The social cost of playing by the rules in the credit market

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Abstract

We present a model of the credit market under imperfect information, with a lender and many would-be entrepreneurs who need external funding for their projects. Some borrowers may have the incentive to divert part of the loan received to other, illegal or non-contractible, uses. We first show that the equilibrium is more likely to be efficient when there is a high proportion of potential diverters. Another result is that, if diversion output is included in the social well-being function, equilibrium welfare can be higher than under symmetric information. When there is inefficiency, a regulatory intervention can be welfare improving but, the cost and desirability of the policy depend on whether the proceeds from diversion are classified as a contribution to social welfare or not.

Keywords: loan diversion, entrepreneurial financing, imperfect information, policy intervention.

JEL Classification: D82; E44; E50.

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Introduction

In the credit market, borrowers are expected to adopt all kinds of strategies to outwit creditors and maximize the value or utility of the loan money received. One case is when borrowers have access to business or personal activities other than the projects financed, and creditors have considerable market power that reduces the profitability of formal investment. This is the scenario we explore in this paper. We propose a simple banking model under imperfect information with a single lender and many would-be entrepreneurs who need outside finance to undertake their investment projects. Some borrowers may have the incentive to divert part of the loan received to other private uses. We will refer to this misallocation of resources as loan diversion.

Loan diversion is a typical moral-hazard problem, which is generally more relevant for small and medium-sized enterprises because of their informational opacity, lack of initial capital, and risky nature (Berger and Udell, 2002). Here, we model the relationship between cashless entrepreneurs and a profit-maximizing lender. Based on the empirical observations of Petersen and Rajan (1995), Beck et al. (2004), and Howorth and Moro (2012), the rent-extraction ability may result from specific institutional and industry conditions or alternative lending arrangements, such as relationship or shadow banking (usually provided by non-standard financial institutions).

It is useful to illustrate the logic of the model by means of a simple example. Consider many farmers in a rural context. Each is endowed with two different and independent projects, one formal and one informal. Farmers have no liquid wealth, but can borrow from a local lender or microfinance bank. The formal project involves the cultivation of a piece of land for the production of a cereal, and requires a specific quantity of pesticides, chemicals and protective devices to prevent infestations or other crop damages. A lower application increases the possibility of insect or animal attacks and reduces the probability of a good harvest. The informal project consists of the cultivation of an illicit drug crop, and thus is impossible to formalize in financial contracts. This production requires a variable investment and yields the farmer some private and non-transferable benefits. Farmers are distinguished in compliant and (potentially) defiant: compliant farmers carry out only the formal project, while defiant farmers may be tempted to use part of the loan for the informal investment. The lender cannot observe either the farmer type or the formal planting investment, and so whether the crop has been contaminated and destroyed by pests or wild animals because the appropriate combination of pesticides and protection was missing.

The same logic may be applied to other frameworks involving a moral hazard problem. For instance, in a tax evasion model, with a tax agency and two types of taxpayers. Some taxpayers may have an incentive to underreport their income to lower the tax liability and use the money for personal purposes. The tax agency cannot observe the taxpayer type and audit whether the income has been misreported or not.

In the paper, we first show that, contrary to expectations, the higher (lower) the proportion of defiant types, the higher (lower) the payoff obtained by both types of borrowers. The reason is that the fraction of loan diverted is increasing in the interest rate. So, when there is a high proportion of potential diverters, the lender is forced to hedge against the risk of massive default by charging a low interest rate, at the cost of giving up more rent to borrowers. The novel result is that, thanks to the propensity of defiant types, even compliant borrowers are able to keep some of their project's rent, despite the monopolistic bank. In our paper, it is "good" types who may end up benefiting from the wrong behavior of "bad" types and from their numerosity. This result is in contrast to most of the literature on credit market imperfections. For instance, in Akerlof (1970), an equilibrium in which only lemons are sold is more likely to occur when their proportion is relatively high. In Stiglitz and Weiss (1981) and de Meza and Webb (1987), a higher fraction of high-risk borrowers leads to an increase in the pooling interest rate, which is also charged to low-risk borrowers. The same conclusion is reached in Minelli and Modica (2009), where the credit sector is in monopoly.

For the same reasons described above, in terms of social welfare, the equilibrium is more likely to be efficient when there is a large number of defiant entrepreneurs. Specifically, if their proportion is higher than a certain threshold, the interest rate is such that no fraction of the loan will be diverted, and the equilibrium is efficient. Conversely, the bank will tend to charge increasingly higher interest rates for lower proportions of defiant types. The latter will respond by shifting more and more resources in informal investments so that loan diversion will result in a socially inefficient use of resources.

The improper use of financial resources is one of the main causes of loan default. The data in Table 1 appears to support our result that interest rates are positively correlated with the proportion of funds diverted and, thus, to the share of non-performing loans.[1]

Table 1. Lending interest rate and non-performing loans

Country	Lending interest rate (%)	Non-performing loans (%)
Congo	26.0	23.1
Tajikistan	23.5	20.4
Iraq	12.4	16.2
Kenya	12.0	14.1
Armenia	11.6	6.6
Lebanon	10.5	15.2
Zambia	9.5	11.6
India	9.2	7.9
Bangladesh	8.3	7.7
China	4.3	1.8
United States	3.5	1.1
Switzerland	2.6	0.7
Italy	2.3	4.4
Netherlands	1.5	1.9
United Kingdom	0.5	1.2

Source: Bankscope
Countries ranked by lending interest rate and non-performing loans. In 2020, the average of bad loans based on 102 countries was 5.86%.

Another result of the model is that, when diversion utility is factored in the social well-being function, equilibrium welfare can be higher than under symmetric information. This result is obtained when diversion is particularly "attractive", or when the productivity of formal projects is relatively small. The logic is very simple. If information were symmetric, the profit-maximizing lender would not allow any diversion activity, regardless of its value for borrowers. This implies that, if diversion is not observable and the productivity of formal projects is relatively less valuable than

[1] In a report of the European Central Bank, in 2020, non-performing loans of the European banks worth over 550 billion euro, nearly 3% of their total loan investment.

informal projects, equilibrium welfare can be higher than under perfect information.

