

**BANK INTERMEDIATION AND RISK-TAKING IN AFRICA:
DOES PROTECTION OF CREDITOR RIGHTS MATTER?**

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Abstract

This paper seeks to identify and quantify specific mechanisms through which the institutional setting for protection of creditor rights impacts on the development of the credit market. An integrated analytical model is specified to show how banks' asset-allocation decisions, between loans and other competing stock of earning assets, depend on: risk and return; bank-specific elasticity of supply; and operating costs. The model is augmented with metrics on the institutional setting for protection of creditor rights, and is then estimated and tested on an unbalanced panel dataset of commercial banks in 20 African countries during the period 1995-2008. It is found that three metrics of institutional setting induce banks to allocate a significantly higher proportion of their earning assets to loans: higher level legal codes for creditors; better enforceability of legal rights; and availability of information sharing among banks. However, the three metrics appear to work through different channels. The enforceability of legal rights works not only through mitigating the credit risks banks take, but also through a composite effect of market competition and lowering costs of information acquisition and contract enforcement. The legal codes metric and information sharing metric exclusively rely on the composite effect.

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Keywords: Creditor rights, Law enforcement, Financial intermediation, Information sharing, Bank risk-taking

JEL Classification: D23, G21, G28, G32, K10, K42

1. Introduction

There has been considerable interest in the role of non-market institutions and the banking system in explaining economic transition and growth (Henisz, 2000). Research on institutional setting and economic growth generally concedes that the institutional framework, such as the protection of parties involved in a contract, the quality of judicial enforcement and economic freedom, affect economic growth and are crucial elements to define the incentives and constraints in a world characterized by incomplete contract and incomplete information (Rodrik, 2000; Aron, 2000). It is argued that good quality non-market institutions reduce the cost and increase the efficiency for the measurement and enforcement of exchanges by improving the understanding of the nature of contracts and their enforceability as well as the temperament and motivations of the participants involved (North, 1990). In addition, research on finance and development has accumulated robust empirical evidence demonstrating that a well-functioning banking system is strongly causally associated with high economic growth (DemirgucKunt and Levien, 2008). Furthermore, this literature indicates the specialness of the banking industry in the economy. Banks arise because of incomplete and asymmetric information in the financial markets (Neuberger, 1997). They contribute economic growth by easing the capital accumulation process in the real economy. Such facilitation is not only through intermediating savings and investment but also producing information that mitigates information asymmetry and agency costs between lenders and borrowers (Northcott, 2004).

The important insights provided by the institutional setting-economic growth and the finance-development literature offer important economic justification for the growing research on the association between the institutional setting on the protection of creditor rights (encompassing legal rights for creditors, the enforcement of legal rights and information sharing mechanism among creditors) and the development of the credit market. Although banks play the special role as financial intermediaries and information processors, their incentives, capacity and efficiency to carry out their function would subject to the rules that govern and shape the interactions among banks, borrowers and other players in the market place, just as the case in other industries. To the extent that the institutional setting functions as institution for facilitating banks to gather the information about the borrowers, helping banks to form the expectation of the likelihood of the borrowers to honour their debt obligation, protecting banks' legal rights in the case of a violence of financing contracts, and

influencing the competitiveness condition in the credit market, the quality of the institutional setting affects the cost, risk and payoff of banks in the overall financial intermediation process, thereby leading to the variation in the quantity and allocative efficiency of banks' financial intermediation. Indeed, starting from the seminal paper of La Porta, Lopez-de-Silanes, and Vishny (1998, henceforth LLSV), a series of research in the law and finance literature, based on country-level aggregate data, has established a general consensus that the quality of the legal protection, the enforceability of legal rights and the improvements in information sharing among creditors are positively associated with the depth of financial system¹ (LLSV, 1997, 1998; Levine, 1998, 1999; Jappelli and Pagano, 2002; Djankov et al., 2007). Also, strong institutions for ensuring law and contract enforcement and for information sharing among banks appear to be necessary characteristics to reduce the fragility of the banking sector (Demirgüç-Kunt and Detragiache, 1998; Jappelli and Pagano, 2002).

Although the existing theory has indicated the testable channels through which the institutional settings on the protection of creditor rights get transmitted to the aggregate outcome in the credit market, the micro-analysis to identify and quantify the specific mechanisms is scant (Haselmann, 2010). In contrast with the general agreement reached by the empirical research at the macro-level, the evidence presented by this small microeconomics literature is controversial (Houston et al., 2010). Moreover, the literature devotes the majority attention to study the role of the institutional settings on the protection of creditor rights for the quantity of credit supplied by banks and banks' risk taking. The other channel, i.e. its influence on banks' operating cost associated with producing information and enforcing various covenants in the loan contracts and on the degree of competition in the credit market, is typically overlooked. Additionally, the study on the quantity of credit and banks' risk taking is largely developed in a separated manner. Given the observation that the credit market is characterized not only by incomplete information but also by imperfect competition, it is plausible to argue that banks' decision making on the quantity of credit supply would be a net reflection of the credit risk banks face, the cost of banks' financial intermediation and the competitiveness condition in the market place (Freixas and Rochet, 1997). To our best knowledge, the current research presents the first integrated analysis of how the institutional settings on the protection of creditor rights affect

¹ The common indicators used by those papers for financial depth are ratio of private credit to gross domestic product and the degree to which the central bank versus commercial banks is allocating credit.

the credit risks banks are taking, the degree of competition in the credit market and banks' operating cost associated with informational production and contract enforcement, and ultimately exert their impacts on the quantity of credit supply. Establishing the evidence on the presence and strength of all the potential transmission channels would not only yield valuable insights into the inconsistency between macro and micro evidence in the existing literature but also produce important implication for the formulation of conducive policy initiatives to achieve an efficient credit market. Toward the end, we first set forth an analytical framework for the allocation of a bank's loanable funds between private credit (loans) and other competing stock of earning assets in an operational environment characterised by risk, imperfect asset elasticities and operating costs, within a general model of portfolio selection. We further empirically apply this analytical framework to an unbalance panel dataset of commercial banks in 20 African countries during the period 1995-2008. The empirical background of African banking is particularly suited to the nature of our analytical approach. The banking systems are at the heart of African financial systems, bank loans are the primary external financing sources of the real sectors. Since the 1980s, African countries have initiated various financial reforms efforts to promote an efficient credit market. However, the reforms have largely failed to deliver the expected results. While there are sizable differences between different countries within the region, financial sectors in Africa are among the shallowest in the world (McDonald and Schumacher, 2007). Credit to the private sector provided by the banking sector as a percentage of GDP has been declining over years. Moreover, this outcome can not be attributable to the shortage of liquidity in the banking system. Many African banking systems are fairly liquid by international standards. It is rather a result of banks' preference for allocating the financial resources they have mobilized to other competing stock of earning assets, particularly safer government securities, over private credit (Allen et al., 2010). Among several reasons that have been identified to explain such dysfunctionality in financial intermediation, high risks and costs of financial intermediation induced by the absence of a stronger micro and institutional infrastructures including in information, contract enforcement, and especially, legal dimensions along with the reform processes are recognised as the important factors (Honohan and Beck, 2007)². There is a general agreement in the policy circle that regulatory reforms in

²“ Certain building blocks, including rationalization and clarification of laws, streamlining of court procedures, establishment of credit registries, training of financial professionals, are well-accepted as key components in moving towards more effective financial systems” (Honohan and Beck, 2007, p. 16).

the banking sector cannot be viewed in isolation from policies and regulations stem from national institutions. Efforts are under way to correct the weaknesses to provide an enabling institutional environment for African banking. Given those ongoing efforts and the high hopes which policy makers place in those arrangement, there is a need for empirical analysis which examines how those aspects of institutional settings influence banks' provision of loans.

The rest of the paper proceeds as follows. Section 2 lays out the detailed structure of the general model of portfolio selection which specifically allows for risk and imperfect competition as well as cost of financial intermediation. Section 3 reviews the various channels proposed by the literature to capture the effects of creditor rights, the enforcement of legal rights and information sharing on credit market performance. Section 4 describes our empirical design, data and variable. The estimation results and robustness test results are resented and the findings are discussed in Chapter 5. Section 6 concludes.

2. A model of bank's selection of asset portfolio

Our analytical framework to banks' asset allocation of between private credit (loans) and other competing stock of earning assets is based on explicit profit maximization objective function of the bank. The model is closely related to Klein (1970), Klein (1971) and Hannan (1991). The model presented in this section is not intended to be explained a theory of the banking firm. It is chosen because its direct applicability to questions of the differences across different types of earning assets in risk and return characteristics, in the elasticity of supply to the individual bank and in the operating cost and bank's selection of asset portfolio. Also, it provides guidance for our empirical analysis.

