the seller is possible only in case of a cash transactions and the cost for the seller of using the cash earned in direct transactions is zero. I show that, under fairly general assumptions, the introduction of a cash threshold decreases the cash expenditure of the seller more than the one of a buyer if the threshold is small enough to be binding. In this case, total tax evasion also decreases.

I use data from the Survey of Household Income and Wealth (SHIW) implemented by the Bank of Italy, a well-established and comprehensive survey on household consumption and saving decisions administered to a representative sample of the Italian population. The treatment group consists of households with at least one self-employed member, or at least one member with real estate or autonomous work income. These individuals, who can evade taxes, are the "potential evaders". The control group consists instead of all employees and pensioners without rental income and without autonomous work income, who, being subject to tax withholding, cannot evade taxes. The tricky part of the empirical implementation is the choice of the post-policy period, given that there has been a cash threshold in Italy since 1991, and given that threshold has been adjusted frequently. My main empirical results are for the threshold decrease to 1000 euros implemented in 2011, using the period 2012-2014, without threshold adjustments, as post-policy. I show empirically that the thresholds that were effective before 2011 were too high to be binding, which allows me to use all years before 2011 as pre-policy. Nevertheless, to test for robustness, I also consider a narrower sample where the pre-policy year is 2010 only.

I find that the total cash expenditure of the potential evaders, after the implementation of the 1000 euros cash threshold, decreased more. This effect is obtained controlling for income changes, for consumption changes and for a wide set of covariates which includes, among others, the possession of payments cards and the use of e-banking services. I also show, in a DDD (difference-in-differences-in-differences) framework with, as additional dimension, the sector of economic activity, that the effect of the threshold was very big in two cash intensive sectors: retail and hospitality and services to individuals. These results, interpreted through the model, suggest that the cash threshold was indeed effective at reducing evasion. I propose several empirical tests, including placebos, that address the validity of the estimates, as well as

a throughout discussion of the potential confounding effects induced by the economic policies implemented between 2010 and 2012.

From the empirical results, as well as from additional external information, I am also able to compute the implied increase in tax revenue generated by the threshold. Assuming full evasion on the cash transactions, I estimate a 5.4% upper bound increase in income tax revenue and a 6.1% upper bound increase in VAT revenue, which corresponds to a 19% reduction of the VAT GAP according to the European Commission (2014) estimates. The next question that I address is if these gains could have been more substantial with a lower cash threshold. I calibrate the model on SHIW to perform such counterfactuals. Under additional assumptions, I find that, everything else equal, a 500 euros threshold in 2011 could have increased VAT revenues at most by 7.8% and income tax revenues by at most 6.8%, while a 100 euros threshold by at most, respectively, 24.2% and 21.3%. These counterfactual thresholds are arguably very small, perhaps smaller than what many people would accept and surely low enough to call the legal tender of money into question, but they show indeed both the potential and the limitations of the cash thresholds.

To the best of my knowledge, this is the first paper that attempts to estimate the effects of cash thresholds on evasion using individual data. The only previous work that studies the effects of cash thresholds is Rainone and Valentini (2019), who focus on cash demand in Italy. They find, using high frequency data, that the the threshold increase from 1000 to 3000 euros in 2016 increased the demand for high denomination bills. Sands et al. (2017) propose instead a discussion of the potential effect of a cash threshold on evasion, financial crime and money laundering, but they do not propose a statistical analysis. They argue that cash thresholds can be effective at reducing tax evasion and limiting money laundering, although not at fighting terrorist financing or petty crime, and that it will have very limited negative effects for law-abiding citizens. They also argue in favor of a uniform cash threshold in a currency union.

The paper is related to the literature on the relationship between cash and evasion[3], which also propose and analyzes several policies to reduce evasion thorough a reduction of cash in

[3]Andreoni, Erard and Feinstein 1998, Slemrod and Yitzhaki 2002, Cowell 1990, Marchese 2004, Sandmo 2005 and Slemrod 2007 propose reviews of the economic literature on tax evasion

circulation. Among others, Immordino and Russo (2018a) show a positive relationship between cash use and VAT evasion in a panel of European countries. Benshalom (2012) proposes a tax on cash to fight evasion, and Immordino and Russo (2018b) analyze extensively the effect of such policy, in combination with a tax rebate conditional on a transaction receipt. Gordon and Li (2009) stress instead that an additional cost of evasion with cash payments is the impossibility to use the financial sector, which stifles firm growth.

The paper is also related to the literature on cash use (Baumol 1952; Attanasio, Guiso and Jappelli 2002; Amromin and Chakravorti 2009; Alvarez and Lippi 2009; Lippi and Secchi 2009) and credit card use (Rysman 2007). Among others, Drehman et al. (2002), Bagnall et al. (2014) and Hesselink and Hernandez (2017) show that cash use is widespread in many countries regardless of the advancement in cashless payments technologies, although there is evidence of a decreasing trend. Hayashi and Klee (2003) and Cohen and Rysman (2013) show that cash is used primarily on small transactions, while payment cards on bigger transactions. These results form the basis of my model. Klee (2008), in addition to showing that cash is mostly used in small transactions, also shows that the transaction costs of cash and payment cards are very similar and quite small, and that younger, more educated individuals are more likely to use payment cards. Similar results appear in Arango, Huynh and Sabetti (2011). Fischer Kohler and Seitz (2004) show instead that the transaction demand for cash in the Euro area accounts at most for 35% of total euros in circulation, which means that a lot of cash is used for illicit activities. In a related contribution, Buiter (2009) proposes the abolition of currency to overcome the zero lower bound on monetary policy. Along the same line, Rogoff (2014 and 2016) discusses extensively the cost and benefits of a cashless society, with particular emphasis on tax evasion and on negative interest rates. Chodrow-Reich et al. (2020), study instead the effects of the demonetization program that started in India in 2016 and that entailed the substitution of most of the banknotes in circulation. They find a sharper contraction of economic activity and a quicker adoption of cashless payment technologies in the districts that were more affected by the demonetization because of a slower banknotes substitution. This evidence suggests that reducing cash circulation might actually have adverse aggregate consequences and it is a potential side effect of all anti-evasion policies based on cash limitations.

The rest of the paper is organized as follows: section 2 describes the cash thresholds implemented in Italy; section 3 illustrates the model; section 4 clarifies the research design; section 5 describes the empirical model; section 6 illustrates the main results; section 7 explores the robustness of the empirical results and proposes additional empirical evidence; section 8 discusses the other policies that could have affected cash expenditure; section 9 estimates the tax proceeding increases implied by the estimates; section 10 proposes a counterfactual exercise, based on a calibration of the model, to quantify the potential effect of lower cash thresholds; section 11 concludes. The appendix shows the proof to the main theoretical result (proposition 1 in section 3).

2 Institutional Background

The cash threshold is a law that establishes the maximum transaction amount that can be settled in cash. Above the threshold it is mandatory to use traceable instruments such as credit cards, bank transfers and non-transferable cheques. Multiple payments to the same recipient in a short period of time are also forbidden if their total is above the threshold. Violators are punished with a fine, which might be substantial[4]. The law typically also provides exceptions, for instance for foreign visitors who buy merchandise at retail shops.

There is a long history of cash thresholds in Italy and an abundance of comments and opinions on them accumulated over the years. The political economy of this policy, however, is not that complicated: it is proposed as a way to fight tax evasion and money laundering (Riccardi and Levi 2018), as well as to stem terrorist financing, so its proponents include political parties who campaign against tax evaders and whose polity is mostly composed of employees and pensioners. Conversely, shop-owners, professionals and, in general, all individuals who are not subject to tax withholding are typically against it, mostly claiming an infringement of their individual liberties ("money is coined liberty ", as in Dostoyevsky 1861 novel The House of the Dead) and the disruptive potential for their businesses because of a demand decrease, so the political parties whose electorate is mostly composed of those individuals oppose it. Cash thresholds are so salient in the political debate in Italy not only because

[4]Up to 40% of the transaction amount with a minimum fine of 3000 euros according to the cash threshold law of 2011.

of their presumed anti-evasion effects, but also because cash use is widespread: according to ECB data (Hesselink and Hernandez 2017), 86% of all transactions in Italy in 2016 were settled in cash, for a total of 68% in value. Given these numbers, it is not surprising that any policy that attempts changing payment habits faces resistance. The result is the enactment of 10 different cash thresholds in 20 years. Table 1 summarizes the time-line, together with the head of the government that changed it.

Table 1: **Cash Thresholds in Italy**

Year	**Month and Day**	**Threshold (euros)**	**Prime Minister**
1991	May 9	10329*	Andreotti
2002	December 26	12500	Berlusconi
2008	April 30	5000	Prodi
2008	June 25	12500	Berlusconi
2010	May 31	5000	Berlusconi
2011	August 13	2500	Monti
2011	December 6	1000	Monti
2016	January 1	3000	Renzi
2020	July 7	2000	Conte
2022	January 1	1000	Conte

*=Threshold originally fixed at 20 millions Lire and converted to euros in the table

The first cash threshold was set at 20 millions lire in 1991 by the government headed by mr Giulio Andreotti, and later converted to 10329 euros in January 2002. The December of that year, the center-right government by mr Silvio Berlusconi increased the threshold to 12500 euros. The subsequent center-left government headed by mr Romano Prodi reduced the threshold to 5000 euros in April 2008 as part of a broader anti-evasion and anti money-laundering strategy, but the threshold was quickly set back to 12500 euros by mr Berlusconi in June 2008 as soon as he replaced mr Prodi as head of the government. However the very same government headed mr Berlusconi decreased the threshold to 5000 euros in may 2010, partly as a response to the increase public pressure in favor of more equitable fiscal contributions.