To our knowledge, the only theoretical works in which equilibrium welfare can be larger than under full information are Shneyerov and Wong (2011) and Lauermann (2012). In an analysis of bilateral trade, Shneyerov and Wong (2011) show that, when sellers and buyers have private valuations, social welfare can be larger than under full information. The reason is that asymmetric information can deter entry in the market and, if there are matching frictions, such an effect can be welfare enhancing. Similarly, and independently, Lauermann (2012) comes to the same conclusion, but extends the analysis to the effect of different levels of frictions and concludes that whether asymmetric information is welfare superior or not depends on the exit rate of sellers, that is on the individual specific discount rate. As in their models, we consider a "seller" making take-it-or-leave-it offers with full bargaining power, but the source of trade inefficiency is different: in our case, it simply depends on the profit-maximizing objective of the lender, which would prefer to perfectly observe the behavior of borrowers, neglecting the benefits they would derive from diversion.[2]

When the equilibrium is inefficient, a regulatory intervention, for instance an interest rate cap, can be welfare improving. However, the cost and desirability of the policy depend on whether the proceeds from informal projects are counted as a contribution to the welfare of the economy or not. The question of whether introducing illegal activities in the statistical measures of national accounts has long been debated by academics and policymakers. In 2010, the European System of National and Regional Accounts (ESA 2010) established a new methodology that allows EU countries to include estimates of part of the black economy (prostitution, drug trafficking, counterfeit goods, smuggled cigarettes) in their gross domestic product to reduce the underground or informal sectors. In a report of Eurostat, published in 2018, it is made clear that: "Illegal transactions are treated the same way as legal actions. Illegal transactions are those that are forbidden by law. Illegal economic actions are transactions only when the institutional units involved enter the actions by mutual agreement".[3] For example, according to the OECD, the inclusion of illegal

[2] This conclusions can be related to the strand of literature on the welfare costs of asymmetric information. See the recent contribution by de Meza et al. (2021).

[3] Handbook on the compilation of statistics on illegal economic activities in national accounts

activities in national accounts has produced an increase in the GDP of 1% in Italy, 0.9% in Spain and, 0.6% in the United Kingdom. Among the reasons that push institutions towards this direction, there are the need for a more accurate and reliable measure of the GDP (including all economic activities, whether legal or illegal), comparability issues across countries, and inconsistency in national accounts.

The main prediction of the model is that credit is more likely diverted when there is a high proportion of borrowers who comply with the rules, that is essentially the clause that loan money cannot be generally used for other purposes than those stated in the financial contract. This result is supported by the data in Table 2. In the presence of high bank concentration, countries with a high crime index report low levels of non-performing loans. For instance, Argentina has a very high crime index (63.8), associated with a share of non-performing loans below the average (3.9%). Whereas, in countries like Cyprus and the United Arab Emirates, where the crime index is low (31.3 and 15.2), the share of bad loans is above the average (15.0% and 8.2%).

Table 2. Crime index, non-performing loans and bank concentration

Country	Crime index	Non-performing loans (%)	Bank concentration
Argentina	63.8	3.9	41.4
Guatemala	58.7	1.8	65.9
Malaysia	57.3	1.6	55.4
Mexico	54.2	2.4	49.4
France	52.0	2.7	57.1
Ethiopia	49.3	3.4	80.8
Sweden	48.0	0.5	91.1
United States	47.8	1.1	34.8
United Kingdom	46.1	1.2	49.1
Italy	44.9	4.4	71.1
Canada	41.9	0.5	60.5

Source: Bankscope, World Population Review.
Countries ranked by crime index. The crime index is expressed per 100,000 people.
Bank concentration is the percent of bank assets held by top three banks.

In terms of our stylized model, loanable funds might also be diverted into non-contractible socially acceptable ends, such as schooling for children or medical expenditures, whose benefits are not directly observable or measurable and thus cannot

and balance of payments - Sections 3.4-3.6.

be specified in financial contracts. When diversion output is excluded from welfare accounting and is relatively small, a policy can achieve a Pareto efficient equilibrium, whereas when it is included in welfare, an improvement is often not possible and, in any case, this would lessen the need for intervention. This result suggests that the decision to factor in non-contractible activities in welfare may serve as a basis for maintaining the status quo and not changing the regulatory framework. Moreover, if the informal project is highly productive, the socially optimal fraction of loan diverted can even be positive. In such cases, a policy is never Pareto improving, despite social optimality would require a positive informal production.

Related literature

The article by Bhat (1971) is one of the first to offer a detailed analysis of loan diversion. He identifies several reasons for borrowers to misuse financial funds, such as inadequate assessment of project risk or weak correlation between investment required and amount lent. Von Pischke and Adams (1980) add that the fungibility of money makes it easier to shift resources from productive to non-productive activities. Our paper is in line with the theoretical literature on the welfare implications of credit market frictions. On this topic, Burkart and Ellingsen (2004) analyze a banking model in which borrowers can divert investment resources to personal uses. They argue that trade credit can be an efficient substitute for financial loans, thanks to input illiquidity and the monitoring advantage of suppliers over banks. Similarly, Repullo and Suarez (2000) consider both market and bank finance, and assume that the latter involves a higher monitoring activity that may reduce the moral-hazard problem and thus loan diversion. They show that the choice between market and bank finance depends on the ratio of internal funds to investment needed. Bougheas (2004) shows that if the bank's monitoring activity is missing, firms may have the incentive to misuse resources intended to finance investments in intangibles, like R&D. Madestam (2014) focuses on the coexistence of formal and informal lenders and shows that the inability of the legal system to enforce contracts may increase loan diversion and even lead to credit rationing. Our results are also close to those of Navajas et al. (2003), who analyze the impact of interest rates on the strategic behavior of borrowers and show that "unfair" rates may increase the incentive to misallocate financial flows.[4]

On the empirical side, measuring loan diversion is not straightforward or even practically feasible. Many papers focus on the legal protection of investors and try to provide indirect proxies and indicators of diversionary tactics. La Porta et al. (2002) find that the lower the legal protection, the lower the valuation of firms on financial markets, and this may be interpreted as a signal of resource misallocation. Durnev and Kim (2005) report that, as protection becomes weaker, managers tend to divert a higher share of returns to their own advantage, at the expense of shareholders. Other papers find evidence that loan diversion is more widespread in less-developed contexts and for small enterprises, which usually tend to have loose accounting standards. Garikipati (2013) and Mungai et al. (2014) show that, although microfinance institutions provide credit and financial support for income-generating activities, acute poverty may force households to use borrowed money for basic family needs, such as consumption goods, health care, children education and repayment of old loans. In addition, poor property rights can induce borrowers to misallocate funds to protect the property (Besley et al., 2012).