We assume that a bank i has two primary sources of loanable funds, one is equity invested in the banks, denoted by E_i and another is the deposits mobilized by the bank, denoted by D_i . The bank allocates the aggregate loanable funds between a single aggregate loans and a single aggregate competing stock of other earning assets, i.e. public security, denoted by L_i and S_i respectively.

We assume that a market for loans is characterised by oligopolistic market structure where bank i operates along other $N-1$ banks, facing a given price of deposit and that of non-interest

operating cost. The inverse demand for loans of the industry as a whole at time t is $P_t(Q_t)$, $Q_t \equiv \sum_{i=1}^N L_i$. The revenue associated with the provision of loans for bank i is $P_t L_i$ when all the loans is repaid in contractual term. With the loss in the event of default larger than zero, the expected revenue associated with loans is $u_i P_t L_i$, where u is the probability of recovery upon default, and $u \leq 1$. $1 - u$ therefore stands for the default risk the bank actually gets involved in the credit supply. u is exogenously given for the bank's decision at time t .

Following the common assumption used in models of the banking firm, we assume public security in perfectly elastic supply to the bank (i.e. a perfective competitive market since each individual bank is one of an infinite number of other operators in the market) and public security is free of default risk. Therefore, the revenue associated with the holding public security for bank i is $r_s' S_i$, r_s is the interest rate on public security. We further assume that the variable operating cost (i.e. non-interest operating costs) associated with loans and public security are separable. Since in addition to normal administrative cost as incurred by public security, Loans have an additional operating cost which is associated with dealing with asymmetric information and enforcing repayment in the case of default, variable operating cost per unit of loans is expected to be larger than that of public security.

The expected profit of bank i at time t can be written as:

$$\pi_i^e = u_i P_t * L_i + r_s * S_i - C_L * L_i - C_s * S_i - r_D * D_i - C_{\hat{f}} \quad (1)$$

Where C_L and C_s are variable operating cost per unit of loans and public security. r_D is the interest rate of deposits, $C_{\hat{f}}$ is the fixed costs.

The bank chooses the quantity of loans and the quantity of public security in order to maximize the expected profit expressed as in Equation (1), subject to its balance sheet constraint: $L_i + S_i = D_i + E_i$, and $E_i / L_i = \delta_i$, $0 < \delta_i < 1$, indicating the level of capitalization of the bank.

The first-order conditions for the bank's expected profit maximization yields the following equations, where τ is the Lagrangean multiplier:

$$\frac{\partial \pi_i^e}{\partial L_i} = u_i P_t + u_i L_i * \frac{\partial P_t}{\partial Q_t} \left(\frac{\partial Q_t}{\partial L_i} + \sum \frac{\partial Q_t}{\partial L_{j \neq i}} * \frac{\partial L_{j \neq i}}{\partial L_i} \right) - C_L - (1 - \delta_i) \tau = 0 \quad (2)$$

$$\frac{\partial \pi_i^e}{\partial S_i} = r_s - C_s - \tau = 0 \quad (3)$$

Manipulating equation (2), we get³:

$$\frac{\partial \pi_i^e}{\partial L_i} = u_i P_t \left\{ 1 - \frac{1}{\eta_i} * \theta_i \right\} - C_L - (1 - \delta_i) \tau = 0 \quad (4)$$

Where $\eta_i = -\frac{\partial \ln Q_t}{\partial \ln P_t}$ is the industry elasticity of demand. $\theta_i = (\partial Q_t / \partial L_i) M_i$, $M_i = \frac{L_i}{Q_t}$ is the market share of bank i in the market for loans. θ_i measures the interdependence of banks in a quantity-setting game. It indicates the change in loans provided by all other banks anticipated by bank i in response to an initial change in its own provision of loans. The value of θ_i lies in the range between 0 and 1. In the case of perfect competition, an increase in the quantities of loans by one particular bank has no impact on the market price and quantity, therefore, $\theta_i = 0$. In the case of Cournot-competition, bank i does not expect any response from the other banks in reaction to its increase of loans, therefore $\theta_i = M_i$. Under perfect collusion (cartel), bank i expects full retaliation from the remaining banks, therefore, $\theta_i = 1$. Intermediate values of θ_i correspond to various degrees of imperfect competition. A smaller θ_i suggests a more competitive market condition.

From (4) and (3), we can have:

$$\frac{1}{1 - \delta_i} \left[u_i P_t \left\{ 1 - \frac{1}{\eta_i} * \theta_i \right\} - C_L \right] = r_s - C_s \quad (5)$$

³ As highlighted by Klein (1970, p.492), “what is particularly interesting about this framework is that it allows explicitly for difference in loan demand confronting banks and for differences in the elasticity of demand for bank loans”. It is very important to understand the framework we are looking at is not constructed as a loan supply curve. It is rather, a reduced form equation relating the equilibrium loan/total earning asset ratio to variables which are exogenous to both individual bank and its borrowers.

In Equation (5), the expression on the left is the marginal return on public security, the expression on the right is the expected marginal return on loans (adjusted for the capitalization of the bank). Let X_L is the proportion of total loanable funds allocated by the bank to loans, and X_S is the proportion of total loanable funds allocated by the bank to public security, and $X_L + X_S = 1$. Thus, X_L is chosen by the bank at the point at which the expected marginal return on loans is equal to the marginal return on public security.

Equation (5) can be rewritten as:

$$u_i P_i \left\{ 1 - \frac{1}{\eta_t} * \theta_i \right\} - \{ C_L - (1 - \delta_i) C_s \} = (1 - \delta_i) r_s \quad (6)$$

Figure 1: Equilibrium for loans

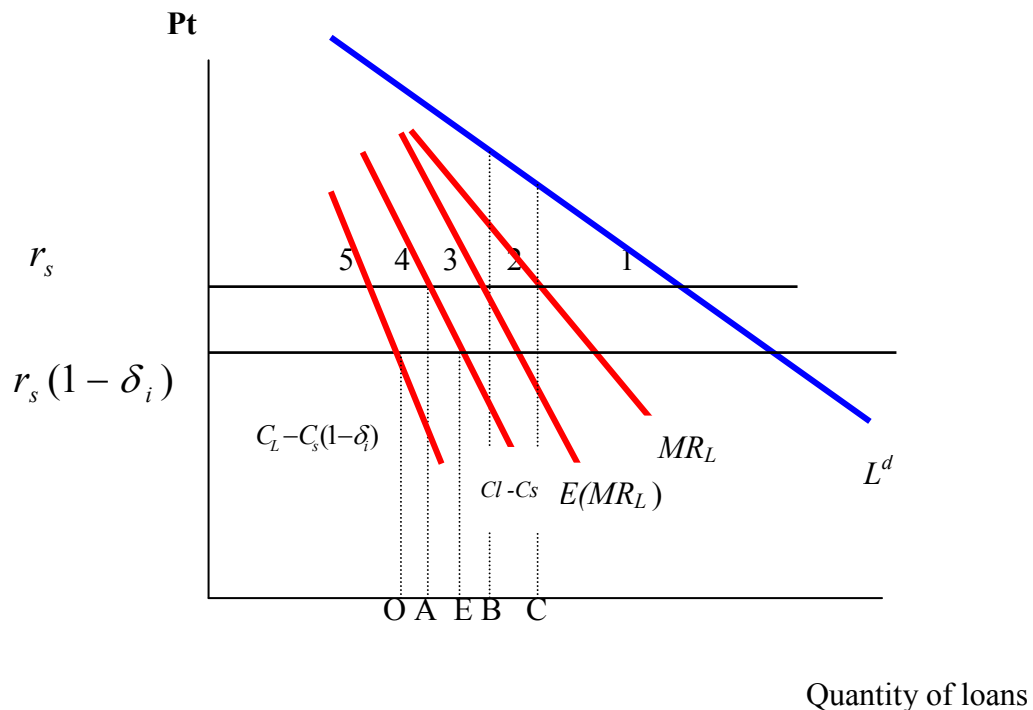


Figure 1 decomposes the determinates of the equilibrium level of the quantity of loans for the bank implied in Equation (6). Line 1 (L^d) indicates the downward demand curve faced by

bank i . Line 2 (MR_L) is the marginal revenue of loans. The difference between line 1 and line 2, therefore the different quantity of loans in equilibrium is attributable to the presence of market collusion. The larger degree of market collusion is associated with a larger the difference, and a smaller of the quantity of loans, *Ceteris paribus*. Line 3($E(MR_L)$) is the expected marginal revenue of loans. As indicated above, the presence of the loss upon default is the reason for the divergence between line 2 and line 3. The larger the risks upon default would induce a larger decrease in the quantity of loans, *Ceteris paribus*. The further left-hand shift from line 3 to line 4 is due to additional marginal operating cost of loans associated with dealing with asymmetric information, relative to public security. The larger difference is related to a larger decrease in the quantity of loans, *Ceteris paribus*. An increase in the capitalization has two effects. It would increase $C_L - C_s(1 - \delta_i)$, it would also push r_s down to $r_s(1 - \delta_i)$, the net effect is uncertain depending on not only the magnitude of those two effects but also the slope of the demand curve. Finally, the increase in P_i , *Ceteris paribus*, brings about a rightward shift of L^d and therefore a increase in the equilibrium level of the quantity of loans. Summarizing those properties, we have the following expression of the proportion of total loanable funds allocated by the bank to loans. The expected signs are shown in the bracket under the corresponding determinants.