Mr Mario Monti and his government took office after mr Berlusconi in the middle of a severe financial crisis and, in an attempt to stem it, as well as to to reduce the growth of public debt, they implemented several austerity measures within what they called the the "Salva-Italia" (save Italy) strategy. The cash threshold was set to 2500 euros in August 2011 and, later that year, in December, further reduced to 1000 euros. The center-left government headed by mr Matteo Renzi reversed the tendency, increasing the threshold up to 3000 euros in 2016, in an attempt they claimed, to increase consumption and domestic demand. In 2019, mr Giuseppe Conte and his government supported by populist parties decreased again the threshold to 2000 euros, to be effective in July 2020, and scheduled a further decrease back to 1000 euros in 2022.

In this paper I am primarily concerned with the decrease to 1000 euros established in 2011. The reason is that previous thresholds, higher or equal to 5000 euros per single transaction, were hardly binding given the distribution of total cash expenditure in Italy: a median monthly cash expenditure of 2100 euros between 2000 and 2011, with a 95th percentile of 4600 euros. Actually even a 1000 euros threshold per single transaction might seem high, especially as compared to an average cash transaction amount of 14 euros in 2016 (Hesselink and Hernandez 2017). This is in fact one of the main objections to cash thresholds, namely that they will not be effective because large transactions are infrequent. There are at least two arguments against this objection. First, large transactions, although infrequent, are not uncommon in the course of the year for many consumers: medical bills, purchases of appliances, TV sets, furniture and jewels, hotel bills, car services etc. Second, cash threshold on big transactions will also decrease cash transactions of smaller amount. To illustrate the argument, suppose that, say, a dentist, receives, as an effect of the threshold, a 1000 euros payment with a wire transfers instead of a cash payment. Then he will probably not use cash on his 200 euros shoes purchase, perhaps also choosing a less expensive pair because of the taxes paid on his bill. The shoes seller, in turn, will have less cash income and less income and, thus, he will spend less cash when buying groceries, and so on. In the end, the cash threshold will induce less cash transactions of all amounts.

Importantly, the enforcement of a cash threshold is actually quite complicated, since it involves auditing single transactions at the time of execution, rather than a more standard

fiscal audit based on business accounts and bank movements. This difficulty is actually an additional objection to the threshold. However, even absent a throughout enforcement, it is still possible that the threshold will be an anchor to individual behavior. Furthermore, the threshold is also a signal of the willingness to fight evasion and, as such, might contribute to an increased perception of the severity of enforcement which, by itself, can help reduce evasion.

3 The Model

In this section I propose a model that clarifies the conceptual framework behind the empirical exercise to help interpreting the results. In section 9 I will instead calibrate the model to perform counterfactuals on the effects of lower cash thresholds.

The economy is composed by $\delta > 1$ buyers of various goods and services, by a representative seller and by a single external provider/seller of the same goods and services. Suppose that the seller and the buyers meet to complete several transactions whose amount $x \in [0, \infty]$ is distributed according to the pdf $f_X(x)$. All buyers have an exogenous income Y_b, while the seller's income is the result of those transactions with the buyers. Suppose that the seller purchases the same goods and services as the buyers from the external provider.

There are two possible ways of settling transaction. The first is cash, whose cost is linear in the amount, so that a transaction of amount x costs $x(1 + c)$. The motivation for this linear cost is that cash must be withdrawn, stored and protected from theft, and the bigger the cash amount the bigger the cost of those activities. The second is a payment card, whose cost per transaction is fixed an equal to d regardless of the transaction amount. Given this structure, cash is preferred if $x(1+c) < x+d$, which means that there is a threshold transaction amount $\beta = d/c$ such that transactions amounts lower than β are settled in cash while bigger transactions with a payment card. This feature makes the model consistent with the empirical evidence in Hayashi and Klee (2003), Klee (2008), Cohen and Rysman (2013) and Hesselink and Hernandez (2017), who show that cash is primarily used on small transactions. The last work, in particular, shows that, in Italy, the average transaction amount in cash in 2016 was slightly less than 14 euros, while the average transaction amount with a payment card around

38 euros. Suppose that each buyer has just enough exogenous income to purchase all goods and services:

$$\int_0^{\beta} x(1+c)f_X(x)dx + \int_{\beta}^{\infty}(x+d)f_X(x)dx = Y_b \tag{1}$$

Given these structure of payments, the seller has both cash income and non-cash income, which is directly credited in his bank account. Suppose that tax evasion is possible only in case of a cash payment, because cashless payments are easily traced by the tax authority. Total income of the seller is

$$R = \delta\left[\int_0^{\beta}[(1-\gamma)x(1-t)+\gamma x]f_X(x)dx + \int_{\beta}^{\infty}x(1-t)f_X(x)dx\right] + Y_s \tag{2}$$

where t is the statutory tax rate, γ the percentage of evaded income on the cash transactions and Y_s the difference between the exogenous income of the seller and his operating costs, both of which I assume not to be paid cash. The seller uses this income to buy goods and services from an external provider. The crucial assumption of the model is that the seller has no cost for using the cash coming from the transactions with the buyers, but that he pays the same costs for the cash exceeding that amount and for the credit cards. This entails normalizing to zero some of the costs of cash management. Furthermore, this assumption implies that there is no cash hoarding for the seller. Define α the threshold transaction amount that the seller can settle with the cash gained from the transactions with the buyer, i.e.:

$$\int_0^{\alpha} xf_X(x)dx = \delta\int_0^{\beta} xf_X(x)dx \tag{3}$$

which entails assuming that the tax is not paid cash. Since $\delta > 1$, it must be the case that $\alpha > \beta$, which means that the seller uses cash on more transactions. As a final assumption, suppose that the seller has enough exogenous, non-cash, income such that, once paid the operating costs, he has enough to buy all goods and services available, exactly as the buyers. Thus:

$$\int_0^{\alpha} xf_X(x)dx + \int_{\alpha}^{\infty}(x+d)f_X(x)dx = R \tag{4}$$

Assuming that the external provider is subject to the same tax rate of the seller and that

he evades the very same fraction γ of the seller, total tax evasion in this economy is simply equal to the total amount of cash expenditure multiplied by the fixed evasion rate γ and by the fixed tax rate t:

$$T^{ev} = \gamma t \left[\int_0^{\alpha} x f_X(x) dx + \delta \int_0^{\beta} x f_X(x) dx \right] \tag{5}$$

The cash threshold policy is a maximum transaction amount L that can be settled in cash. The effect of such policy depends crucially on how big is L compared to α and β. If L is bigger than α and bigger than β, both the buyer and the sellers do not change their behavior and the policy is ineffective. Basically the threshold is above the transaction amount for which the buyer finds it convenient to use cash and above the amount that exhausts the cash in the register of the seller. The threshold in this case is not binding. Suppose instead that the threshold L is lower than α but bigger than β. In this case the buyers do not change behavior, but the seller does. In particular, if $\beta \leq L \leq \alpha$ the seller cannot use all the cash in the register and for some transactions of amount $L \leq x \leq \alpha$ he must use the payment card, at the fixed cost d for transaction. Suppose that the extra cash that the seller cannot use can be deposited at no cost with the banking system, and then used to settled the payment card balance. Since the seller must pay an extra cost for payment card use on transactions whose amount is between L and α, assuming that there is a proportional consumption decrease and that it is possible to buy fractions of each single good and service, his income is now sufficient to buy only $B < 1$ times the consumption goods and services available, with

$$B \left[\int_0^{L} x f_X(x) dx + \int_L^{\infty} (x + d) f_X(x) dx \right] = R \tag{6}$$

Suppose that the cost of cash is not paid cash but, rather, at the moment of withdrawing the money via a direct debit to the bank account. Total cash expenditure for the seller is $B \int_0^L x f_X(x) dx < \int_0^{\alpha} x f_X(x) dx$, while the total cash expenditure for a buyer is $\int_0^{\beta} x f_X(x) dx$ and it does not change. Therefore the effect of the policy is a reduction of cash expenditure for the seller but not for the buyers. Total tax evasion in this case is equal to

$$T^{ev}(L) = \gamma t \left[B \int_0^{L} x f_X(x) dx + \delta \int_0^{\beta} x f_X(x) dx \right] \tag{7}$$

Suppose now that the policy is binding for both the buyers and the seller, or $L < \beta$. Since the buyers must pay an extra cost for transactions of amount $L < x < \beta$, that they would not have paid absent the policy, their exogenous income, absent any form of compensation, is now sufficient to buy $G < 1$ times the consumption goods and services, with

$$G\left[\int_0^L x(1+c)f_X(x)dx + \int_L^\infty (x+d)f_X(x)dx\right] = Y_b \tag{8}$$