Our conclusions are also consistent, empirically, with the findings in Banerjee et al. (2015), which show that loan diversion is significantly correlated with the interest rates charged by local monopolistic moneylenders. On the topic of market structure, part of the literature reports that the interest rates charged by most microfinance institutions are far higher than normal bank rates (Kar and Swain, 2014). The global average interest rate is around 35-40%, and it is not uncommon to observe rates above 80%. The riskiness of clients and small-sized loans are the most cited reasons for the strong difference between microcredit and standard bank interest rates, though default can usually explain only a small part of observed spreads (Banerjee, 2013). This is the reason why some recent theoretical and empirical works claim that the focus of many microfinance institutions has shifted from social outreach to financial performance, a process known as mission drift (Madajewicz, 2003; Cull et al., 2007). In terms of our paper, this means that microcredit banks may simply be taking advantage of their monopoly position. Other empirical evidence on mo-

[4]See Coco (2000) for a brief review on diversionary models.

nopolistic, for-profit microfinance institutions is reported in Armendariz de Aghion and Szafarz (2011), and de Quidt et al. (2011). Both papers also present a theoretical model with a single lender (for other theoretical papers with profit-motivated microfinance institutions, see Guha and Roy Chowdhury, 2013, and Caserta et al., 2018). Loan diversion is a serious and widespread problem of moral hazard that limits and tightens credit access. In some countries, the government has introduced measures of personal identification through fingerprints of loan applicants to subject future lending conditions on borrowers' credit history, as documented by Giné et al. (2012).

The next section introduces the model. Then, we describe the equilibrium and discuss the welfare and policy implications. Finally, some brief conclusions are drawn.

1 The Setup

Consider a one-period, risk-neutral credit market with a large number of cashless would-be entrepreneurs. At the beginning of the period, each entrepreneur is endowed with two different and independent projects, which we will refer to as formal and informal projects. The formal project requires 1 unit of capital to be properly executed, and yields a deterministic output, y. The informal project requires a variable amount of capital and it too yields a deterministic output, $u_D(\delta)$, increasing and concave in the amount of funds invested. Entrepreneurs have no initial wealth and, to undertake their projects, they need external financing, which can be provided by a single lender/bank.[5] The returns of informal projects are either illicit or unobservable, so the bank will only consider loan applications for formal projects. We restrict attention to debt contracts, which specify the loan advanced, equal to the capital cost of 1, and the repayment (principal plus interest), r, made in case of project success. Implicitly, the contract contains the clause that loan money cannot be used for other purposes than the formal investment. To simplify, we consider limited liability on the part of borrowers, and a risk-free rate normalized to 0.

Entrepreneurs are of two types, differentiated by their attitudes towards the or-

[5] In Remark 2, we will briefly discuss the case of perfectly competitive lenders.

ganization and implementation of the two projects. Specifically, there are potentially "defiant" (D) borrowers, who have the ability to scale down the investment size of the formal project, at the cost of higher failure risk. That is, they can invest a fraction, δ, of the loan in the informal project, deriving private utility $u_D(\delta)$, and lowering the probability of success for the formal project down to $1 - \delta$. In other words, loan diversion makes the formal project stochastic. The other borrowers are "compliant" (C), in that they do not possess the downsizing ability and do not derive utility from the informal activity, so they are expected to undertake only the formal project.[6] This setup is consistent with the argument of Hart and Moore (1998), and Diamond (2004), in which earnings are not contractible when borrowers can easily divert or hide their cash flow. In our case, loan diversion is more (infinitely) costly for C types and less for D types.

We will use the following form for the diversion utility of D types:

$$u_D(\delta) = \tfrac{\theta}{2}[1 - (1 - \delta)^2], \quad \text{with } \theta > 0. \tag{1}$$

The parameter θ can be interpreted as the utility weight or productivity parameter of the informal project and can reflect several aspects, such as profitability, social acceptance, stigma, security, and legal risks, associated with this activity. The assumption in (1) is made to allow for an interior fraction of funds diverted other than the corner solutions. The functional form of the diversion utility is similar to that in the paper by Repullo and Suarez (2000) to make the analysis more tractable. The key difference between our and their setup is that they consider a single type of borrowers, so there is no hidden information.

The model involves both hidden action and hidden information. The bank cannot distinguish C from D types, but knows their proportions, $1 - \lambda$ and λ. We do not consider monitoring activity during the investment stage of the formal project, so

[6] The combination of fixed loan size and potential diversion of investment funds is used, among others, by Carter (1988), Repullo and Suarez (2000), Wydick (2001), and Diamond (2004).

The justification for our assumption of fixed loan size may be that formal projects must meet some minimum technical requirements to qualify for financing, without compromising the basic standards established for the legal or material operation of the business. So, C types are simply unable or unwilling to adopt those riskier production technologies.

the quantity of funds diverted by D borrowers is unobservable.[7] But, at the end of the period, the bank can perfectly observe the formal project output. To simplify, we assume that, for institutional constraints, no penalty can be imposed on defaulters, so contracts based on *ex-post* verification would be equivalent to the debt structure introduced above (as long as the bank can pre-commit to an *ex-ante* fixed payment rule).

The timing of the game is: 1) nature determines y, θ and λ; 2) the bank offers the contract, loan-repayment, $(1, r)$; 3) C and D individuals decide whether to accept or not; 4) if D individuals accept, they choose δ and obtain $u_D(\delta)$ from informal projects; 5) the formal project output is realized and state-contingent payments are made.

Had we symmetric information, the bank would force D borrowers not to divert ($\delta = 0$) and set $r = y$ (a higher repayment would not be accepted). Each borrower would obtain the reservation payoff, $\pi_C(y) = \pi_D(y) = 0$, and the bank the full-information profit, $\pi_B(y) = y - 1$, which we assume is positive (otherwise, the bank would not finance any project). Under perfect information, the bank is able to extract all the rent from every contract.

The result under perfect information may provide a rationale for why D borrowers may want to activate the informal project if information is asymmetric, as shown below.

2 Equilibrium

In what follows, we describe the equilibrium properties under the pooling contract, debt repayment, r (in Remark 1 below, we will show that a separation, in which D types are excluded, cannot be achieved).

The expressions for the expected profits by C and D entrepreneurs are:

$$\pi_C(r) = y - r; \tag{2}$$

$$\pi_D(r) = u_D(\delta) + (1 - \delta)(y - r). \tag{3}$$

[7] Using data on mills' contracts in the colonial Taiwan, Koo et al. (2012) show that, when monitoring is possible, high interest rates can deter borrowers from improper uses of funds.

The fraction of funds diverted derives from the maximization of (3), yielding

$$\delta = 1 - \tfrac{y-r}{\theta}, \tag{4}$$

so, as r increases, D types will choose to divert more resources (the second-order condition is satisfied).

The expression for the lender's expected profit (per borrower) is

$$\pi_B(r) = \lambda(1-\delta)r + (1-\lambda)r - 1, \tag{5}$$

where, if the borrower is of type C (D), the lender obtains r with probability 1 ($1-\delta$). The lender maximizes (5), taking into account the participation constraints and the reaction function of D types.

Remark 1. With a large enough penalty in case of default, equal or above the diversion productivity parameter θ, the lender would be able to separate the two types of borrowers. Denote the penalty by τ. The first-best profit is obtained when the participation constraints of C and D types are satisfied with equality, that is $\pi_C(r,\tau) = y - r = 0$ and $\pi_D(r,\tau) = u_D(\delta) + (1-\delta)(y-r) - \delta\tau = 0$. The system is satisfied when $r = y$ and $\tau = \theta/2$. This solution requires that the penalty must be large enough, and this might be difficult to implement for legal or other institutional restrictions.