$$X_L = f(P_i, r_s, \text{competition}, \text{loss on default}, \text{MC of information production}, \text{capitalization}) \quad (7)$$

(+) (+) (-) (-) (?)

3. Institutional setting on the protection of creditor rights and bank loans

We hypothesize that the strength of institutional setting on the protection of creditor rights through legal rights for creditors, the efficiency of the enforcement of legal rights and information sharing mechanism among creditors influence the degree of competition in the lending market, the default risk banks are taking and the operating cost banks paid in informational production, and those in turn affecting the proportion of total loanable funds allocated by the bank to loans. In this section, we review both theoretical and empirical literature on those potential components.

3.1. Theory

The efficient allocation of credit in the financial market is plagued by the credit risk and the asymmetric information between the borrower and the creditor. As identified by Djankov et al., (2007), two views to explain the quantity of private credit supplied by the creditor are information theory of credit and power theory of credit. As a whole, the two theories, focusing on different stages of the loans contract, suggest the bank's perception regarding the likelihood of the borrower's repayment of credit in the due course and the possibility of recovery in the case of default plays main role for its willingness to grant credit. Moreover, the costs the bank incurs in screening, monitoring and enforcing loans contract also matter. The information theory of credit highlights the importance of bank's knowledge about the ability and willingness of the borrower to honour the credit in the precommitted contracted manner for their credit supply. The asymmetric information between borrowers and banks gives incentives for less-informed banks to acquire information; it is reasonable to believe the more a bank invests in information acquisition, the more accurate its prediction of repayment probability of the borrower and the better the quality of its lending (Jappelli and Pagano, 2002; Hyytinen and Toivanen, 2004). However, the increase in the intensity of information acquisition would also result in higher operating cost for the bank. The presence of informational sharing institutions among banks about the characteristics of their borrowers, either via private credit bureaus and/or public credit registries, would facilitate the bank's lending through: 1) reducing the cost of information acquisition, given the level of quality of lending, and/or 2) increasing the quality of lending, given the cost of information acquisition. The exchange of information would not only enable the bank to distinguish good applicant from the bad one, but also incentivise the borrower to exert more effort to honour their debt obligation (Brown et al., 2009). Indeed, default would be a signal of bad quality for outside banks and thus brings in a cutting-off from credit in the future. Thus, the reduction of operating cost undertaken by the bank brought about by the presence of informational sharing institutions could include the cost of screening potential borrowers ex ante contract and that of interim monitoring the various covenants written in the loans contract. The increase of the quality of lending results from the mitigation of adverse selection ex ante loans contract and/or that of moral hazard during the course of loans contract. While the information theory of credit mainly focuses on the role of institutional setting for a cost-effective prevention of default, the power theory of credit is based on the transfer of control rights upon default.

Stronger legal rights grant the bank more power to force repayment by seizing collateral, or even take control of the borrowers, ex post contract, in default. This would lead to a higher recovery rate in the event of default and a decrease of the default risk banks eventually bear. In addition, given the same level of legal codes, more efficient judicial enforcement of legal rights reduces the uncertainty and cost of the bank in the enforcement of repayment. Therefore, banks operating in an institutional environment characterised by higher legal creditors' rights and higher quality of procedure show more willingness to provide credit, even with limited information about the borrower. Although the power theory of credit mainly emphasizes the recovery of bad loans, it also carries implication for the prevention of the presence of bad loans. Arguably, the power of creditors endowed by better institutional protection creates more credible threat to borrowers to perform in line with banks' interest, which would attenuate the credit risk associated with moral hazard on part of borrowers and banks' cost of dealing with it.

However, the prediction that a stronger creditor rights and information sharing would lead a lower default rate is only valid if it is referred to an individual borrower and if it is not tempered by the change of the bank' incentives to acquire information about the individual borrower (Jappelli and Pagano, 2002; Brown et al., 2009; Houston et al., 2010). In the business condition where both the informational opaqueness of an individual borrower and the losses of the bank upon default of the given borrower decrease, the marginal benefit of banks' informational production also decreases, so does banks' effort to gather and process additional information about the borrower. Further, the expectation of the decreased losses upon default of the given borrower may also guide banks to reduce the number of covenants in the financial contract (Houston et al., 2010). As a result, the probability of default of a given borrower would increase. While under higher protection in the case of default, the actual losses of the bank would either increase or decrease. Furthermore, even if a stronger creditor rights and information sharing really lead a lower default rate of an individual borrower, such effect may not necessarily translate an decrease in the average default rate of the loan portfolio if there is concomitant change in the bank's willingness to grant credit to riskier and previously rationed borrowers (Brown et al., 2009; Laven and Majnoni, 2005). If the relative weight of lower-grade borrowers increases in the loan portfolio, the average default rate of the loan portfolio would increase although the probability of default rate of each borrower decreases. Similar to the case of a given borrower, whether the actual average

losses of the loan portfolio increase or not depends on the extent to which higher recovery rate in default compensates for the higher default rate (Houaton et al., 2010).

Absent from the discussion thus far is the influence of the strength of those aspects of institutional setting on the protection of creditor rights on the degree of competition in the credit market, which in turn leads to the change in the quantity of credit supplied by banks. Differing from the other markets, an idiosyncratic barrier that undermines the contestability in the credit market is the informational advantage of the inside bank compared to outside banks (Boot, 2000; Sengupa, 2007). The repeated interaction with the same customer over time and/or across products entails a lower information asymmetry between the inside bank and their borrowers. In recognition of the informational advantages the inside bank has, outside banks are concerned with the failure to sort between the “lemons” rejected by the inside bank and creditworthy borrowers seeking to mitigate the “hold up” problem of their existing banking relationship. Such “winner’s curse” problem deters other incumbent banks to compete the inside bank for borrowers and hinders potential entrants to materialize their entry intention. Informational sharing among banks reduces the informational disadvantage of the outside banks ex ante loans contract. A stronger legal protection ex post strengthens the efficacy of collateral used by outside banks to bridge information gap ex ante and to seize collateral as defensive line in the event of default. This allows outside banks bid more aggressively with the inside bank. In this way, a stronger creditor rights and information sharing contribute positively to the enhancement of competition in the lending market and lead to greater credit supply (Barth et al., 2009).

3.2. Empirical literature

The existing empirical analyses support the quality of the legal framework on the protection of credit rights matters for the quantity of credit supply, and also indicate that the legal enforceability of financial contract seems to be more important than the legal codes in stimulating larger volume of credit. Using bank-level data in both developing and developed countries over the period 2000-2006, Cole and Turk-Ariss (2010) find that banks allocate smaller portion of their assets to loans when creditors’ rights are stronger, while the opposite is true when the legal enforcement of creditor rights is more efficient. Their finding appears to be consistent with Bae and Goyal (2009), who use firm-level data and find that it is the enforcement of contracts generates a significant impact on increasing loan quantities rather

than the legal right of creditors. Furthermore, Safavian and Sharma (2007) use firm-level data on 27 European countries in 2002 and 2005, and show that the positive impact of legal rights on firms' access to bank credit decreases with the decrease in the court efficiency. Therefore, the poorer enforceability would detract the positive impact of legal rights on the quantity of credit supply. Safavian and Sharma (2007)'s result concurs the argument put by Berkowitz, et al. (2003), Pistor (2002), and Pistor, et al. (2000), which highlight that the effectiveness of law is more important than the written law in promoting financial development for transition and developing countries. Given the fact that law is a transplanted institution for most of those countries, the readiness and the competence of the recipient country are crucial for the legal system to work. The written law in book therefore does not carry much implication for its practical functioning. Regarding the role informational sharing for banks' credit supply, Love and Mylenko (2003) use cross-sectional firm level data and find that private informational sharing facility are associated with lower financial constraints perceived by firms. Based on firm-level cross-sectional and panel data covering transition economies, Brown et al., (2009) also find that information sharing is associated with improved availability of firms. Further, both studies seem to suggest that banks are motivated by informational sharing to provide loans to riskier and previously rationed borrowers as the positive association between information sharing and credit availability is stronger for small and young firms (Love and Mylenko, 2003; Brown et al., 2009). In contrast, Bennardo et al., (2009) indicates that the improvement of bank's knowledge that borrowers have multiple lending relationships as a result of information sharing among banks induces the bank to ration credit, for fear of increased default probability of a given borrower due to the large total exposure of the borrower.