Assuming again that there is a proportional decrease in consumption of all goods and services. The seller's income is lower

$$R(L) = \delta G\left[\int_0^L [(1-\gamma)x(1-t)+\gamma x]f_X(x)dx + \int_L^\infty x(1-t)f_X(x)dx\right] + Y_s < R \tag{9}$$

and, therefore, also the threshold value for which he exhausts the cash in the register $\alpha(L) < \alpha$, which is now a function of the threshold, is smaller

$$\int_0^{\alpha(L)} x f_X(x)dx = \delta G \int_0^L x f_X(x)dx \tag{10}$$

Total cash expenditure for a buyer is lower than before, $G\int_0^L x f_X(x)dx < \int_0^\beta x f_X(x)dx$. The effect on the seller's cash expenditure depends on how small the threshold $\alpha(L)$ is. In case $\alpha(L) > L$, the seller has extra cash that he cannot use because of the threshold, so that his cost of cash is zero until he reaches the threshold. The income of the seller is now sufficient to buy $C < B$ times the consumption goods and services available, where:

$$C\left[\int_0^L x f_X(x)dx + \int_L^b (x+d)f_X(x)dx\right] = R(L) \tag{11}$$

and it is easy to see that his total cash expenditure is also lower $C\int_0^L x f_X(x)dx < B\int_0^L x f_X(x)dx < \int_0^\alpha x f_X(x)dx$. Total tax evasion is equal to

$$\hat{T}^{ev}(L) = \gamma t\left[C\int_0^L x f_X(x)dx + \delta G\int_0^L x f_X(x)dx\right] \tag{12}$$

Conversely, in case the cash expenditure of the buyers decreases so much to have $\alpha(L) < L$, than the seller exhausts the cash before reaching the threshold, so that he must pay the cost

c on all transactions of amount $\alpha(L) < x < L$. His income, in this case, is just enough to buy D times the consumption goods and services, where $D < C < B$ and

$$D\left[\int_0^{\alpha(L)} x f_X(x)dx + \int_{\alpha(L)}^{L} x(1+c) f_X(x)dx + \int_L^{\infty} (x+d) f_X(x)dx\right] = R(L) \qquad (13)$$

and total cash expenditure for him is even lower, i.e. $D\int_0^L x f_X(x)dx < C\int_0^L x f_X(x)dx < B\int_0^L x f_X(x)dx < \int_0^{\alpha} x f_X(x)dx$. Total tax evasion is

$$\widetilde{T}^{ev}(L) = \gamma t\left[D\int_0^L x f_X(x)dx + \delta G\int_0^L x f_X(x)dx\right] \qquad (14)$$

In conclusion, the effect of the cash threshold, in case it is binding, is a reduction of cash expenditure for the seller and, if it is small enough, also for the buyers. The following proposition, proved in appendix, shows that, in both cases, the cash expenditure of the seller decreases more.

Proposition 1. *A small cash threshold decreases the cash expenditure of the seller more than the one of each buyer and decreases evasion.*

The intuition behind the proposition is simple: if tax evasion is possible only in case of cash transactions, a binding cash threshold, which reduces the number of cash transactions, decreases the extra income from evasion for the seller, thereby reducing his cash expenditure. Moreover, a binding threshold reduces the amount of cash income for the seller, which increases his cost of cash, further reducing his cash use. The tax evasion reduction implied by the binding threshold is just a straightforward consequence of the less cash circulating and of the assumption that evasion is possible only for cash transactions.

The implication of proposition 1 is that if, after the introduction of the threshold, the average cash expenditure of the sellers decreases more than the average cash expenditure of the buyers, then it means that the threshold was low enough to be binding and, as an effect, that tax evasion decreased. Viceversa, if the average cash expenditure of the sellers does not decrease more than the average cash expenditure of the buyers, this is because the threshold was too high to be binding, which also implies the absence of any effect on evasion. This is the motivation behind my empirical test.

In what follows, I will identify the buyers with the employees and pensioners who are subject to tax withholding, that cannot evade taxes and whose income is typically credited in bank accounts. The seller, instead, is identified with the self-employed individuals, who can evade and whose income is partly in cash, which is the reason why I will also call them "potential evaders".

4 Data and Research Design

The empirical strategy consists in comparing, before and after the implementation of the threshold, the cash expenditure of the potential evaders with the cash expenditure of those who are subject to tax withholding. Consistently with the model, if the cash expenditure of the former group decreases more after the threshold implementation, there is a tax evasion reduction.

I use data from the Survey of Household Income and Wealth (SHIW), a long-established survey run by the Bank of Italy since 1977 on spending and financial decisions of Italian households. The survey proceeds in bi-annual waves (tri-annual before 1998) and, crucially for my analysis, there is an extensive panel component. There is information on cash expenditure since 1995, so I focus only on the following waves: 1995, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014. I discard 2016 because of the cash threshold increased to 3000 euros. I restrict the analysis to the panel component, keeping only households surveyed at least once before the policy, (from 1995 to 2010) and at least once after the policy (in 2012 or 2014).

Although the survey is at the household level, there is personal information available for all members, which allows a quite precise classification in the treatment and control groups. The control group consists of households whose members are all employees or pensioners without rental income or additional sources of income other than their wage/salary or pension. This group includes, among others, households whose members are office workers, clerks, teachers, managers, executives, judges, academics, researchers and police officers. The treatment group consists instead of all households where at least one member is self-employed or where at least one member, while being an employee or pensioner, has some additional income not subject to tax withholding, either from real estate or from a second job. The control group

includes therefore households where at least one member is, among others, a shop-owner, an entrepreneur, a plumber, a lawyer, a hairdresser, a baby-sitter, a pensioner with rental income from a family property, a school teacher that moonlights as a piano teacher etc. In order to classify households in the treatment and control groups, I require them to be in the same group over all waves in which they are surveyed, and I drop them otherwise. For instance, a household who is classified in the control group because all members are employees, but where one of the members buys a house to rent, is dropped from the sample. Similarly, a household whose members are all self-employed is dropped if one of them becomes a pensioner. This requirement is necessary to avoid including households whose members change occupation because of the policy. For instance, a household whose only income earner is a shop owner who, fearing an income reduction after the threshold implementation, closes the shop and becomes a pensioner, might still have some hoarded cash in a bank vault as a result of past evasion, and this cash can can be used for transactions. Classifying such an household in the control groups is therefore wrong.

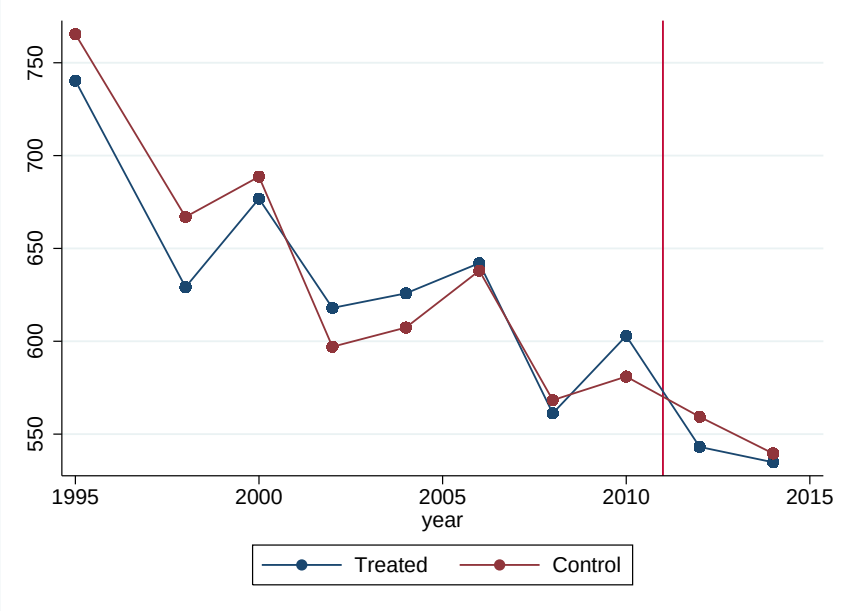
I exclude from the analysis all households whose main income earner is either: unemployed, looking for the first job, a housewife, a student or a volunteer. In case some households members besides the main wage earner are in the above categories, I simply exclude them from the classification algorithm. For instance, a household whose main income earner is an entrepreneur and where the second and third members are, respectively, a housewife and a student, is classified in the treatment group. I also exclude households whose main income earner is an immigrant or an Italian born abroad. This is because immigrants might have different attitudes towards cash use. Few households are unbanked: none of the the members own a bank account. I classify those in the treatment group, regardless of their occupation, since everything they earn is in cash.

This classification is quite conservative, because, say, a household of three where the two most important wage earners are employees subject to tax withholding, but where the third is a self-employed with a very small income, is classified in the treatment group. This household, according to the model, should respond less to the policy as compared to another whose members are all self-employed. The implication is that the diff-in-diff coefficient in my regression should be biased towards zero. In section 7, I will discuss the results obtained with

a more liberal classification based on the most frequent occupation, which delivers a bigger sample. To see why, consider a family of three with one wage earner that looses the job, being unemployed in some, but not all, of the survey waves. In the conservative classification, this household is simply dropped while in the more liberal classification based on the most frequent occupation, it is classified in the control group.