There are three relevant levels for the loan repayment charged by the moneylender. These will be derived and discussed below.

The first is the repayment such that D borrowers have no incentive to divert any fraction of the loan, that is $\delta = 0$, which gives

$$r = y - \theta \equiv r_{\min}.$$

If $r < r_{\min}$, D borrowers would still choose not to divert, but the expected profit to the bank would be lower. Hence, $r_{\min}$ is the lowest repayment in this model setup. Note that $r_{\min}$ can be positive or negative depending on whether the diversion productivity parameter is lower or higher than the formal project's output (with no diversion on the part of D types). Specifically, in the latter case, $r_{\min} < 0$, and a repayment for which there is no diversion is not possible. The reason is that, when θ is relatively high, diversion is particularly attractive, so it is never profitable for the lender to charge a repayment such that the informal project is not worth undertaking. Below, we will show that for values of θ even lower than y, an equilibrium at $r_{\min}$ may not exist.

The second repayment derives from the maximization of the expected profit by the bank in the range where $\delta \in (0,1)$. The solution is

$$r = \tfrac{\lambda y + (1-\lambda)\theta}{2\lambda} \equiv \widetilde{r},$$

with $\partial \widetilde{r}/\partial \lambda < 0$, so the higher the proportion of D types, the lower the repayment. Similarly, $\widetilde{r}$ is increasing in θ, as the higher the productivity of informal projects, the higher the fraction diverted and thus the repayment burden on formal loans.

The third repayment is such that $\delta = 1$, which gives

$$r = y \equiv r_{\max}.$$

At this repayment, $\pi_C(r_{\max}) = 0$, so C borrowers obtain an expected profit of 0, and D types take all the loan money and run. This means that $r_{\max}$ is the highest possible repayment level, and implies the following

Lemma 1. *In equilibrium, there is no adverse selection, as the lender will never set a repayment such that C types drop out of the market.*

The equilibrium repayment will depend on the relative proportion of C types. The lender must take into account that, depending on λ, $\widetilde{r}$ may be either lower than $r_{\min}$ or higher than $r_{\max}$. We derive two critical thresholds for λ:

$$\widetilde{r} = r_{\max} \Leftrightarrow \lambda = \tfrac{\theta}{y+\theta} \equiv \underline{\lambda};$$

$$\widetilde{r} = r_{\min} \Leftrightarrow \lambda = \tfrac{\theta}{y-\theta} \equiv \overline{\lambda}.$$

with $\underline{\lambda} < \overline{\lambda}$. Hence, we have the following three possibilities.

a) $\lambda < \underline{\lambda} \implies \widetilde{r} > r_{\max}$. In this case, $\widetilde{r}$ would be above the highest acceptable by C types, so the equilibrium repayment is $r_{\max}$

b) $\underline{\lambda} < \lambda < \overline{\lambda} \implies r_{\min} < \widetilde{r} < r_{\max}$. In this case, $\delta \in (0,1)$ and the maximizing repayment is $\widetilde{r}$.

c) $\lambda > \overline{\lambda} \implies \widetilde{r} < r_{\min}$. For any repayment lower than $r_{\min}$, D types would still choose $\delta = 0$, so it is profit maximizing to set $r_{\min}$.

Using δ in (4), we have $\pi_D(r) - \pi_C(r) = (\theta + r - y)^2/2\theta = 0$ when $r = r_{\min}$, and $\pi_D(r) > \pi_C(r)$ when $r > r_{\min}$. Hence, we have the following

Lemma 2. *In equilibrium, if $r = r_{\min}$, all borrowers will earn the same payoff, whereas if $r > r_{\min}$, D types will obtain a payoff higher than C types.*

The threshold $\overline{\lambda}$ is equal to 1 when $y = 2\theta$. Hence, if $y < 2\theta$ the inequality $\widetilde{r} > r_{\min}$ always holds and the bank would never find it profitable to choose $r_{\min}$. If, instead, $y > 2\theta$, an equilibrium with $r = r_{\min}$ is possible. Hence, depending on y, there can then be either two or three relevant intervals of λ characterizing the equilibrium. These possibilities will be discussed in the following three sub-sections.

2.1 Equilibrium at $r_{\max}$

When $\lambda \in (0, \underline{\lambda}]$, $\widetilde{r} \geq r_{\max}$ and the repayment charged by the bank is $r = r_{\max}$, such that $\delta = 1$.

In equilibrium, the bank receives the loan repayment from C borrowers (D types divert the entire loan), and its expected profit is

$$\pi_B(r_{\max}) = (1 - \lambda)y - 1, \tag{6}$$

linear and decreasing in λ, as in figure 1a and 1b. The profit does not depend on the diversion utility weight, θ, so we do not have to distinguish between the cases $y > 2\theta$ and $y \leq 2\theta$.

The payoff by C borrowers at $r_{\max}$ is

$$\pi_C(r_{\max}) = 0,$$

whereas D types obtain

$$\pi_D(r_{\max}) = \tfrac{\theta}{2}, \tag{7}$$

corresponding to the highest possible output from diversion and no output from the formal project.

The bank extracts all the rent from the formal projects of C types, and no rent from D types, as they do not even activate them. By shifting resources into informal investments, D borrowers are able to earn a positive payoff, although a relatively low λ, that is a high average quality of the pool of entrepreneurs, is the worst possible scenario for them, and especially for C types.

2.2 Equilibrium at $\widetilde{r}$

If $y > 2\theta$, there is an interval, $(\underline{\lambda}, \overline{\lambda})$, in which $r_{\min} < \widetilde{r} < r_{\max}$, so it is profit maximizing for the lender to choose $\widetilde{r}$, such that $\delta \in (0,1)$. When $y \leq 2\theta$, the interval in which an equilibrium at $\widetilde{r}$ exists is $(\underline{\lambda}, 1)$, and we will show that this case implies that the equilibrium described in the following subsection (2.3) is never possible.

When $r = \widetilde{r}$, in equilibrium, the lender obtains

$$\pi_B(\widetilde{r}) = \tfrac{[\lambda y + (1-\lambda)\theta]^2}{4\lambda\theta} - 1, \tag{8}$$

which can be shown is a non-rectangular hyperbola with vertical asymptote at $\lambda = 0$, and with the right branch decreasing in the range $(\underline{\lambda}, \overline{\lambda})$. A numerical example is illustrated in figure 1a. As expected, the higher the proportion of D types, the lower the lender's profit.