To our best knowledge, there are only two studies that use bank-level data to investigate the link between legal framework on the protection of credit rights and risks banks are taking. With respect to 297 default banks for the period 1990 to 2002 in 34 emerging market economies, Godlewski (2006) find banks' risk taking behaviour is negatively affected by quality of the rule of law and bank's default probability is positively related to the excess risks banks are taking. In contrast, Houson et al., (2010) find that stronger creditor rights tend to promote greater risk taking of banks and increase the likelihood of financial crisis in a large cross-country study during the period 2000-2007. On the other hand, the empirical evidence derived from the firm-level data is also controversial. John et al., (2008) find that

increase protection on investors leads to higher firm-level riskiness. However, Acharya et al., (2009) suggest that a stronger credit rights encourage management of firms to reduce corporate risk-taking through diversifying mergers and adopting appropriate operating policy.

The existing empirical evidence appears to confirm the positive impact of information sharing among lender on the probability of default of individual borrower. Kalberg and Udell (2003) document that trade credit history in Dun & Bradstreet reports improves default predictions relative to financial statements alone. Also, Brown and Zehnder (2007)'s experimental study suggest that the presence of information sharing increases an individual borrower's repayment rate in the case where the mobility of borrowers across banks is high. However, Doblus-Madrid and Minetti (2009) reveal that such improvement in the repayment performance of risky and opaque borrowers may not necessarily leads a easing of financial constraint of those firms since information sharing induces creditors to grant smaller loans and to demand more guarantees. Finally, Houson et al., (2010) find that greater information sharing leads to a decreased bank risk, and a reduced likelihood of financial crisis. From a different perspective, Barth et al, (2009) find that information sharing reduce lending corruption, and that information sharing also helps enhance the positive effect of competition in curtailing lending corruption.

Despite the existence of a broad set of research on the quality of institutions and the competition throughout the economy (Engerman and Sokoloff, 1997; Acemoglu, et al., 2001), the empirical research on the relationship between legal framework on the protection of credit rights and information sharing on cost of financial intermediation and the degree of competition in the lending market is sparse. Three exceptions closely related to this research are Claessens and Laeven (2004), Demirgüç-Kunt et al., (2004), and Laeven and Majnoni (2005). Measuring the degree of competition at the industry-level by the estimated extent to which changes in input prices are reflected in revenues earned by specific banks in 50 countries' banking systems, Claessens and Laeven (2004), find that the quality of protection of property right, a broad measure of the quality of legal framework, does not exercise an independent effect on competition. Measuring the quality of institutions by national indicators of economic freedom or property rights protection, Demirgüç-Kunt et al., (2004), however, indicates that better quality of institutional indicator is associated with lower net interest margins and overhead expenditures cross-bank, suggesting a beneficial effect of the overall institutional environment that is more conducive to private sector competition on

reducing market power and the cost of financial intermediation of banks. Finally, Laeven and Majnoni (2005) also find that the improvement in the quality of a broad measure of the quality of legal framework lowers the country-level interest rate spread.

4. Empirical design, Variables and Data

The analytical framework of a bank's selection of asset portfolio between loans and public security we presented in Section 2 show that the proportion of total earning assets allocated by the bank i to loans at time t is a function of the difference between interest rate on loans and that on public security (MAR), the degree of competition in the lending market (COM), the default risk the bank actually gets involved in the credit supply ($RISK$), the marginal information production cost of loans ($COST$), and the capitalization level (CAP) of the bank:

$$X_L = f(MAR, COM, RISK, COST, CAP) \quad (8)$$

(+) (+) (-) (-) (?)

The literature we reviewed in Section 3 hypothesizes that legal rights for creditors (LEG), the enforceability of legal rights ($ENFOR$) and information sharing mechanism among creditors ($SHAR$) have impact on the degree of competition in the lending market (COM), the default risk banks are taking ($RISK$) and the operating cost the bank paid in informational production ($COST$), along with other influencing factors (X). Thus, we have:

$$COM_t = f(LEG, ENFOR, SHAR, X_{com}) \quad (9)$$

$$RISK_t = f(LEG, ENFOR, SHAR, X_{risk}) \quad (10)$$

$$COST_t = f(LEG, ENFOR, SHAR, X_{cost}) \quad (11)$$

X_{com} , X_{risk} and X_{cost} may not be necessarily the same. We substitute equation (9), (10) and (11) into (8), and get:

$$X_L = f\{MAR, COM(LEG, ENFOR, SHAR, X_{com}), RISK(LEG, ENFOR, SHAR, X_{risk}), COST(LEG, ENFOR, SHAR, X_{cost}), CAR\} \quad (12)$$

Recall our objective is to examine the impact of legal rights for creditors, the enforcement of contracts and information sharing mechanism among creditors on the degree of competition in the lending market, the default risk banks are taking and the operating expenditure banks

cost in informational production, and through those channels to influence the credit supply of banks, disentangling those channels from each other is thus crucial for us to achieve the goal. Toward the end, we adopt a two-stage analysis. In the first stage, we examine the influence of legal rights for creditors, the enforcement of contracts and information sharing mechanism among creditors on credit risks banks are taking, controlling for other industry-wide and bank-specific variables. Credit risks predicted by the first equation are then taken one period lag and incorporated into a second regression equation to explain the proportion of total loanable funds allocated by the bank to loans, along with legal rights for creditors, the enforcement of contracts, information sharing mechanism among creditors and other industry-wide and bank-specific variables. By doing so, we essentially single out the influence of the institutional setting indicators in question on default risk, while combine other two channels into a composite effect. Further, such procedure assumes the bank's decision making into a two-step process, i.e. the bank forms its expectation of default risk in the supply of credit at time t according to the actually loan loss appearing on its financial statements for the time $t-1$, and then decide how to allocate its assets between public security and loans. Therefore, default risk is exogenous to the bank at time t , although the actually loan loss at time $t-1$ is determined jointly by various incentives internal to the bank and certain institutional and economic environment which truly are exogenous to the bank. From an econometric estimation perspective, such procedure also overcomes any potential two-way causality between the supply of credit and credit risk.

In detail, the model estimated is:

$$RISK_{jit} = \beta_0 + \beta_1 LEG_{jt} + \beta_2 ENFOR_{jt} + \beta_3 SHAR_j + \gamma Z_{jt} + \eta M_{jt} + \xi B_{jit} + \ell \sum_{t=96}^{2008} TIME_t + \varepsilon_{jit} \quad (13)$$

$$X_{jLt} = \alpha_0 + \alpha_1 MAR + \alpha_2 \hat{RISK}_{ji(t-1)} + \alpha_3 LEG_{jt} + \alpha_4 ENFOR_{jt} + \alpha_5 SHAR_j + \nu R_{jt} + \lambda M_{jt} + \rho BANK_{jit} + \psi \sum_{t=96}^{2007} TIME_t + \omega_{jit} \quad (14)$$

Equation (13) is employed in our first stage analysis. Equation (14) is employed in our second stage analysis.

The dependent variable of Equation (13) is the default risk of bank i in country j at time t . We measure it using the ratio of loan loss provision over total loans (*PROV*). In terms of other explanatory variables, we consider four categories.

4.2.1. National institutional setting on the protection of creditor rights

Our main explanatory variables are national-wide institutional setting on the protection of creditor rights; it includes the measures of legal right of creditors (*LEG*), the enforceability of legal rights (*ENFOR*) and information sharing (*SHAR*).