Given that the data are self-reported, there is the possibility of misclassification, mostly because employees and pensioners with second jobs might fail to report their additional income, especially in case of an informal occupation. However these mistakes, if any, are actually against my results, biasing the diff-in-diff coefficient towards zero: if the policy is effective, the incorrectly classified households in the control group should decrease their spending more than the correctly classified. Furthermore, some of the employees in the control group might be paid their salary in cash, while still having a bank account. Those individuals might have decreased their cash expenditure more than similar employees who are not paid cash, thereby further biasing my estimates towards zero.

Figure 1: **Cash Thresholds and Cash Expenditure**

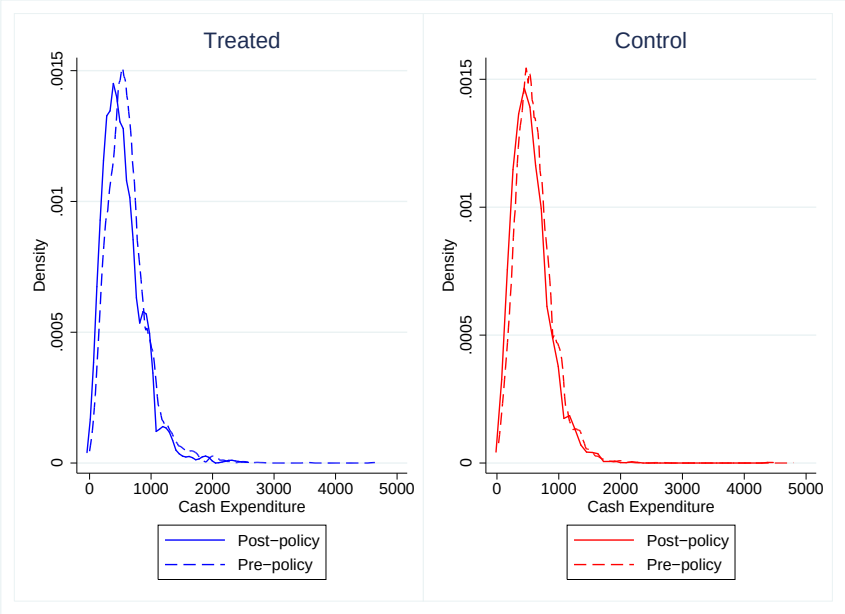


Notes: Average monthly cash expenditure per household member in euros for the treatment group (in blue) and for the control group (in red). The vertical line is for 2011, the year when the threshold was set to 1000 euros. Source: own computations based on SHIW data.

Figure 1 shows the time series of average monthly household cash expenditure per member

separately for the treatment and for the control groups. The vertical line is for 2011, the year when the cash threshold was lowered to 1000 euros. The picture clearly shows the absence of pre-trends. The figure also shows that the cash expenditure was bigger for the treatment group in 2010, but that it decreased faster, becoming lower than the cash expenditure of the control group in 2012 and 2014. Figure 2 shows instead the full density of household monthly cash expenditure per member before and after the threshold decrease to 1000 euros, again separately for the treatment and for the control group. In both cases, the distribution shifts to the left after the 2011 threshold decrease, but the more so for the treatment group. The empirical estimation in the next section aims at quantifying this differential response.

Figure 2: **Cash Expenditure**



Notes: Empirical density of monthly household cash expenditure per member (in euros) for the treatment group (left panel) and for the control group (right panel) before and after the implementation of the 1000 euros cash threshold in 2011. Source: own computations based on SHIW

5 Estimation

The unit of analysis is the household. The estimated equation is the following:

$$cash_{it} = \gamma_i + \tau_t + \lambda\, w_{it} + \Gamma X_{it} + \varepsilon_{it} \tag{15}$$

where $cash_{it}$ is the monthly average cash expenditure per household member of household i during year t, γ_i are household fixed effects and τ_t time dummies. $w_{it} = treat_i \cdot post_t$ is the interaction term between the dummy variable $treat_i$, equal to one for the the potential tax evaders defined in section 4, and the dummy $post_t$, equal to 1 for the post-policy period, 2012-2014. X_{it} are control variables, while ε_{it} a well behaved error term. The coefficient of interest is λ, which picks up the differential response to the policy between the treatment and the control group. The control variables in X_{it} include: household yearly disposable income per member and household yearly total consumption per member, because changes in cash expenditure might be the result of income or consumption changes (over and above the response to the policy), and because Cohen and Rysman (2013) show that cash payments decrease with income. Head of the household age, because older individuals, less familiar with new technologies, tend to prefer cash (Klee 2008). A dummy for female head of the household, because Hesselink and Hernandez (2017) show that men are more likely to use payment cards, and because many households in the sample switch from having a male head of the household to a female and viceversa. Head of the household marital status dummies, because getting married, becoming widowed or divorced might impact spending decisions, and there is a lot of variation in the sample in the marital status. Head of the household higher education attainment dummies, because Klee (2008) shows that more educated individuals are more likely to use payment cards (although there is not much variation in this variable, especially for older individuals). A dummy equal to one if a household member used e-banking services during the year, because Hayashi and Klee (2003) show that the propensity to use payment cards increases in case of heavier use of new technologies. A dummy equal to one if there is at least one debit card in the household, and a dummy equal to one if there is at least one credit card in the household, to control for the adoption of new payment technologies that influence cash use. A dummy equal to one for households living in big cities above 500(k) inhabitants and a dummy equal to one for households living in very small cities below 20(k) inhabitants, because, when people move to a smaller or bigger city, they might find it easier or more difficult to withdraw cash at an ATM (his bank might not have a local branch in all

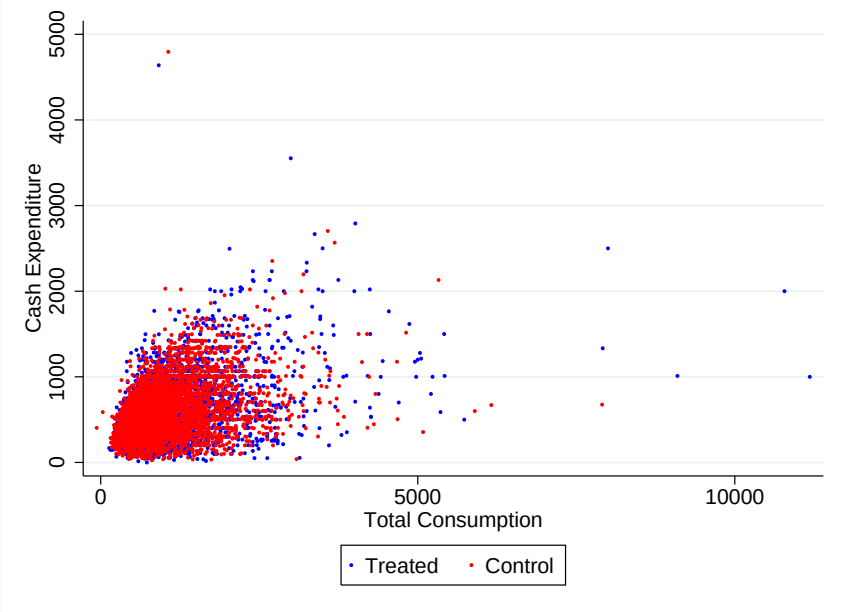
small cities) or to pay with credit cards (not all small retailers might accept cards in small towns).

Table 2 lists the summary statistics separately for the treatment and control groups in the pooled sample (1995-2014). One potential concern for my identification is that the household in the treatment group have a higher average cash expenditure. In other words, a cash threshold could have affected those households more than others simply because they typically spend more cash for reasons other than tax evasion. However, among the top 90% of household by cash expenditure before 2011, 43% are classified in the treatment group and 57% in the control group. Among the top 75%, 45% are in the treatment group. Among all households above the median cash expenditure, 44% are in the treatment group. These numbers suggest that heavy cash users are both in thee treatment and control groups. As additional evidence, figure 3 shows the relationship between total household monthly cash expenditure per member and total household monthly consumption per member, separately for the treatment and for the control groups. The scatter shows no evidence of a systematic difference between the two groups, stressing that the higher average cash expenditure of the treatment group might actually be a consequence of their higher consumption expenditure, which is controlled for in all regression specifications.

6 Empirical Results

Table 3 summarizes the main result. Columns 1 and 2 refer to the long time series (1995-2014), assuming that all threshold changes before 2011 where not biding, including the 2010 decrease to five thousand euros. I propose a full test for this assumption in what follows (see infra). Given an average reported monthly cash expenditure of 900 euros per household, and given that the 99^{th} percentile of the monthly cash expenditure per household is 2500 euros, the assumption looks however plausible. Columns 3 and 4 refer instead to the shorter time series (2010-2014), to avoid potential confounding effects coming from previous cash threshold movements. For both sample, the table reports the results obtained including (columns 2 and 4) or excluding (columns 1 and 3) control variables. Note that there are more households in the short time series. This is the result of two opposite forces. On the one hand, I classify

Figure 3: **Cash Expenditure and Total Consumption**



Notes: Monthly cash expenditure and consumption per household member in euros for the treated (in red) and for the control group (in blue). Source: own computations based on SHIW

households in the treatment and control groups based on occupation conditioning on being in the same group in all years, and dropping them otherwise. Since there is a bigger number of individuals who switch between occupations in a longer time series, the result is a bigger number of households in case of a shorter time span. For instance, a household with one member that quits is job to become self-employed in 2010 is classified in the treatment group in the short time series, but it is not part of the analysis in the long time series. On the other hand, I need to observe households at least once before the policy and at least once after it, which means that focusing on a longer time series allows to include more of them. For instance, a household who is surveyed in 2008 and in 2012 is included in the long time series but not in the short one.