To restrict the analysis, we assume that $\theta < y^2/4$, which implies that $\pi_B(\widetilde{r})$ is always positive, as in the example of figure 1a and 1b, and an equilibrium at $\widetilde{r}$ exists, whether in the interval $(\underline{\lambda}, \overline{\lambda})$ or $(\underline{\lambda}, 1)$. This assumption implies that also the equilibrium at $r_{\max}$, analyzed in subsection (2.1) exists in the interval $(0, \underline{\lambda}]$.

The equilibrium payoff by C borrowers is

$$\pi_C(\widetilde{r}) = \tfrac{\lambda y - (1-\lambda)\theta}{2\lambda}, \tag{9}$$

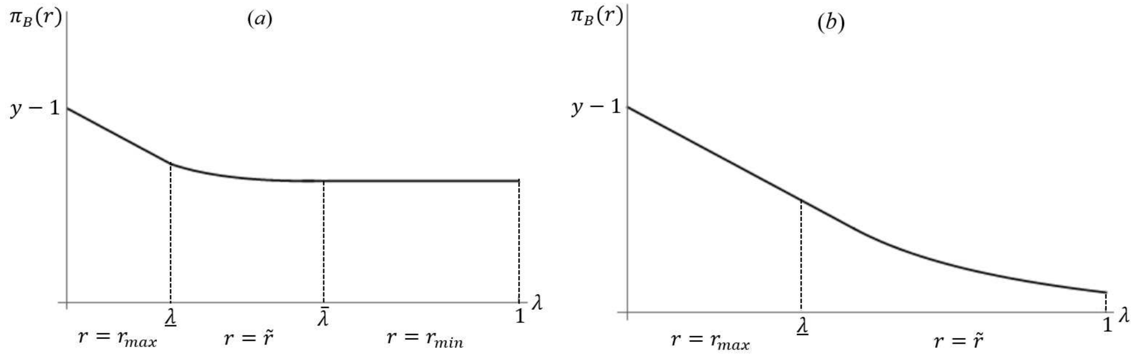

Figure 1. Bank's profit. Numerical example.
$a)$ $y > 2\theta$. Parameters: $y = 6$; $\theta = 2.5$.
$b)$ $y \leq 2\theta$. Parameters: $y = 6$; $\theta = 4.5$.

equal to 0 if $\lambda = \underline{\lambda}$, increasing in λ, and equal to θ if $\lambda = \overline{\lambda}$, as in figure 2$a$. Hence, in this interval C types obtain a positive rent.

At $\widetilde{r}$, the diversion fraction of funds diverted by D types is

$$\delta = \tfrac{1}{2}\left(1 + \tfrac{1}{\lambda} - \tfrac{y}{\theta}\right) \equiv \widetilde{\delta}, \tag{10}$$

decreasing in λ, so we obtain the following key result for our analysis.

Lemma 3. *The higher the proportion of D entrepreneurs, the lower the fraction of loan diverted.*

Using $\widetilde{\delta}$, the equilibrium payoff of D borrowers is

$$\pi_D(\widetilde{r}) = \tfrac{\theta}{2} + \tfrac{[\lambda y - (1-\lambda)\theta]^2}{8\lambda^2\theta}, \tag{11}$$

positive and above $\pi_C(\widetilde{r})$ for Lemma 2. The shape of the function $\pi_D(\widetilde{r})$ is similar to $\pi_C(\widetilde{r})$ in (9), as shown in figure 2a.

The utility from diversion,

$$u_D(\tilde{\delta}) = \tfrac{\theta}{2} - \tfrac{[\lambda y - (1-\lambda)\theta]^2}{8\lambda^2\theta},$$

reaches a maximum when $\lambda = \underline{\lambda}$, is decreasing in λ, and is equal to 0 when $\lambda = \overline{\lambda}$.

In equilibrium, the profit of the bank is decreasing in λ, and the payoff of both D and C types is increasing, as shown in figures 1 and 2. Compared to the case of subsection (2.1), the bank can take advantage of cross-subsidization between the two types of entrepreneurs in a pooling equilibrium. The interest rate decreases in λ and, while D types are able to shift part of their debt liabilities, C types bear most of the repayment burden.

2.3 Equilibrium at $r_{\min}$

If $y > 2\theta$ and $\overline{\lambda} < 1$, we can obtain an interval, $[\overline{\lambda}, 1)$, where $\widetilde{r} < r_{\min}$. In this case, the equilibrium repayment is $r_{\min}$, such that $\delta = 0$. When, instead, $y \leq 2\theta$, the equilibrium at $r_{\min}$ does not exist.

The expected profit to the lender is

$$\pi_B(r_{\min}) = y - \theta - 1, \tag{12}$$

With $r = r_{\min}$, D borrowers do not divert any fraction of the loan, and this is why the profit in (12) does not depend on λ and the probability of project's success is equal to the prior, 1.

The equilibrium payoff of both C and D types is

$$\pi_C(r_{\min}) = \pi_D(r_{\min}) = \theta. \tag{13}$$

As this equilibiurm exists when $y > 2\theta$, borrowers obtain less than their project's output. But, due to the relatively large presence of D types in the population, all types of borrowers can earn a positive payoff, more than under perfect information where $\pi_C(y) = \pi_D(y) = 0$.

Therefore, when there is a high number of individuals who do not play by the rules, and thus do not comply with the contract requirement on loan diversion, the lender is forced to charge the lowest interest rate. Setting a repayment higher than $r_{\min}$ is not profitable when most borrowers are prepared to divert their loans and thus can lead to a relevant increase in the default rate. A relatively high θ means that diversion is highly profitable for D types, so the lender will try to compensate for the risk of default by choosing a higher repayment, either $\widetilde{r}$ or $r_{\max}$.

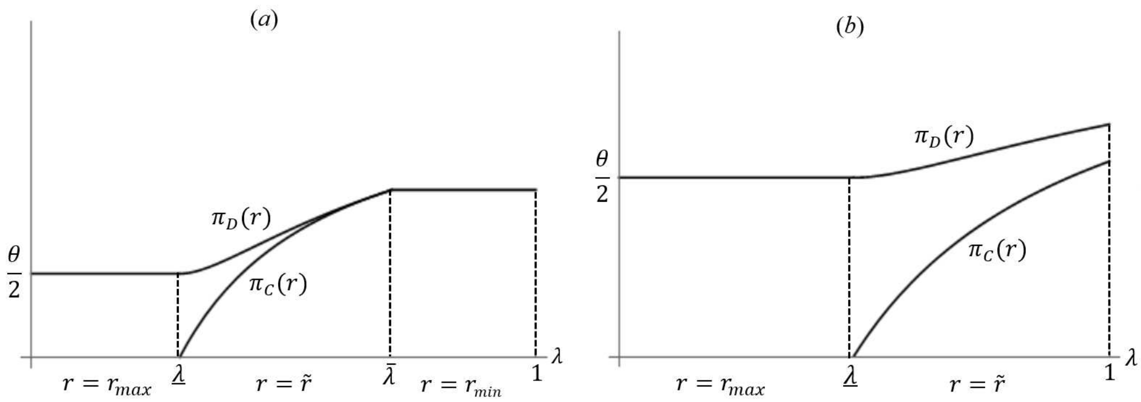

Figure 2. Payoffs of C and D borrowers. Numerical example.
a) $y > 2\theta$. Parameters: $y = 6$; $\theta = 2.5$.
b) $y \leq 2\theta$. Parameters: $y = 6$; $\theta = 4.5$.