To measure the strength of legal right of creditors, we create a rank order index based on the Creditor Right Index developed by Djankov et al., (2007) and a newer, finer version of this index provided by the World Bank's Doing Business Index. Djankov et al., (2007) constructed the Creditor Right Index to measure the legal right of secured creditor in bankruptcy against defaulting borrowers for a sample of 129 countries over the period from 1978 to 2003. It consists of four components: 1) whether secured creditors are able to seize their collateral once a reorganization petition is approved (no "automatic stay" on assets); 2). whether a borrower filing for reorganization is subjected to creditor consent or minimum dividend (restriction on reorganization); 3). whether secured creditors are ranked the first in the distribution of proceeds of liquidating a bankrupt firm among other creditors (secured credit paid first); 4). whether creditors or an administrator is responsible for running the business during reorganization, rather than having the debtor continue to run the business (no management stay). A value of one is given to each component, and the aggregated legal right index ranges from zero (poor creditor rights) to four (strong creditor rights). This index was further refined by the World Bank's Doing Business Report to include 5) Whether general rather than specific description of assets is permitted in collateral agreements; 6). Whether general rather than specific description of debt is permitted in collateral agreements; 7). Whether any legal or natural person may grant or take security; 8). Whether a unified registry including charges over movable property operates; 9) Whether parties may agree on enforcement procedures by contract; 10). Whether creditors may both seize and sell collateral out of court. Again, a score of 1 is assigned for each component. The inclusion of those six features of the laws makes the index ranges from 0 to 10, with higher scores indicating that collateral and bankruptcy laws are better designed to expand access to credit. The new index was updated annually by the World Bank's Doing Business Report 2004 onwards. To handle

the incompatibility of the index across before and after 2003 induced by the different composition of Djankov et al., (2007)'s index and that of the World Bank's Doing Business Report index, we follow the spirit of Berger et al., (2005) and rank the index of each sample country for each sample year in ascending order and then converted to a uniform scale over $[0, 1]$ using the formula $(\text{order} - 1)/(\text{n} - 1)$, where order is the place in ascending order of the country in each year and n is the number of sample countries in that year⁴. The country with the highest index has the best rank of 1, and the country with the lowest index has the worst rank of 0. Thus, a country's rank in a year is the proportion of sample countries in that year with lower index, so a country with an index higher than 70% of other countries in that year has a rank that year of 0.70. The basic principal of the index remains: the higher the rank index of the country is, the stronger the creditor right of the country is.

To measure the effectiveness of law enforcement (*ENFOR*), we use the "Rule of Law" index developed by Kaufmann et al., (2009). This indicator reflects the perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. A higher index implies a better enforcement. Moreover, since the indicator is constructed through reasonably comparable methodologies from one year to the next, it can be used to make comparisons of countries over time, and also can be used to compare different countries' scores at the same year (Kaufmann et al., 2009). The annual indicator is available for 212 countries in 1996, 1998 and over the time period 2000-2008, while our sample period is from 1995 to 2008. To make as much time variation in the indicator as possible, we use the value in 1996 to proxy for that in 1995, use the arithmetic average value of 1996 and 1998 to construct the indicator in 1997, and that of 1998 and 2000 to construct the indicator in 1999.

To capture information sharing among banks, we define a dummy variable (SHAR) with a value one from the year when either a public registry⁵ or a private bureau⁶ starts to operate in

⁴ The correlation coefficient of our legal right index and Djankov et al., (2007)'s is 0.9755, which is significant at 1%.

⁵ A public registry is defined as a database owned by a public authority, usually the central bank or banking supervisory authority, which collects information on the credit worthiness of borrowers and makes it available to financial institutions (Djankov et al., 2007).

a country and onwards, and zero prior to it. We collect the information about the timing when the information sharing mechanism started to operate from Djankov et al., (2007) and the World Bank's Doing Business Report.

4.2.2. Regulatory variables

The inclusion of our proxies for regulations and supervision (Z_{jt}) is to control for the impact industry-wide institutional setting on banks' risk taking. Specifically, we consider bank regulations regarding the stringency of regulatory capital requirement adopted by the authorities (*CAPRQ*), the power granted to authorities to intervene bank's decision (*OFFPR*), private monitoring (*PRI*), regulatory restriction on bank activities (*FREE*) and the existence of deposit insurance scheme (*INSUR*).

The main database for the stringency of regulatory capital requirement adopted by the authorities (*CAPRQ*), the power granted to authorities to intervene bank's decision (*OFFPR*), private monitoring (*PRI*) is three surveys performed by the World Bank in 2000, 2003 and 2008. We use the value in 2000 for the period 1995-2000, use the value in 2003 for the period 2001-2003 and use the value in 2008 for the period 2004-2008. The stringency of regulatory capital requirement (*CAPRQ*) accounts for the regulation regarding the source of funds that can be counted as regulatory capital, whether the sources have to be verified by the regulatory or supervisory authorities, whether risk elements and value losses are considered while calculating the regulatory capital. The power of authorities (*OFFPR*) is relating to supervisory power in terms of prompt corrective action, declaring insolvency, and restructuring. For both, a higher value indicates a stronger official regulation. Despite the expectation that higher capital stringency and a stronger official power would more effectively prevent banks from excessive risk-taking behaviour, some empirical evidences seems to suggest otherwise. The more stringent capital requirement would lead an increase in banks' risk taking if the purpose of the imposition of higher capital requirement is to enhance the ability of banks to internalize their risk taking (Altunbus et al., 2007). In addition, a stronger official power in supervising and regulating banks may imply a higher level of supervisory forbearance discretion when confronted with violations of laws or regulations or

⁶ A private bureau is defined as a private commercial firm that maintains a database on the credit worthiness of borrowers, and its primary role is to facilitate the exchange of information among banks and other financial institutions (Djankov et al., 2007).

with other imprudent behaviour on the part of banks and gives authorities with lower levels of integrity greater leeway to abuse their power for private gain (Barth et al., 2003, Beck et al., 2006). Our index of private monitoring (*PRI*) refers to the degree to which bank supervision forces banks to disclose accurate information to the public and induces private sector monitoring of banks. Arguably, private monitoring has advantage in exerting more effective governance compared to the official supervisory power because it is less likely to be captured by politicians and banks. Therefore, empowering private market discipline would be helpful in mitigating banks' excessive risk taking (Hay and Shleifer, 1998; Barth et al., 2004). However, as warned by Crockett (2002, p979), for private market discipline to be fully effective in ensuring financial stability, four prerequisites have to be met. First, market participants need to have sufficient information to reach informed judgements. Second, they need to have the ability to process it correctly. Third, they need to have the right incentives. Finally, they need to have the right mechanisms to exercise discipline. Moreover, the lack of an efficient functioning of the economic system and legal and institutional underpinnings would seriously compromise the operation of private market discipline. Concurring this, Beck et al., (2006) find that supervisory practices that force the disclosure of accurate, transparent information on banks work best to promote integrity in lending in countries that adhere to the rule of law.

With respect to the proxy for the restrictions on bank activities, we follow Gonzalea (2005) to use the Financial Freedom Index (*FREE*) published annually for each country by Heritage Foundation⁷ since 1995 onwards. The Index stands a description of the country's financial climate. It measures the extent of government regulation of financial services, the extent of state intervention in banks and other financial services, the difficulty of opening and operating financial services firms (for both domestic and foreign individuals), and government influence on the allocation of credit. An overall score is on a scale of 0 to 100 with higher value indicating lower degree of restriction. In theory, the increase in the financial freedom would have two-fold implication for the risks banks are taking. On the one hand, it allows more chance for banks to take risky business, therefore deteriorate the safety

⁷ Using 1997 as example, Gonzalea (2005) calculate the correlation between the Heritage Financial Freedom index and the summary index of the level of regulatory restriction on commercial banks to engage in three non-traditional activities (SECURITIES, INSURANCE, and REAL ESTATE) and to own and control non-financial firms (BANKOWN). Gonzalea (2005) concludes that the Heritage Financial Freedom index basically measures freedom for banks in each country to engage in three non-traditional activities.

and soundness of banks' balance sheet. However, it would also offer banks opportunity to utilize economies of scope and scale, and to explore new profit generation and risk diversification prospect. Further, it would increase the operational autonomy and accountability of banks and therefore incentivise banks to invest in information collection during the course of credit supply and exercise creditors' right to recover the bad debt. Consequently, the increased financial freedom brings in the reduction of risks banks are taking. A negative relation between regulatory restrictions on bank activities and the stability of the banking system have been found by Barth et al., (2001) and Gonzalez (2005). Also, Pasiouras et al. (2006) find that lower restrictions on bank activities results in higher credit ratings of banks.