Regardless of the sample and of the empirical specification, the results indicate that the 1000 euros threshold induced an extra 30 euros decrease of the average monthly household cash expenditure per member for the potential tax evaders. Considering the pre-policy median of roughly 550 euros for the treatment group, the effect of the policy is a 5.4% decrease. In terms of total yearly cash expenditure per household, roughly 1100 euros less for the potential

evaders.

Table 4 reports the result of a first placebo test, performed moving the treatment one period ahead. The sample is slightly different because I need to observe households in 2014 to include them, unlike in the baseline specification that requires observing them at least once between 2012 and 2014. The results clearly highlight the absence of any statistical relationship. Table 5 reports instead the results from 2 further empirical test. The first entails checking if the cash threshold decrease to 5 thousand euros had effects (results in columns 1 and 2). The post-policy period in this case is 2010 while the pre-policy 2008. Using the same treatment and control groups, I did not find any statistically significant relationship. Thus it is possible to use the long time series to estimate the effect of the 2011 threshold reduction. The second entails instead checking if there was a change in cash expenditure for the potential evaders between 2012 and 2014, absent any change in the cash threshold (results in columns 3 and 4). I did not find any statistically significant relationship. Thus the effect of the policy was sudden rather than gradual: all the adjustment took place immediately after. Moreover, this last result adds strength to the placebo exercise in table 4. All in all, these empirical tests suggest that the estimated effect was indeed the result of the cash threshold reduction to 1000 euros.

Quantitatively speaking, the estimated average cash expenditure reduction is not big. However the previous results refer to all treated households and, in particular, do not account for the sector of economic activity. Since some sectors, such as retail trade and services, are more cash intensive than others, there is a higher fraction of income earned in cash for the self-employed in those sectors (Hesselink and Hernandez 2017), which means that their response to the threshold should also be more pronounced. My next empirical test tries to ascertain if there are any differences by sector of activity. In particular, I consider a 3-D model, or a diff-in-diff-in-diff, where the additional dimension, with respect to the previous diff-in-diff design, is a dummy for the cash intensive sectors. Given the quite rough classification of sectors in SHIW, I am quite limited in the choice. I consider the following five to be cash intensive: retail and hospitality, construction, services to firms (which include lawyers tax professionals etc.), services to individuals (such as hairdressers, baby-sitters etc.) and agriculture. In all cases I consider only households whose members are in the same sector over the entire

period, excluding switches. To make the exercise even sharper, I include only employees in the public sector and pensioners in the control group. Table 6 summarizes the results for the long time series. The effect of the threshold is astounding for the retail and hospitality sector: a 380 euros decrease per household member per month even after controlling for income and consumption changes. The other strong effect is in the services to individuals sector, with a 166 euros decrease per member. Conversely, there is no effect for the agriculture sector and for the services to people. In the construction sector, there is actually an increase in cash expenditure. Overall, these evidence explains why the average reduction in cash expenditure summarized in table 3 is modest, namely because it crucially depends on the sector of activity.

In table 7, I show the results from a second placebo exercise, where the households are classified in the treatment and control group according to the sector of activity, rather than according to their professional status. More specifically, I classified as treated the households whose members all work in cash intensive sectors, regardless of their occupational status and ignoring if they are subject or not to tax withholding. As in the previous exercise, the control group consists of public employees and pensioners without rental income or other sources of income. The results indicate the absence of any effect. The conclusion is that it is not the sector of activity per se that matters, but the professional condition.

7 Robustness and Further Evidence

The results are also robust when including region-by-year effects instead of year effects to capture potential different trends by region. The results are also robust when considering, as dependent variable, total monthly cash expenditure, rather than cash expenditure per household member, and including the number of household members as additional control. The only exception is that there is no significant effect in the DDD model for the services to people sector.

I have been quite conservative when classifying households in the treatment and control groups, and the result is the exclusion of many observations. My goal has been to provide the sharpest possible evidence of the effect of the threshold. However it is necessary to test the robustness of the results to a more liberal classification. In particular, I considered

a different assignment based on the most frequent occupation, within the sample, of the following categories: housewives, minors, students, volunteers and those looking for the first job. The change in the classification is for individuals in the above categories in a subset of the survey waves but only in case they are the heads of the household. For instance, I include, in the control group, a housewife head of the household who starts working as an employee, if she reports being working in more survey waves than the ones when she reports that she does not work. Similarly, unemployed are assigned to their most frequent occupation within the panel, and dropped only in case they are unemployed, and head of the household, the entire period. Importantly, new assignments are done for the pre-policy period only, to avoid potential confounding effects coming from individuals who change status because of the policy. For instance, employees who turn unemployed after the policy are dropped from the sample as in the conservative classification. In the long time series, I have now 2757 households versus the 2513 of the conservative specification. In the restricted sample, 3300 versus 3153. All the results, including the placebos, are robust. The magnitude of the effects is also in line with the baseline results.

I also considered several sample splits, to further understand what drives the effect of the policy. In all cases, I restricted both the treatment and the control groups such that there are no switches. For simplicity, I will only discuss the results from the regression specification with control variables, excluding the controls according to which I split the sample, but everything is robust in case all controls are excluded. The baseline policy effect, against which I will benchmark all other results, is 31 euros less of monthly household cash expenditure per member. When splitting according to macroareas within the country, either North, Center or South, I find a significant effect only in the North (40 euros less). When restricting to small cities below 20(k) inhabitants, I find a bigger effect (52 euros less), while there is no effect when restricting to big cities above 500(k) inhabitants, although there are not many households in this last regression. Splitting according to the highest educational attainment of the head of the household results in no significant effect in case of college or higher, although there are few treated households in this case, in a big and significant effect in case of high school degree (47 euros less), and in no significant effect in case of middle or elementary education. Splitting according to the head of the household gender results in a bigger effect (42 euros less) in

case of female head. With respect to the marital status, the effect is statistically significant and particularly big (160 euros less) for divorced head of the household, most likely because an alimony above 1(k) euros cannot be paid cash after the threshold decrease. With respect to head of the household age, the effect if very big in the 55-65 range (77 euros less). It is difficult to say if there is an effect above 65 years because many individuals are pensioners and, therefore, there are very few treated households in case of this split. Similarly, there are no treated households whose head is below 25. There is no statistically significant effect when restricting, respectively, to the 25-35, 35-45 and 45-55 ranges. Perhaps the reason is that those individuals already used heavily cashless payments technologies before the policy. When restricting according to household size, I find a big effect for families of two (62 euros less) while no statistically significant effect both for bigger or smaller families.

In the regressions I control for income and consumption, but it is interesting to see how they change after the threshold decrease. Table 8 summarizes the results. Total consumption, durables consumption and non-durables consumption did not change, while disposable income decreased by 1400 euros per year, or 3.5% of the pre-policy disposable income for the treated group. The slightly reduced disposable income is consistent with the model in case the threshold is binding for the seller only. I also tried looking at the effect of the policy on single consumption items, rather than on the total, at least for those categories for which I have data in SHIW. They include: jewels, furniture and electronic equipment, food and cars and other vehicles (including boats, bikes etc.). In all cases the policy had no effect. I only found a negative effect of the policy on charity donations, of 138 less per year, but significant at the 10% level only.

Similarly, in the regressions I controlled for credit an debit card possession, as well as for e-banking services use, but the policy might have changed that also. In a panel logit regression I find, however, no effects. Unfortunately the SHIW asks for household cash expenditure but it does not ask for payment card expenditure, so it is difficult to test for substitutions between payment methods as an effect of the threshold. I also tried to find if there were some changes in the financial behavior of the potential evaders after the policy. In particular, I considered the effect of the policy on the amount of deposits, and on the holding of bonds, shares and life insurance. I only found an effect on life insurances, but significant only at the 10%.

Furthermore, in less than 25% of the treated households some members hold one. Conversely, the policy had no effect on deposits, bonds or shares.

8 Confounding Policies

To make sure that I am really estimating the effect of the cash threshold, it is important to exclude that other policies implemented between 2010 and 2012 might have affected cash use. As already stressed in section 2, the cash threshold reduction to 1000 euros was part of an austerity package introduced by the Italian government headed by mr Mario Monti in the midst of a financial crisis, the so-called "Salva Italia" strategy. The package included: a pension reform that increased the minimum age and the contribution requirements; new taxes on real estate, boats, private jets and financial investments; a transfers reduction to local governments; several deregulations such as the partial liberalization of non-prescription drugs sales; a throughout spending review; a value added tax increase by 1 percentage point (effective in 2013). All those policies should not have had an impact on cash expenditure over and above their effect on income and consumption, that are controlled for in the regression. The major concern is perhaps the real estate tax, since the treatment group consists also of employees with real estate income, who were severely affected by the tax. But, once again, this effect should be soaked up by the income and consumption controls. Concerning tax evasion, there is no other policy aimed at curbing evasion introduced by the Monti government except the cash threshold reduction.