The discussion of this section leads to the following result.

Proposition 1. *The higher the proportion of D entrepreneurs, the higher the surplus that both types of borrowers can obtain.*

As noted in the introduction, this result is in contrast to the main body of literature on credit markets under informational asymmetries. In our case, the propensity of "bad" borrowers to divert their loans forces the bank to charge a low lending rate, and this benefits also "good" borrowers who obtain a payoff larger than under symmetric information. This effect is intensified when bad borrowers are particularly numerous. Except when the number of D types is very low, both types of borrowers earn a positive expected payoff, despite the presence of a monopolistic lender. This would not be possible under perfect information.

Remark 2. Diversion would be possible also with a perfectly competitive credit market. Consider initially that D borrowers choose not to divert their loans. In this case, the equilibrium repayment derives from the zero profit of each lender, $\pi_B(r) = \lambda r + (1 - \lambda)r = 1$, yielding $r = 1$. However, if D borrowers can divert funds, and if $r_{\min} < 1$, that is $\theta > y - 1$, the equilibrium repayment derives from $\pi_B(r) = \lambda r + (1 - \lambda)(1 - \delta)r = 1$. In this case, using the reaction function in

(4), the equilibiurm repayment[8], r, can be higher than r_{min} if $\theta > y - 1$.[9] Thus, the misallocation of funds can also occur under a competitive equilibrium. Using the setup of this paper, with perfectly competitive banks, the algebraic expressions would become extremely cumbersome, but it can be shown that the conclusions would not differ from the "expected" results: the fraction of loan diverted would be increasing in λ, whereas the payoff of both C and D borrowers decreasing (the complete description is available upon request).

Remark 3. In the paper, we focus on debt contracts and do not consider equity financing. In our case, with asymmetric information and where monitoring is unfeasible, equity contracts between the bank and each entrepreneur would leave the theoretical conclusions unchanged. In the very brief presentation that follows, consider that s is the share of the firm's return that accrues to the bank. We maintain the assumption that, in the partnership, the member "bank" has all bargaining power and that no penalty can be imposed if the output realized with a member who turns out to be a D type is 0. We assume that the bank cannot participate in the diversion activity and, to simplify, we restrict the discussion to the case $\theta < y$.

The contract must satisfy the participation constraints of C and D types,

$$\pi_C(s) = (1-s)y \geq 0;$$
$$\pi_D(s) = u_D(\delta) + (1-s)(1-\delta)y \geq 0.$$

The fraction of funds diverted by D types is $\delta = 1 - (1-s)y/\theta$, increasing in s.

The expression for the bank's expected share-finance profit (on a partnership with an unknown member type) is

$$\pi_B(s) = \lambda sy + (1-\lambda)s(1-\delta)y - 1.$$

From the bank's maximization, we obtain three relevant levels of the participation share, $s_{\min} = (y-\theta)/y$, $\widetilde{s} = [\lambda y + (1-\lambda)\theta]/2\lambda y$ and $s_{\max} = 1$, which have an

[8] $r = \frac{(1-\lambda)\theta+\lambda y-\theta\sqrt{\left[1+\left(\frac{y}{\theta}-1\right)\lambda\right]^2-\frac{4\lambda}{\theta}}}{2\lambda}$

[9] $r - r_{min} = \frac{(1+\lambda)\theta-\lambda y-\theta\sqrt{\left[1+\left(\frac{y}{\theta}-1\right)\lambda\right]^2-\frac{4\lambda}{\theta}}}{2\lambda}$.

analogous interpretation to their repayment counterparts. It can be shown that $\pi_B(s_{\min}) = \pi_B(r_{\min})$, $\pi_B(\widetilde{s}) = \pi_B(\widetilde{r})$, and $\pi_B(s_{\max}) = \pi_B(r_{\max})$. Therefore, with equity contracts, the equilibrium configurations of the analysis of this section would remain unchanged.

3 Welfare

In this section, we determine the equilibrium and the socially optimal welfare, and analyze the potential divergences between these two measures. From the analysis of Section 3, the optimal welfare depends on whether the utility from diversion, $u_D(\delta)$, is included or not in the accounting system and, in the following, we will discuss how this distinction may lead to different levels of δ maximizing social welfare. We will denote welfare (per borrower), when diversion is included and excluded, by $\omega_{in}(\delta)$ and $\omega_{ex}(\delta)$. We assume that the institutional decision to factor in informal activities does not affect the diversion utility weight, θ. In addition, we will not model the potential negative externalities associated with the production of informal projects (which is true for cultivating drug crops, but probably not for entrepreneurs investing in small merchandise or health medication). Informal projects and their outputs will still be considered illegal or non-contractible, otherwise they might be embedded into formal financial contracts. This means that C borrowers will continue to comply with all contract requirements and not misallocate their loans. The bank will still be unable to finance informal investments, otherwise it might take advantage, especially if its output is high.

This conceptual ambivalence, illegal but productive in economic terms, may reflect the recent reform ESA 2010 which allows EU countries to record illicit production within the national accounts. This may give a chance for governments to kill two birds with one stone: on the one hand, there can be a significant (and perhaps more accurate) increase in gross domestic product; on the other, it allows to secure political integrity and legitimacy.

If $u_D(\delta)$ is excluded from welfare, the socially efficient diversion fraction derives from

$$\max_{\delta} \omega_{ex}(\delta) = (1-\lambda\delta)y - 1.$$

Since $\partial\omega_{ex}(\delta)/\partial\delta < 0$, the solution is $\delta = 0$, and optimal welfare is equal to full-information welfare,

$$\omega_{ex}(0) = y - 1 \equiv \omega^{FI}(0). \tag{14}$$

If $u_D(\delta)$ is included in welfare, the optimal diversion fraction derives from

$$\max_{\delta} \omega_{in}(\delta) = \lambda u_D(\delta) + (1-\lambda\delta)y - 1. \tag{15}$$

The solution depends on the utility weight θ and, specifically, on whether it is higher or lower than the formal project's output, y (with no diversion on the part of D borrowers). Thus, we need to distinguish between two further cases.

Case $\theta \leq y$. If the informal activity is relatively less productive than the formal project, the welfare-maximizing diversion share is again $\delta = 0$. Efficient welfare is $\omega_{in}(0) = \omega^{FI}(0)$, thus equal to the full-information welfare.