Finally, we define a dummy variable (*INSUR*) for the presence of explicit deposit insurance to control for its influence on risk taking incentives. It has been long suggested that deposit insurance may intensify the moral hazard problem of banks since depositors are less likely to enforce market discipline on banks (Demirguc-Kunt and Kane, 2002; Gonzalez, 2005). Based on information from Demirguc-Kunt et al., (2005) and the International Association of Deposit Insurers, the dummy variable takes a value of one from the year when the explicit deposit insurance was put into effect, and zero prior to it.

4.2.3. Macroeconomic indicators

To take into account the macro-economic variables (M_{jt}) that may have influence on risks banks are taking, we use inflation rate (*INFLA*) and the natural logarithm of GDP (constant 2000 US dollar) (*LNGDP*) for each country over the period 1996-2008. Both are collected from African Development Indicator. Higher inflation would distort decision-making, exacerbate information asymmetry and introduce price volatility, and therefore a positive relation with the risks banks are taking is expected. *LNGDP* is a proxy for a country's economic development, and is expected to be negatively related to bank risk.

4.2.4. Bank-specific variables

To allow for the bank-specific characteristics (B_{jt}) that might explain cross-bank difference in default risks, we include return on total assets (*ROA*), measured by the ratio of pre-taxation profit over total assets, to capture the impact of franchise value on bank-risk taking. As argued by Gonzalez (2005), more profitable bank would more likely institute conservative

investment policy since they are face higher opportunity cost of going bankruptcy. To capture the impact of scale diversification we include *MARSHAR*, which is measured by the stock of loans of bank *i* as percentage of the sum of the stock of all the sample banks belonging to the same country as bank *i*. We further include a measurement of scope diversification (*SP*). It is measured by the Herfindahl index of income concentration, i.e. $SP = \sum_{i=1}^2 S_i^2$, and $S_i = y_i / \sum_{i=1}^2 y_i$, y_1 refers to interest-income and y_2 refers to non-interest income. $SP=1$ means that the bank is totally specialized, and $SP=0.5$ means that the bank produces totally diversified income (i.e. interest income and non-interest income have the equal share in total income). A smaller value indicated a better diversified income structure. Finally, to capture cross-bank differences in the quality of risk management skill, we include *SKILL*, which is computed by non- interest overhead costs divided by the total earning assets of the bank. A higher value indicates a lower management skill.

In the second stage of the analysis, Equation (14) incorporates one-time period lag of the predicted value of default risk of banks ($\hat{RISK}_{jit(t-1)}$) with our key variables of national institutional setting on the protection of creditor rights (i.e. *LEG*, *ENFOR*, and *SHAR*) with other control variables to explain the dependent variable: the proportion of total earning assets allocated by the bank *i* to loans at time *t* (*CREDITRATIO*), measured by the ratio of total loans to the sum of total loans and government securities. While we control for the same set of macroeconomic indicators (i.e. M_{jt}) in equation (14), the regulatory variables (R_{jt}) and bank-specific variables ($BANK_{jit}$) that are included in Equation (14) is slightly different from that in Equation (13). Such change is mainly due to the change in our selection criterion: we now attempt to control for the potential explanatory influences on the cross-bank difference in the proportion of total earning assets allocated to loans, which is not transmitted through their impacts on default risk of banks. In specific, the regulatory variables included in R_{jt} are the stringency of regulatory capital requirement adopted by the authorities (*CAPRQ*), the power granted to authorities to intervene bank's decision (*OFFPR*), private monitoring (*PRI*) and financial freedom index (*FREE*). Each is defined as in Section 4.2.2. We hypothesize those regulatory variables would impact the operational autonomy, constraint and competitive pressure banks face and therefore have consequence on bank's

selection of the asset portfolio. The bank-specific variables included in $BANK_{jit}$ are the market share of bank i in the national lending market ($MARSHAR$), the ratio of fixed assets over total assets (FIX), the ratio of liquid assets over customer and short-term funding (LIQ) and the ratio of capital over total risky assets⁸ (CAP). We control for $MARSHAR$ and FIX to capture the impact of customer base and physical distributional channel on banks' credit supply. We expect that banks with larger market share and more extensive networks would have higher ratio of loans over total earning assets. We control for LIQ is to catch the preference of banks toward holding public security that is driven by liquidity mismatch of banks. Presumably, banks that are in shortage of liquidity would like to hold more public security since it is more liquid compared to loans, we therefore expected a negative coefficient for LIQ . Finally, we control for the ratio of capital over total risky assets (CAP). As shown in Equation (7), the heterogeneity across banks in the level of capitalization has an ambiguous effect on bank's asset allocation. In addition to the macroeconomic indicators (M_{jt}), the regulatory variables (R_{jt}) and bank-specific variables ($BANK_{jit}$), we introduce the difference between interest rate on loans and that on public security (MAR) into Equation (14). We measure it using the interest rate charged by banks on loans to prime private sector customers minus the "risk free" treasury bill interest rate at which short-term government securities are issued or traded in the market. The data was collected from African Development indicator. Our analytical framework predicts a positive coefficient for MAR and a negative coefficient for $RISK_{jit(t-1)}$.

Both equations include a set of dummy time variables ($TIME_t$) for each year. These dummies capture any unobserved regional shock. Finally, ε_{jit} and ω_{jit} are white-noise error terms. We did not include either country-level or bank-level fixed effect because the time variation of national institutional setting variables on the protection of creditor rights is rather limited. The explanatory power of variables that change slowly over time would be mopped up by the fixed effects. Also, we can not introduce both country-level or bank-level fixed effect simultaneously since for all banks located in the same country, the bank-specific fixed effect will overlap with country-specific fixed effect. The first stage analysis is applied to a sample

⁸ Total risk assets include: total loans (net), other listed securities, other securities, equity investments, investment, securities, bonds, non-listed securities, other investments, deferred tax receivable, other non earning assets, and intangible assets (i.e. line 7480 in BankScope).

composed by commercial banks in 34 African countries during the period 1995-2008. While the second stage analysis is applied to commercial banks in 20 African countries during 1995-2008. The choice of the sample countries is directed by the availability of our key variable of interests. The bank-specific variables including the dependent variables in Equation (13) and (14) are constructed from bank-level financial data from the BankScope database. The definition of the variables and the data sources are given in Appendix. Table 1 presents the summary statistics of variables, and Table 2 reports the correlation coefficient of variables.

<INSERT TABLES 1 & 2 HERE>

5. Econometric issues and empirical results

5.1.1. Econometric issues

The availability of the panel data set enables us to choose estimators among pooled Ordinary Least Square (OLS), random-effect models and fixed-effect models, under the guidance of the appropriate statistics. Due to the limited variation of our key legal and institutional variables of interest, we narrow our options between pooled OLS and the random effects model in both first and second stage. For both stage, the Breusch and Pagan (1980) Lagrange multiplier test (LM) suggest a rejection of the null hypothesis that individual bank effects are not relevant, and therefore indicates the random effect model is preferred to pooled OLS estimator. Another econometric issue we have to deal with is the possibility of the endogeneity of legal right code in our estimated equations⁹. In theory, the reverse causality would take place whenever the policy makers make adjustment on the legal right code according to their knowledge on bank risk-taking and bank asset-allocation. However, as argued by Houston et al., (2010), the reverse causality would be less of a concern in the examination of individual bank firms, although it would be serious in a pure cross-country analysis. In addition, the use of the index rank of legal rights rather than the index of legal right in our study would reduce the endogeneity, if any. Indeed, the endogeneity test in the

⁹ Since our indicator of the enforcement of the legal right is a perception-based index, therefore, we believe we should be worry about the endogeneity of the indicator.

first (Equation (13)) and second stage (Equation (14)) fail to reject the null hypothesis that the specified endogenous regressors can actually be treated as exogenous at P-value 0.18 and 0.56 respectively, supporting our judgement¹⁰. We further carry out the endogeneity test of *MAR*, i.e. the difference in the interest rate charged by banks on loans to prime private sector customers (P_t) minus the "risk free" treasury bill interest rate at which short-term government securities are issued or traded in the market (r_s), in our second stage analysis. As shown in our analytical framework (Equation (2)), the change in the quantity of credit supply by the bank would be transited to the interest rate at the industry-level (P_t). Although our dependent variable in equation (14) is the proportion of the bank's assets to loans over total earning assets while *MAR* is ($P_t - r_s$) rather than P_t , we decide to take a cautious attitude to do an econometric test. We fail to reject the null hypothesis that the specified endogenous regressors can actually be treated as exogenous (P-value is 0.20)¹¹. To take into account the independency of the bank-specific dependent variables within a country since their exposure to the common unobservable country effects, we cluster the heteroskedasticity-robust standard errors by country.