Looking further back, the fourth government headed by mr Berlusconi was in office between 2010 and 2011. The most relevant economic policy measures implemented by this government were a value added tax increase, other minor tax increases on fuels, tobacco products and games, and a reduction of tax exemptions. All governments headed by mr Berlusconi were also notoriously lenient towards evasion[5].

It is also unlikely that the reduced cash use was an effect of monetary policy, because the cash threshold was implemented in a period of expansionary monetary policy. The main refinancing rate (REFI) decreased in fact from roughly 1.5% to zero between 2011 and 2014,

[5]There is a famous quote by mr Berlusconi who, in a public speech, stated that if the government asks you more than one third of your earnings you are justified not paying it.

and the ECB launched the Covered Bond Purchase Program (CBPP) in 2009, the Securities Market Program (SMP) in 2010 and a second wave of the CBPP in 2011, all of which significantly expanded its balance sheet as part of a quantitative easing strategy. Moreover, the ECB also started longer term refinancing operations with a 36 months maturity in 2011, reduced the reserve ratio and expanded the list of assets allowed as collateral in the Repos. Negative interest rates at the deposit facility started instead in 2014. One potential concern is that the ECB decided, in 2014, to stop printing the 500 euros notes, and to withdraw them from circulation in 2016. Thus cash circulation and cash payments could have decreased as an effect of the unavailability of large denomination bills. However, as of today, 500 euros note are still legal tender, so the effects are likely to be only minor.

An additional piece of evidence is that, according to the data by Guardia di Finanza (the tax enforcement police corp in Italy), enforcement against tax evasion actually decreased around the threshold reduction. Their annual reports show that the number of random enforcement activities (excluding the detailed tax audits, which are non-random and targeted to firms who are already part of an investigation, and the police-like activities designed to repress international frauds or to apprehend financial criminals) such as cash registers checks and fiscal obligations compliance analysis, decreased from an average of roughly 780(k) between 2008 and 2011 to slightly more than 480(k) in 2012, to then remain constant around 500(k) towards the end of the sample.

9 The Effect on Evasion

The first step to estimate the impact of the threshold on evasion is the quantification of its effect on cash in circulation. To this end, I simply run, separately for the treatment and for the control group, a panel fixed effects regression of total monthly household cash expenditure on a dummy equal to one for the post-policy period, conditioning on time dummies and on the full set of control variables used to estimate equation (15) augmented by the number of household members (the dependent variable is not adjusted for it):

$$y_{it}^k = \rho^k \, post_t + \beta^k X_{it}^k + \gamma_i + \delta_t + \varepsilon_{it} \tag{16}$$

The dependent variable y is total cash expenditure and k is either the treatment (tr) or the control (ct) group; the coefficient on the *post* dummy ρ^k is the difference between the average cash expenditure before the policy and the average cash expenditure after the policy for group k. since I am controlling for household fixed effect, for time effects, for income changes and for total consumption changes, it is very likely that the estimated difference is an effect of the threshold. The results is $\rho^{tr} = -154$ euros for the treatment group and $\rho^{ct} = -125$ euros for the control group.

The next step entails supplementing this estimates with external information to gauge the magnitude of the cash expenditure change. I assume that the SHIW is representative of the Italian population. The households in the treatment group are 1732 over 5453 or 31.8% of the total. Data from the Italian Statistical Institute (ISTAT) show that, in 2010, there were roughly 24.4 million households in Italy. This figure is obtained divided the total population by the average family size. The total annual change in cash expenditure implied by the above estimates is therefore $[154 \cdot 3(0.318) + 125 \cdot 3(0.682)] \cdot 312 \cdot 324.4 = 39235$ million euros, where the term in square brackets is the weighted average monthly cash expenditure change per household with weights equal to the proportions of households in the treatment and control groups. I assume that there is full evasion (γ=1 in the model notation) on cash transactions, keeping in mind that the computation will produce an upper bound for the actual effect. The statutory VAT rate in Italy in 2010 was 20%, reduced to 10% and 4% for some goods such as foods and books. Since, according to SHIW, roughly 30% of the total household average yearly consumption expenditure is on food, absent more detailed information, I consider an average VAT rate of $0.30.04 \cdot 3(0.3) + 0.2 \cdot 3(0.7) = 0.152$. Multiplying this rate by the yearly cash expenditure reduction and dividing it by the total VAT proceedings in 2010 from the OECD database, I obtain $(0.152 \cdot 339235)/97856 = 6.1\%$. The conclusion is that, according to the data, the cash threshold reduction to 1000 euros in 2011 increased VAT revenues at most by 6.1%. According to the CASE-CPB report on VAT evasion (2014) by the European Commission, total VAT gap in ITALY in 2010 was 31700 million euros. This means that the threshold reduction decreased the VAT GAP at most by 19%.

As for the income tax, OECD data indicate an average tax rate on income and profits equal to 30% in 2010. Assuming again full income tax evasion on the cash transactions, I

can compute the tax revenue increase due to the lower threshold multiplying the total cash reduction by the average rate and dividing the product by the total income tax proceedings from the OECD tax database. The result is a 5.4% increase. Assuming a more modest 50% evasion on both taxes, the effect of the policy is instead a 3% increase of VAT revenues, which is a slightly less than a 10% decrease of VAT gap, and a 2.7% increase of income tax revenues.

10 Counterfactuals

The question, that I try to address in this section is if, everything else equal, a lower cash threshold would have resulted in a bigger increase in tax revenues. To answer, I calibrate the model using SHIW data to perform counterfactuals. Before proceeding, it is necessary to point out that the results from this exercise must be taken with great caution, substantially because of the Lucas' critique: an economy with a very small cash threshold will function very differently. In other words, the model parameters that I calibrate and, therefore, assume as fixed along the policy experiment, such as the cost of cash payments, could change as an effect of small thresholds.

First of all, I need to impose some extra structure on the model. In particular, I need to specify a distribution for x. For simplicity, I consider an exponential with parameter λ, i.e. $f_X(x) = (1/\lambda)\, e^{-\frac{x}{\lambda}}$. The reason why a chose this distribution is because it associates a high probability with small values and a very small probability with extreme values, which seems like a plausible assumption for transaction amounts. In addition, the exponential distribution is indexed by one parameter only, which facilitates the calibration. That said, I will also explore the robustness of the results to alternative distributions. In order to match the data, I also need to assume that the exogenous income of the seller is high enough to buy $H > 1$ times the consumption bundle, not just one time.

The calibration procedure proceeds as follows. First, I set the parameters λ and β in order to match the average cash transaction amount and the average payment card transaction amount in Italy from Hesselink and Hernandenz (2017). More specifically, I solve numerically the following two equations in β and λ: $\int_0^{\beta}(x/\lambda)e^{-\frac{x}{\lambda}}dx = 14$ euros and $\int_{\beta}^{\infty}(x/\lambda)e^{-\frac{x}{\lambda}}dx = 38$ euros. Both target values refer to 2016, with a threshold equal to 3000 euros and, most

likely, not binding according to the evidence that I discussed before. Second, I use the average monthly cash expenditure of the control group in the post-policy period, 807 euros, to compute E using $E\int_0^{1000}(x/\lambda)e^{-\frac{x}{\lambda}}dx = 807$. Then I use a similar relationship to compute C for the treatment group, $C\int_0^{1000}(x/\lambda)e^{-\frac{x}{\lambda}}dx = 867$. Note that it does not matter if I call the above coefficient C or D, in the model notation, because everything that matters is that it represents post-policy average cash expenditure for the treatment group. Using the calibrated λ, β, C and E, I can then compute the average monthly cash expenditure change implied by the model simply as a weighted average, using the same shares as in the first part of this section. Multiplying this figure by the tax rate and by the total number of households, I will finally have the predicted tax evasion change. The resulting tax revenue increase is $t\left[0.318\left(1062-\Lambda(\widetilde{L})C\right)+0.682\left(942-\Lambda(\widetilde{L})E\right)\right]\cdot 312\cdot 324.4$, where 1062 euros and 942 are, respectively, the household average monthly cash expenditure, before 2012, of the treatment and control group and t is the average tax rate. The term $\Lambda(\widetilde{L}) = \int_0^{\widetilde{L}}(x/\lambda)e^{-\frac{x}{\lambda}}dx$, with $\widetilde{L}$ is the new cash threshold. For $\widetilde{L} = 500$ euros, the VAT revenue increase would have been 7.8% while the income tax revenue increase roughly 6.9%. For an extremely lower $\widetilde{L} = 100$ euros, the VAT revenue increase would have been 24.2% and the income tax revenue increase 21.3%. Assuming a Gamma distribution, setting the shape parameter so that it matches the coefficient of variation of total consumption for all household before 2012, I obtained slightly lower tax revenue increases. I obtained even lower gains with a Lognormal distribution, setting again the shape parameter in order to match the coefficient of variation of total consumption. Thus the tax revenue gains for the baseline exponential distribution must be considered as upper bounds.