Case $\theta > y$. If diversion is relatively more productive, the solution to (15) is

$$\delta = 1 - \tfrac{y}{\theta} \equiv \delta^*, \tag{16}$$

with $\delta^* \in (0, 1)$. This means it is socially optimal to let D types divert part of their loans. Namely, social efficiency would require the presence of some entrepreneurs who engage in informal activities, even if illegal (and even if, in theory, they may end up being punished by the law). Welfare is

$$\omega_{in}(\delta^*) = y + \tfrac{\lambda(\theta-y)^2}{2\theta} - 1. \tag{17}$$

It is easily verified that $\omega_{in}(\delta^*) > y - 1 = \omega^{FI}(0)$, so we have the following

Proposition 2. *When* $\theta > y$ *and* $u_D(\delta)$ *is included, the optimal diversion fraction is* $\delta^* > 0$, *and the socially efficient welfare is larger than under full information.*

Therefore, optimal welfare is equal to full-information welfare if the proceeds from diversion are excluded or, if included, the productivity of informal projects is relatively low. When the productivity is relatively high, welfare can be larger than under full information. But, as shown below, we will not derive a situation in which the equilibrium welfare under asymmetric information is higher than the socially efficient level.

3.1 Equilibrium welfare

3.1.1 Welfare at $r_{\max}$

When the equilibrium is $r_{\max}$, then $\delta(r_{\max}) = 1$. If $u_D(1)$ is excluded, social welfare is

$$\omega_{ex}(1) = (1 - \lambda)y - 1, \tag{18}$$

the expected output produced by C borrowers and transferred to the bank, as the loans received by D borrowers are entirely diverted. Since $\omega_{ex}(1) = (1 - \lambda)y - 1 < y - 1 = \omega^{FI}(0)$ for all $\lambda \in (0, \underline{\lambda}]$, welfare is lower than under full information (and thus inefficient).

If the informal output produced by D types is included, welfare is

$$\omega_{in}(1) = \tfrac{\lambda\theta}{2} + (1 - \lambda)y - 1, \tag{19}$$

below optimal welfare, $\omega_{in}(\delta^*)$. We can thus conclude that the equilibrium at $r_{\max}$ is socially inefficient.

However, the difference between $\omega_{in}(1)$ and welfare under full information is $\omega_{in}(1) - \omega^{FI}(0) = (\lambda\theta - 2\lambda y)/2$, which is positive if $\theta > 2y$, as depicted in figure 3a. Even if the proportion of funds diverted is above the socially efficient level, welfare including the proceeds of the informal project is larger than that of full information for all $\lambda \in (0, \underline{\lambda}]$.

3.1.2 Welfare at $\widetilde{r}$

If the equilibrium is at $\widetilde{r}$, and $u(\widetilde{\delta})$ is excluded, equilibrium welfare is

$$\omega_{ex}(\widetilde{\delta}) = \tfrac{[\theta + \lambda(y - \theta)]y}{2\theta} - 1, \tag{20}$$

which is lower than $\omega^{FI}(0)$, and inefficient, since $\widetilde{\delta} > 0$.

When $u(\widetilde{\delta})$ is included, welfare is

$$\omega_{in}(\widetilde{\delta}) = \frac{(2\lambda-1)\theta^2+3\lambda[2y\theta+\lambda(\theta-y)^2]}{8\lambda\theta} - 1, \tag{21}$$

again lower than optimal welfare, $\omega_{in}(\delta^*)$. The reason is that $\widetilde{\delta} - \delta^* > 0$, so D borrowers tend to divert too much resources compared to what social efficiency requires. Therefore, the equilibrium at $\widetilde{r}$ is inefficient, whether or not $u_D(\tilde{\delta})$ is counted as social welfare.

It can be shown that the difference between equilibrium welfare in (21) and full-information welfare can be positive for all $\lambda > \theta/3(\theta - y) \equiv \widetilde{\lambda}$. The threshold $\widetilde{\lambda}$ is smaller than one if $\theta > 3/2y$, and equal to $\underline{\lambda}$ if $\theta = 2y$. For $\theta \geq 2y$, then $\widetilde{\lambda} < \underline{\lambda}$ and equilibrium welfare is higher than the full information in the interval $[\underline{\lambda}, 1)$. For instance, in the numerical case of figure 3b, if $y = 2$ and $\theta = 4$, then $\omega_{in}(\widetilde{\delta}) > \omega^{FI}(0)$ for all $\lambda \in (0.67, 1]$. If $\lambda = 0.8$, then $\omega_{in}(\widetilde{\delta}) - \omega^{FI}(0) = 0.175$.

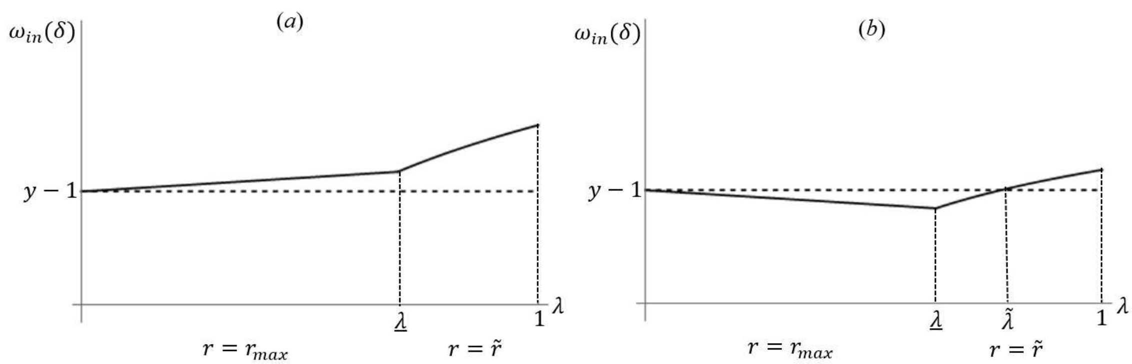

Figure 3. Equilibrium and full-information welfare (diversion output included). Numerical example.
a) Parameters: $y = 2$; $\theta = 4.5$.
b) Parameters: $y = 2$; $\theta = 4$.

3.1.3 Welfare at $r_{\min}$

If $y > 2\theta$, in equilibrium, the repayment is $r_{\min}$, for $\lambda \in [\overline{\lambda}, 1)$. Since $\delta(r_{\min}) = 0$, social welfare does not depend on whether the output from diversion is included or not, so

$$\omega_{ex}(0) = \omega_{in}(0) = y - 1 = \omega^{FI}(0).$$

Thus, if an equilibrium at $r_{\min}$ exists, it is socially efficient, and welfare is equal to the full-information level. In contrast, when $y \leq 2\theta$, both the interval $(\overline{\lambda}, 1]$ and the equilibrium at $r_{\min}$ do not exist.