5.1.2. First stage: the impact of legal rights, the enforceability of legal rights and information sharing on bank risk-taking

The results of the random effect estimation of equation (13) are presented in the column 2 of the Table 3.

<INSERT TABLE 3 HERE>

The key variables of interest on the right-hand are the legal right index, the enforcement of legal rights and the presence of informational sharing. As seen in Table 3, the first-stage analysis results indicates that the presence of informational sharing mechanism and the strength of legal code do not seem to have significant effect on bank risk-taking. The results therefore appear to be consistent with the view that a stronger legal rights and information sharing may not necessarily translate a decrease in the average default rate of the loan portfolio even it really lead a lower default rate of an individual borrower since there may exist a concomitant change in the composition of the loan portfolio. However, the

¹⁰ The instrument we use for the tests are legal origin, religion and latitude, following the standard practice in literature.

¹¹ The instruments we use for the test is one time period lag of *MAR*.

enforceability of legal right has statistically significantly negative impact, suggesting that higher protection of the creditor rights taking in the manner of more efficient enforcement of legal rights exerts an independent positive influence on reducing the risks banks are taking. In specific, the magnitude of the coefficient on *ENFOR* suggests that one standard deviation increase in the enforceability of legal rights (0.659), keep other things equal, is associated with a change in the ratio of loan loss provision by -1.144 ($=0.659 \times -1.736$). Given the mean of the ratio of loan loss provision is 3.175, the effect is not only statistically significant but also economically significant.

Regarding the regulatory variables, we find the increase in the financial freedom (*FREE*) induces a decrease in bank risk-taking, consistent with the insight of Barth et al., (2001) and Gonzalez (2005). We also find that increased stringency of capital requirement (*CAPRQ*) seems to bring in an increase in the risks banks are taking, in accordance with the argument that banks under more restrictive regulatory capital requirement incur more cost associated with raising capital and therefore incline to take risky investment to neutralize the cost. However, private monitoring (*PRI*) and the existence of explicit deposit insurance scheme (*INSUR*) have no significant impact. The insignificant impact of private monitoring does not seem to be a surprise once one takes into account the lack of the prerequisites for an effective private discipline in the African countries. With respect to the insignificant effect of the presence of explicit deposit insurance, we believe it could result from a combination of the low presence of the explicit deposit insurance scheme in our sample countries¹², and the existence of implicit insurance in the countries that lack explicit deposit insurance schemes (Demirgüç-Kunt et al., 2005). Furthermore, the low competence and the shortage of right mechanism for depositors to monitor bank activities in both countries with explicit and implicit insurance may also contribute to the insignificant result. With respect to other control variables, we find that banks with higher profitability (*ROA*), higher management skill (*SKILL*), and larger market share (*MARSHAR*) have a lower level of risk-taking. We also find that lower inflation (*INFLA*) and higher GDP (*LNGDP*) are correlated with lower risk-taking of banks.

¹² Among our 20 sample countries, only 5 of them, namely, Kenya (1988), Nigeria (1989), Tanzania (1994), Uganda (1994) and Zimbabwe (2003) have has explicit deposit insurance in place.

5.1.3. Second stage: The impact of legal rights, the enforceability of legal rights and information sharing on bank asset-allocation

The results of the random effect estimation of equation (14) are presented in the column 2 of the Table 4¹³.

<INSERT TABLE 4 HERE>

We first check the consistency of our estimated results with the analytical framework on which our empirical analysis is based. The significant positive coefficient for *MAR* and a significant negative coefficient for $\hat{RISK}_{ji(t-1)}$ confirm the prediction of Equation (7) that a larger difference between the interest rate charged by banks on loans to prime private sector customers minus the "risk free" treasury bill interest rate at which short-term government securities are issued or traded in the market, keep other things equal, lead the bank to allocate more their loanable funds to loans¹⁴, while the increase in the default risks in the bank's balance sheet leads banks to decrease the bank's asset-allocation to loans, confirming the conjecture that a high loan default rate is the major factor for most banks in Africa to choose to shed away from the provision of credit.

Looking at the key variables of interest, we see that stronger legal rights (*LEG*), more effective enforcement of the legal right (*ENFOR*), and the presence of information sharing institutions (*SHAR*) all are significantly associated with a higher proportion of loans, through the net impact on degree of competition and the operating cost of information production. Turning to the results on the various control variables, we find that a significant positive coefficient on the financial freedom (*FREE*), implying that the less restriction and intervention of the government on banks' participation in a broad range of activities would reduce the constraints for banks to perform their intermediation role and thus positively encourage the banks to engage more in the supply of credit. The results on market share (*MARSHAR*) and the ratio of fixed assets over total assets (*FIX*) indicates that the larger market share and higher ratio of fixed assets over total assets lead a significant increase in the proportion of loans over total earning assets, supporting the positive role of consumer base

¹³ We cut off the predicted default risks of bank derived from the first stage analysis that are smaller than zero in the second stage.

¹⁴ It could be interpreted as a movement along the supply curve due to a right hand shift of the demand curve.

and distribution channel on the bank's credit supply. Furthermore, the significant negative coefficient on liquidity assets over liquidity liability ratio (*LIQ*) suggests that managing liquid risks is not the reason for banks to reduce credit supply¹⁵. Finally, we find that the increase in the capitalization ratio¹⁶ and the increase of inflation are negatively related to the proportion of loans over total earning assets.

We test the robustness of these main results in two ways. First, we examine whether our results hold when alternative measure of the enforceability of the legal rights is used. Here, we consider the "Control of Corruption" constructed by Kaufmann et al., (2009). The index is a measurement of the perceptions of a very diverse group of respondents regarding the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. As documented by Kaufmann, et al., (2005), the perception-based corruption indicator explains a good deal of the extent to which a de jure notion of laws 'on the books' that differs substantially from the de facto reality that exists 'on the ground'. Therefore, it would be a suitable indicator to measure the extent to which laws on books are effectively applied in practice. Higher values indicate better control of corruption and more effective implementation of the written laws. The results are presented in Column 3 in Table 3 and 4 for the first and the second stage analysis, respectively. Secondly, we expand our sample countries from 20 to 34 in the first stage analysis and then perform the second stage analysis based on the predicted default risks derived from using 34 sample countries¹⁷. In both cases, the empirical results are highly consistent with our previous findings.

<INSERT TABLE 5 HERE>

¹⁵ We are aware of the concern that such negative relationship would be a reflection of inverse relation from the dependent variable to *LIQ* in equation (14), i.e. banks that hold higher government securities (lower loans) have higher liquid assets. We redo our estimation of the equation (14) using one time period of *LIQ* rather than contemporary *LIQ* as independent variable. The estimated coefficient on one time period lag is positive but insignificant, other results remain the same.

¹⁶ We have highlighted in Equation (7) that the relationship between the level of capitalization and the proportion of loans in bank's portfolio is not clear. In addition, the negative association we find here seems to be consistent with Honohan and Beck (2007), which indicates that well capitalized banks in Africa incur higher operating cost.

¹⁷ We can only use commercial banks in 20 countries in our second stage analysis since those are countries that have government bond market and data for "risk free" treasury bill interest rate at which short-term government securities are issued or traded in the market and other key variables of interest.

<INSERT TABLE 6 HERE>

Summarizing the results on the first and the second stage, our analysis indicates that the stronger creditor rights, the presence of information sharing and the increase in the effectiveness of the enforcement of creditor legal rights leads to an increase in the proportion of loans over total earning assets, which is consistent with the essential idea of the law and finance literature that some environments are more conducive to writing and enforcing financial contracts than others, and that better contracting leads to a higher financial depth. However, those three aspects of the institutional setting on the protection of creditor rights appear to materialize their influence in different manners. While the stronger creditor rights, the presence of information sharing exert their impact through a composite effect of the enhancement of competition and the reduction of the operating cost of information production, the increase in the effectiveness of the enforcement of creditor legal rights does it through mitigating default risks of banks as well as the composite effect of enhancing competition and reducing the operating cost of information production. In addition, for the enforcement of creditor legal rights, the latter channel is stronger than the former. To be specific, one standard deviation increase in the enforceability of legal rights (0.659), keep other things equal, is associated with a change in the proportion of loans over earning assets by 4.67 $\{= (-0.345)*(-1.144)+(0.659*6.483)\}$, 75% of which $(=1-(1.144/4.67))$ contributes to the latter channel.