The problem with all of the above calibrations is that the ratio of cash consumption to total consumption in the model is 28%, regardless of the distribution assumption, while it is 47% in SHIW before 2012 and 58% in the data analyzed by Hasselink and Hernandez (2017). Therefore I tried an alternative calibration procedure using the ratio of cash expenditure to total consumption as a target. As second target, instead of using the average cash transaction amount in Hasselink and Hernandez (2017), I divided the total monthly cash expenditure per capita for my control group before 2012 by the average monthly number of cash transactions per capita from Hasselink and Hernandez (2017), equal to 1.2 per day. The result is a slightly

higher average cash transaction amount of 16.8 euros. Following exactly the same steps as before, I obtained, for a 500 euros threshold, a VAT gain of 7.8% and an income tax gain of 6.9%. For a 100 euros threshold, the gains are instead 16.6% for the VAT revenue and 14.6% for the income tax revenue. As in the previous calibration exercise, the gains are slightly lower in case of a Gamma or Lognormal distribution. I also tried computing the average transaction amount using a slightly higher average number of transaction per capita, to account for innovations in payment technologies. I tried with 1.5 and 1.7, obtaining slightly smaller gains in both VAT and income tax revenue.

In conclusion, these counterfactuals show that the thresholds should be very small to have substantial tax revenue increases, perhaps smaller than what most individuals will find reasonable. In addition, such low thresholds could also induce a lower efficiency of the payment systems, increasing the transaction costs for many individuals such as the elderly. Furthermore, very small cash thresholds must be routinely changed to account for inflation, at least annually, and this could induce further inefficiencies and/or potential delays in durable consumption that could also decrease aggregate demand and, therefore, tax proceedings. Some individuals could also reduce their consumption for privacy concerns, further reducing aggregate demand and tax proceedings. For all these reasons, the tax proceeding increase induced by a small threshold might not be big enough to yield a welfare increase.

11 Conclusion

The empirical results suggest that the cash threshold policy that, in Italy, decreased the maximum transaction amount that could be settled in cash to 1000 euros in 2011 was effective at reducing cash circulation and at increasing tax revenue. The effect, however, is not very big, most likely because of the widespread evasion on transactions of small amount and because of a problematic enforcement that requires single transactions audits. This small gains must also be weighed against the cost of the threshold: a loss of privacy, an excessive burden placed on the individuals who are not familiar with cashless payments technologies, like the elderly, an increase in the cost of banking services and perhaps also a demand reduction. These costs, however, might be subsidized by the government, as suggested by Rogoff (2016), for

instance using some of the extra proceedings from the tax evasion reduction to provide free basic banking services.

My computations indicate that, in order to increase the tax revenue by a more substantial amount, the threshold must be set at a much lower level, but this is problematic not only because the above mentioned costs, but also because a low threshold will contrast with the legal tender of money and because it could also cause inefficiencies in the payment system, since cashless transactions do not clear instantaneously. There is also the problem of how often to update the thresholds to account for inflation and frequent changes might actually introduce further inefficiencies. Monetary policy will also need a radical re-thinking (Buiter 2000; Rogoff 2014 and 2016). The effect of the threshold on welfare is therefore ambiguous, and my simplified model does not allow for a proper welfare computation. However even a more detailed model would not be sufficient to properly study the effect of cash thresholds, because an economy with small thresholds or, in the limit, without cash will not function as an economy with high thresholds, thereby hampering the possibility of doing comparative statics.

The analysis that I propose is also limited in scope, because the cash threshold is not just an anti-evasion policy, but it is also supposed to prevent money laundering and terrorist financing and these motivations can themselves justify the introduction of a cash threshold regardless of its effect on evasion.

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Appendix: Proof of Proposition 1

If the threshold is not binding for both the sellers and the buyer, with $L > \alpha > \beta$, then there will be no change in cash expenditure after the introduction of the threshold, resulting in no change in evasion. If the cash threshold is binding for the seller only, with $\alpha > L > \beta$, there will be a reduction of cash expenditure for seller but not for the buyers, decreasing evasion. Thus the proposition does not require a proof for this case. Suppose instead that $L < \beta < \alpha$, in which case the cash expenditure of both the seller and the buyers changes. Since $C > D$, in order to prove the proposition, it is sufficient to show that

$$\int_0^{\alpha} x f_X(x)dx - C\int_0^{L} x f_X(x)dx > \int_0^{\beta} x f_X(x)dx - G\int_0^{L} x f_X(x)dx$$

Since $\alpha > \beta$ before the policy, it is sufficient to show that $G > C$. Given their definition, I have to show that

$$G\left[\int_0^{L} x f_X(x)dx + \int_L^{\infty}(x+d)f_X(x)dx\right] > R(L)$$

From equation 8, the lhs of the inequality can be rewritten as $Y_b - cG\int_0^{L} x f_X(x)dx$. Since $R > R(L)$ it is sufficient to show that

$$Y_b - cG\int_0^{L} x f_X(x)dx > R$$

Using equation 1 results in $Y_b = \int_0^{\beta} x(1+c)f_X(x) + \int_{\beta}^{\infty}(x+d)f_X(x)$. Equivalently:

$$Y_b = E(X) + c\int_0^{\beta} x f_X(x) + d[1 - F_X(\beta)]$$

where $E(x)$ is the expected value of X and $F_X(x)$ the cumulative density function of x. From equation 4 we can write $R = \int_0^{\alpha} x f_X(x) + \int_{\alpha}^{\infty}(x+d)f_X(x)$ or:

$$R = E(X) + d[1 - F_X(\alpha)]$$

Therefore I need to show that:

$$d[F_X(\alpha) - F_X(\beta)] + c\left[\int_0^{\beta} x - G\int_0^{L} x\right] > 0$$

Since $\alpha > \beta$ before the policy, the first term is positive. Similarly, $\beta > L$ because the threshold is binding for the buyers. Since $G < 1$, the second term is also positive. Therefore the above inequality is always true, which proves the first part of proposition 1. Since both the cash expenditure of the seller and the cash expenditure of the buyer decreases in this case, there will also be a lower evasion, which proves the second part of proposition 1, thereby completing the proof.

Table 2: **Summary Statistics**

	Treated					Control Group				
	med	mean	std	1^{st} qrt	3^{rd} qrt	med	mean	std	1^{st} qrt	3^{rd} qrt
Cash	949	1050	583	600	1385	852	938	516	558	1200
Income	39347	45039	29740	26727	55578	30910	34510	19167	21693	42883
Cons tot	28114	31642	17380	20098	38500	23017	25711	12816	17029	31221
Cons nond	26021	29124	14783	19243	35294	21840	24055	11066	16785	29103
Cons dur	0	2536	6655	0	1318	0	1673	4893	0	831
Comp	3	2.79	1.18	2	4	2	2.39	1.18	1	3
Age	57	57.4	13.3	48	67	61	60.4	14.6	49	72
Female		0.28	0.45				0.33	0.47		
College		0.18	0.38				0.11	0.31		
High School		0.41	0.49				0.36	0.48		
Married		0.74	0.44				0.65	0.48		
Divorced		0.06	0.24				0.07	0.26		
Ebank		0.25	0.43				0.15	0.36		
Credit		0.49	0.5				0.34	0.48		
Debit		0.8	0.39				0.76	0.42		
Big city		0.05	0.22				0.07	0.25		
Small city		0.28	0.45				0.28	0.45		

Notes: Cash is household monthly average cash expenditure. Income is household yearly disposable income; Cons tot is household yearly total consumption; Cons nond is household yearly total non-durables consumption; Cons dur is household yearly total durables consumption; Comp is the number of household components. Age is head of the household age Female is a dummy variable equal to 1 for female head of the household. College is a dummy equal to 1 if the head of the household higher education attainment is college or higher. High school is a dummy equal to 1 if the head of the household higher education attainment is high school. Married is a dummy equal to 1 if the head of the household is married. Divorced is a dummy equal to one if the head of the household is divorced. ebank is a dummy equal to one if at least one household member used e-banking services during the year. credit is a dummy equal to one if there is at least one credit card in the household. debit is a dummy equal to one if there is at least one debit card in the household. bigcity is a dummy equal to one for households living in big cities, above 500(k) inhabitants, smallcity is a dummy equal to one for households living in small cities, below 20(k) inhabitants.

Table 3: **Cash Thresholds and Cash Expenditure. Main Results.**

	All years		Restricted sample	
	(1)	(2)	(3)	(4)
policy	-30.7226**	-31.2093**	-33.4679***	-29.5251**
	(13.8797)	(13.5192)	(13.1485)	(12.8583)
R^2	0.01	0.16	0.01	0.12
obs	11994	11994	8247	8247
households	2513	2513	3153	3153
mdv	562	562	533	533
years	1995-2014	1995-2014	2010-2014	2010-2014
controls	no	yes	no	yes

Notes: Dependent variable is monthly household cash expenditure per household member (in euros). policy is the interaction term between a dummy equal to one for treated households (see text) and a dummy equal to one for the post-policy period (2012-2014). mdv is the median dependent variable for the treated households before the policy. Control variables included in columns (2) and (4) are: household yearly disposable income per household member, household yearly total consumption per household member, head of the household age, a dummy for female head of the household, marital status dummies (married, unmarried, divorced-excluded: widowed), head of the household higher education dummies (college or higher, high school, middle school-excluded: elementary or no formal education), a dummy equal to one if the head of the household used e-banking services during the year, a dummy equal to one if there is at least one debit card in the household, a dummy equal to one if there is at least one credit card in the household, a dummy equal to one for households living in big cities, above 500(k) inhabitants, and a dummy equal to one for households living in small cities, below 20(k) inhabitants. Clustered standard errors at the household level in brackets. *** significant at 1% level. * significant at 5% level. * significant at 10% level.