From the analysis of this section, we can state the following.

Proposition 3. *The credit market equilibrium is socially efficient only when the equilibrium is at $r_{\min}$, when the proportion of D types is relatively high and the utility weight of diversion is small. The equilibria at $\widetilde{r}$ or $r_{\max}$ are socially inefficient.*

From this proposition, we come to the rather counterintuitive conclusion that the equilibrium is more likely to be efficient when there is a high proportion of potential diverters. When both $y > 2\theta$ and $\lambda \in [\overline{\lambda}, 1)$, the equilibrium at $r_{\min}$ exists and this is the only situation in which equilibrium welfare is socially efficient.

Proposition 4. *In the social inefficient equilibria at $\widetilde{r}$ and $r_{\max}$, when diversion output is included and the productivity of informal projects is relatively high, equilibrium welfare can be higher than under full information.*

3.2 Policy

When the equilibrium is inefficient, a social planner (government) might want to implement policies to improve the allocation of resources in the credit market. To restrict the discussion below, we will only present what would happen if the planner were to implement a policy when diversion output is particularly valuable, that is $\theta > y$, and is included in the measure of social welfare.[10] In this situation, the socially optimal welfare would be $\omega_{in}(\delta^*)$ in (17), which would call for a diversion fraction equal to δ^*, as derived in (16).

[10] In the other cases in which $\theta < y$ and diversion output is excluded, there may be a range where a policy can be welfare improving (a complete description of the policy is available upon request).

We follow the Kaldor-Hicks compensation principle, so the policy should be implemented only if borrowers, who will gain from the intervention, can potentially compensate the lender and still be better off. To be more specific, for Pareto efficiency, the lender's post-policy payoff must be equal to pre-policy equilibrium profit, based on the (inefficient) equilibrium repayment. The difference between these two profit levels will correspond to the policy cost. The *gross* expected benefit of the policy is the difference between optimal and equilibrium welfare. Therefore, the *net* expected benefit is the difference between gross benefit and cost.

From the welfare analysis above, including the utility from diversion in welfare means that socially efficient diversion fraction *should* be equal to the positive level, δ^*. And, if we follow this thought-provoking line of reasoning, this welfare maximizing fraction of loan diverted can be obtained by introducing an interest rate cap. In the specific case in which diversion output is included in welfare and $\theta > y$, using the reaction function of D borrowers in (4), the cap such that $r = 0$. At this interest rate, the bank makes a loss of $\pi_B(0) = -1$.

In the following, we will derive the net benefit of the policy in the two inefficient equilibria at $r_{\max}$ and $\widetilde{r}$.

3.2.1 Equilibrium at $r_{\max}$

From (17) and (19), the difference between socially efficient and equilibrium welfare is

$$\omega_{in}(\delta^*) - \omega_{in}(1) = \tfrac{\lambda y^2}{2\theta}.$$

The policy cost is the difference between the pre-policy profit in (6) and $\pi_B(0) = -1$, that is

$$\pi_B(r_{\max}) - \pi_B(0) = (1 - \lambda)y.$$

Comparing policy gain and policy cost, we obtain

$$[\omega_{in}(\delta^*) - \omega_{in}(1)] - [\pi_B(r_{\max}) - \pi_B(0)] = \left[\lambda\left(1 + \tfrac{y}{2\theta}\right) - 1\right] y, \qquad (22)$$

increasing in λ and equal to 0 when $\lambda = 2\theta/(y + 2\theta)$, which is above the lower threshold $\underline{\lambda}$. So, the net benefit in (22) is negative in the interval $(0, \underline{\lambda}]$, that is when the equilibrium at $r_{\max}$ exists.

3.2.2 Equilibrium at $\widetilde{r}$

The gross expected benefit of the policy, using the optimal welfare in (17) and the equilibrium welfare in (21), is

$$\omega_{in}(\delta^*) - \omega_{in}(\widetilde{\delta}) = \tfrac{[\lambda y+(1-\lambda)\theta]^2}{8\lambda\theta}.$$

In equilibrium, the bank obtains the profit in (8), the policy cost is

$$\pi_B(\widetilde{r}) - \pi_B(0) = \tfrac{[\lambda y+(1-\lambda)\theta]^2}{4\lambda\theta}.$$

Therefore, it is immediate that the net benefit of the policy would be

$$[\omega_{in}(\delta^*) - \omega_{in}(\widetilde{\delta})] - [\pi_B(\widetilde{r}) - \pi_B(0)] = -\tfrac{[\lambda y+(1-\lambda)\theta]^2}{8\lambda\theta} < 0. \qquad (23)$$

Proposition 5. *If diversion output is included in welfare and $\theta > y$, a policy intervention is never Pareto improving.*

This is a key result for our analysis, and will be true also for the equilibrium at $r_{\max}$ below. When the informal activity is extremely productive and included in welfare, it is better for the government to let D borrowers divert their loans and not intervene with a policy. Even though diversion will result in a relatively unproductive investment for formal projects, the government can exploit the welfare gains achievable through the illegal but tolerated informal activities. Of course, this conclusion does not involve any issue of ethics and morality. The reason is simply that achieving the socially efficient diversion production would require a target repayment of zero on formal contracts, and this would be too costly to implement.

This type of policy analysis is in line with the literature on the effects of public interventions in credit markets under imperfect information (see Innes, 1991). In particular, our policy setup is close to the moral-hazard section of Minelli and Modica (2009), where they analyze a series of public interventions in a monopolistic credit market. They discuss the effects of two of the most widely used policy instruments, the interest-rate subsidy and the investment subsidy, and show that the former is optimal, as it maximizes net welfare benefits. In contrast, we compare the cost with the efficiency gain that the regulator can expect to obtain and, in particular, we focus on the quantity and "quality" of the output produced before the policy intervention.

4 Conclusion

We model the strategic interaction between a monopolistic lender and a large number of cashless entrepreneurs, in the presence of asymmetric information. Some of the borrowers may have the incentive to use part of the loan received for other projects, which may be or not more productive than the formal business. There are two main results. The first is that the equilibrium is more likely to be efficient when there is a high proportion of borrowers who can potentially divert funds into informal projects. The reason is that this propensity of defiant individuals forces the bank to reduce the loan repayment, which otherwise would be equal to the entire output produced. The second result is that, when funds are diverted into highly productive projects and the informal output is included in the social well-being function, the equilibrium welfare, although inefficient, can be higher than that of full information.

When the equilibrium is socially inefficient, we analyze the impact and, in particular, the desirability of policy interventions. The key determinant of desirability is the productivity of the alternative projects and, in particular, whether their output is included or not in the social welfare accounting. We show that, when the informal project output is included in welfare, the need for public intervention is weaker, and even absent if the informal activity is highly productive.

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