Table 4: **Cash Thresholds and Cash Expenditure. Placebo 2014.**

	All years		Restricted sample	
	(1)	(2)	(3)	(4)
placebo	-13.8561	-14.1379	-11.1122	-12.4464
	(15.5397)	(15.1713)	(13.9207)	(13.6722)
R^2	0.01	0.16	0.01	0.11
obs	10409	10409	7987	7987
households	2631	2631	3023	3023
mdv	549	549	500	500
years	1995-2014	1995-2014	2010-2014	2010-2014
controls	no	yes	no	yes

Notes: Dependent variable is monthly household cash expenditure per household member (in euros). placebo is the interaction term between a dummy equal to one for treated households (see text) and a dummy equal to one for the placebo post-policy period (2014). mdv is the median dependent variable for the treated households before the policy. Control variables included in columns (2) and (4) are: household yearly disposable income per household member, household yearly total consumption per household member, head of the household age, a dummy for female head of the household, marital status dummies (married, unmarried, divorced-excluded: widowed), head of the household higher education dummies (college or higher, high school, middle school-excluded: elementary or no formal education), a dummy equal to one if the head of the household used e-banking services during the year, a dummy equal to one if there is at least one debit card in the household, a dummy equal to one if there is at least one credit card in the household, a dummy equal to one for households living in big cities, above 500(k) inhabitants, and a dummy equal to one for households living in small cities, below 20(k) inhabitants. Clustered standard errors at the household level in brackets. *** significant at 1% level. * significant at 5% level. * significant at 10% level.

Table 5: **Cash Thresholds and Cash Expenditure. Further Evidence.**

	Decrease in 2010		Between 2012 and 2014	
	(1)	(2)	(3)	(4)
DD	-11.7448	-16.6347	-8.5713	-8.2223
	(12.5155)	(12.2771)	(14.0967)	(13.9637)
R^2	0.01	0.13	0.01	0.12
obs	6688	6688	6378	6378
households	3344	3344	3189	3189
mdv	505	505	473	473
years	2008-2010	2008-2010	2012-2014	2012-2014
controls	no	yes	no	yes

Notes: Dependent variable is monthly household cash expenditure per household member (in euros). DD is the diff-in-diff regressor, the interaction term between a dummy equal to one for treated households (see text) and a dummy equal to one for the post-policy period, equal to 2010 in columns (1) and(2) and 2014 in columns (3) and (4). mdv is the median dependent variable for the treated households before the policy. Control variables included in columns (2) and (4) are: household yearly disposable income per household member, household yearly total consumption per household member, head of the household age, a dummy for female head of the household, marital status dummies (married, unmarried, divorced-excluded: widowed), head of the household higher education dummies (college or higher, high school, middle school-excluded: elementary or no formal education), a dummy equal to one if the head of the household used e-banking services during the year, a dummy equal to one if there is at least one debit card in the household, a dummy equal to one if there is at least one credit card in the household, a dummy equal to one for households living in big cities, above 500(k) inhabitants, and a dummy equal to one for households living in small cities, below 20(k) inhabitants. Clustered standard errors at the household level in brackets. *** significant at 1% level. * significant at 5% level. * significant at 10% level.

Table 6: **Cash Thresholds and Cash Expenditure. Cash Intensive Sectors.**

	Retail and Hospitality		Construction		Services to Firms		Services to People		Agriculture	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
policy sect	-535.73***	-379.79***	70.41*	81.21**	107.81	88.49	-225.43	-166.26**	57.11	6.71
	(36.50)	(41.41)	(38.52)	(35.24)	(101.30)	(111.21)	(149.76)	(75.22)	(43.58)	(52.40)
R^2	0.02	0.14	0.01	0.14	0.01	0.14	0.01	0.14	0.01	0.14
obs	7171	7171	7171	7171	7171	7171	7171	7171	7171	7171
households	1446	1446	1446	1446	1446	1446	1446	1446	1446	1446
mdv	531	531	533	533	529	529	500	500	480	480
Treated	9.8	9.8	3.2	3.2	4.3	4.3	2.8	2.8	0.9	0.9
controls	no	yes	no	yes	no	yes	no	yes	no	yes

Notes: Dependent variable is monthly household cash expenditure per household member (in euros). policy sect is the interaction term between a dummy equal to one for treated households (see text), a dummy equal to one for the post-policy period (2012-2014) and a dummy equal to one for household whose main income earner works in the sector indicated in column. mdv is the median dependent variable for treated households in the sector indicated in column before the policy. Treated is the percentage of treated households in the cash intensive sector indicated in column. Control variables included in columns (2), (4), (6), (8) and (10) are: household yearly disposable income per household member, household yearly total consumption per household member, head of the household age, a dummy for female head of the household, marital status dummies (married, unmarried, divorced-excluded: widowed), head of the household higher education dummies (college or higher, high school, middle school-excluded: elementary or no formal education), a dummy equal to one if the head of the household used e-banking services during the year, a dummy equal to one if there is at least one debit card in the household, a dummy equal to one if there is at least one credit card in the household, a dummy equal to one for households living in big cities, above 500(k) inhabitants, and a dummy equal to one for households living in small cities, below 20(k) inhabitants. All regression include an interaction term between the treatment dummy and the post policy dummy, an interaction between the sector dummy and the post policy dummy, and an interaction term between the treatment dummy and the sector dummy. Clustered standard errors at the household level in brackets. Regressions for all years (1995-2014). *** significant at 1% level. * significant at 5% level. * significant at 10% level.

Table 7: **Cash Thresholds and Cash Expenditure. Placebo by Sector.**

	Retail and Hospitality		Construction		Services to Firms		Services to People		Agriculture	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
placebo	-21.7753	-17.7672	23.7402	45.8713	46.0216	49.8488	14.7657	20.8287	60.1384	74.2178
	(21.7159)	(19.9361)	(38.3488)	(35.0773)	(77.3322)	(79.3948)	(35.5823)	(38.7182)	(53.3999)	(49.4278)
R^2	0.01	0.15	0.01	0.12	0.01	0.12	0.01	0.11	0.01	0.11
observations	8691	8691	8096	8096	8167	8167	8177	8177	7969	7969
households	1812	1812	1681	1681	1693	1693	1703	1703	1651	1651
mdv	500	500	504	504	499	499	478	478	450	450
controls	no	yes	no	yes	no	yes	no	yes	no	yes

Notes: Dependent variable is monthly household cash expenditure per household member (in euros). placebo is the interaction term between a dummy equal to one for households whose head works in the sector indicated in column and a dummy equal to one for the placebo post-policy period (2014). mdv is the median dependent variable for the treated households before the policy. Control variables included in columns (2), (4), (6), (8) and (10) are: household yearly disposable income per household member, household yearly total consumption per household member, head of the household age, a dummy for female head of the household, marital status dummies (married, unmarried, divorced-excluded: widowed), head of the household higher education dummies (college or higher, high school, middle school-excluded: elementary or no formal education), a dummy equal to one if the head of the household used e-banking services during the year, a dummy equal to one if there is at least one debit card in the household, a dummy equal to one if there is at least one credit card in the household, a dummy equal to one for households living in big cities, above 500(k) inhabitants, and a dummy equal to one for households living in small cities, below 20(k) inhabitants. Clustered standard errors at the household level in brackets. Regressions for all years(1995-2014). *** significant at 1% level. * significant at 5% level. * significant at 10% level.

Table 8: **Cash thresholds, Income and Consumption.**

	Income	Consumption (tot)	Consumption (dur)	Consumption (non dur)
	(1)	(2)	(3)	(4)
policy	-1409.64**	65.22	-85.24	140.78
	(641.31)	(441.97)	(269.38)	(359.62)
R^2	0.15	0.53	0.05	0.56
obs	11994	11994	11994	11994
households	2513	2513	2513	2513
mdv	40347	28497	0	26232

Notes: Dependent variable in column (1) is household yearly disposable income; in column (2) is household yearly total consumption; in column (3) is household yearly durables consumption; in column (4) is household yearly non durables consumption. All dependent variables are in euros. policy is the interaction term between a dummy equal to one for treated households (see text) and a dummy equal to one for the post-policy period (2012-2014). mdv is the median dependent variable for treated households before the policy. Control variables included in all regressions are: head of the household age, a dummy for female head of the household, marital status dummies (married, unmarried, divorced-excluded: widowed), head of the household higher education dummies (college or higher, high school, middle school-excluded: elementary or no formal education), a dummy equal to one if the head of the household used e-banking services during the year, a dummy equal to one if there is at least one debit card in the household, a dummy equal to one if there is at least one credit card in the household, a dummy equal to one for households living in big cities, above 500(k) inhabitants, and a dummy equal to one for households living in small cities, below 20(k) inhabitants. Regressions for all years (1995-2014). Clustered standard errors at the household level in brackets. *** significant at 1% level. * significant at 5% level. * significant at 10% level.