6. Conclusion

The recent research on the relation between the institutional setting on the protection of creditor rights and the development of the credit market accumulates macro-level evidence indicating the quality of the legal protection, the enforceability of legal rights and the improvements in information sharing among creditors are positively associated with the depth of financial system. However, the micro-analysis to identify and quantify the specific mechanisms through which the institutional settings on the protection of creditor rights get transmitted to the aggregate outcome in the credit market is less developed. In this paper, inspired by Klein (1970, 1971) and Hannan (1991), we set up an analytical framework for the allocation of a bank's loanable funds between private credit (loans) and other competing stock of earning assets in an operational environment characterized by risk, imperfect asset elasticities and operating costs, within a general model of portfolio selection. We then link

the institutional setting on the protection of creditor rights encompassing legal rights for creditors, the enforcement of legal rights and information sharing mechanism among creditors with the default risks banks are facing, the degree of competition in the credit market and banks' operating cost associated with informational production and contract enforcement. Finally, we empirically test whether and how the institutional settings on the protection of creditor rights affect those three channels and ultimately influence banks' credit supply.

With respect to a unbalanced panel dataset of the commercial banks in 20 African countries during the period over 1995-2008, our investigation suggests that better institutional setting on the protection of creditor rights taking the form of the higher level of legal codes for creditors, the better enforceability of legal rights, and the presence of informational sharing among banks encourage banks to allocate a significantly higher proportion of their earning assets to loans, which is consistent with empirical evidence presented by the macro-level study. However, those three aspects of institutional setting appear to rely on different channels to materialize their positive influence. While the enforceability of legal rights work through mitigating the credit risks banks are taking, and a composite net effect of promoting competition in the credit market and reducing banks' operating cost of informational acquisition, legal codes and information sharing materialize their positive effect through the composite effect on competition in the credit market and banks' operating cost of informational acquisition only.

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Appendix: Variable definition and data sources

Variable	Definition and data source
<i>National institutional setting on the protection of creditor rights.</i>	
RULE OF LAW	A measurement of the perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Data source: Kaufmann et al., (2009).
CONTROL OF CORRUPTION	A measurement of the perceptions of a very diverse group of respondents regarding the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Data source: Kaufmann et al., (2009).
LEG	A measurement of the legal right of secured creditor in bankruptcy against defaulting borrowers. Data source: Djankov et al., (2007) and the World Bank's Doing Business Index.
SHARE	A dummy variable with a value one from the year when either a public registry or a private bureau starts to operate in a country and onwards, and zero prior to it. Data source: Djankov et al., (2007) and the World Bank's Doing Business Index.
<i>Industry regulatory variables</i>	
CAPRQ	Defined by answering the following questions: (1) Is the minimum required capital asset ratio risk-weighted in line with Basle guidelines? (2) Does the ratio vary with individual bank's credit risk? (3) Does the ratio vary with market risk? (4-6) Before minimum capital adequacy is determined, which of the following are deducted from the book value of capital: (a) market value of loan losses not realized in accounting books? (b) unrealized losses in securities portfolios? (c) unrealized foreign exchange losses? (7) Are the sources of funds to be used as capital verified by the regulatory/supervisory authorities? (8) Can the initial or subsequent injections of capital be done with assets other than cash or government securities? (9) Can initial disbursement of capital be done with borrowed funds? The value is determined by adding 1 if the answer is yes to questions 1-7 and 0 otherwise, while the opposite occurs in the case of questions 8 and 9 (i.e. yes=0, no =1). Data source: three surveys performed by the World Bank in 2000, 2003 and 2008.
OFFPR	Defined by answering the following questions: (1) Can the supervisory authorities force a bank to change its internal organizational structure? (2) Are there any mechanisms of cease-desist type orders whose infraction leads to automatic imposition of civil & penal sanctions on banks directors & managers? (3) Can the supervisory agency order directors/ management to constitute provisions to cover actual/potential losses? (4) Can the supervisory agency suspend director's decision to distribute dividends? (5) Can the supervisory agency suspend director's decision to distribute bonuses? (6) Can the supervisory agency suspend director's decision to distribute management fees? (7) Can the supervisory agency supersede bank shareholder rights and declare bank insolvent? (8) Does banking law allow supervisory agency to suspend some or all ownership rights of a problem bank? (9) Regarding bank restructuring & reorganization, can supervisory agency remove and replace management? (10) Regarding bank restructuring & reorganization, can supervisory agency remove and replace directors? The value is determined by adding 1 if the answer is yes to questions 1-

	10 and 0 otherwise. Data source: three surveys performed by the World Bank in 2000, 2003 and 2008.
PRI	The value is determined by adding 1 if the answer is no to questions 1, while the opposite occurs in the case of questions 2-10 (i.e. yes=0, no=1): (1) Does accrued, though unpaid interest/principal enter the income statement while loan is non-performing? (2) Are financial institutions required to produce consolidated accounts covering all bank and any non-bank financial subsidiaries? (3) Are off-balance sheet items disclosed to supervisors? (4) Are off-balance sheet items disclosed to public? (5) Must banks disclose their risk management procedures to public? (6) Are directors legally liable for erroneous/misleading information? (7) Is an external audit compulsory? (8) Are there specific requirements for the extent of audit? (9) Are auditors licensed or certified? (10) Do regulations require credit ratings for commercial banks? Data source: three surveys performed by the World Bank in 2000, 2003 and 2008.
INSUR	A dummy variable that takes a value of one from the year when the explicit deposit insurance was put into effect, and zero prior to it. Data source: Demircuc-Kunt et al., (2005) and the International Association of Deposit Insurers.
FREE	The Financial Freedom Index measuring the extent of government regulation of financial services, the extent of state intervention in banks and other financial services, the difficulty of opening and operating financial services firms (for both domestic and foreign individuals), and government influence on the allocation of credit. Data source: Heritage Foundation.
<u>Macro-economics variables</u>	
LNGDP	The natural logarithm of GDP (constant 2000 US dollar). Data source: African Development Indicator
INFLA	Inflation GDP deflator. Data source: African Development Indicator
<u>Industry-wise variable</u>	
MAR (%)	The difference between the interest rate charged by banks on loans to prime private sector customers and the "risk free" treasury bill interest rate at which short-term government securities are issued or traded in the market. Data source: African Development Indicator.
<u>Bank-specific variables</u>	
RISK (%)	Provision/total loans. Data source: BankScope
ROA (%)	Pre-taxation profit/total assets. Data source: BankScope
SKILL (%)	Overhead/(loans + total other earning assets). Data source: BankScope
MARSHAR (%)	Loans of bank I at year t/the sum of loans of commercial banks belonging to the same country. Source: BankScope, Author calculation.
SP	$SP = \sum_{i=1}^2 S_i^2$, and $S_i = y_i / \sum_{i=1}^2 y_i$, y_1 refers to interest-income and y_2 refers to non-interest income. Source: BankScope, Author calculation.
ASSET_ALLOCATION	Loans/(loans + total other earning assets). Data source: BankScope.
FIX (%)	Fixed assets/ total assets. Data source: BankScope.
CAP(%)	Total equity/total risky assets. Data source: BankScope.
LIQ (%)	Liquidity assets/ customer and short-term funding. Source: BankScope.

Table 1: Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
RULE OF LAW	-0.480	0.659	-1.717	0.940
CONTROL OF CORRUPTION	-0.476	0.663	-1.757	1.071
LEG	0.663	0.284	0.000	1.000
SHAR	0.608	0.488	0.000	1.000
CAPRQ	5.676	1.838	2.000	9.000
OFFPR	8.013	2.696	1.000	10.000
PRI	7.480	1.478	3.000	10.000
INSUR	0.389	0.488	0.000	1.000
FREE	45.080	15.690	10.000	70.000
LNGDP	23.566	1.593	19.873	25.929
INFLA	17.618	118.404	-5.755	5399.526
MAR	8.114	16.944	0.028	330.192
DEFAULT RISK	3.175	5.552	0.000	90.715
ROA	2.690	3.728	-40.030	29.647
SKILL	7.108	7.840	0.000	131.318
MARSHAR	10.183	14.006	0.000	100.000
SP	0.603	0.133	0.500	1.000
ASSET-ALLOCATION	54.123	22.038	0.283	99.983
FIX	3.626	4.323	0.000	49.944
CAP	30.249	56.138	0.447	1526.087
LIQ	59.753	152.895	0.130	5575.393

Note: The 20 African countries includes Algeria, Angola, Botswana, Burundi, Egypt, Ethiopia, Kenya, Lesotho, Madagascar, Malawi, Morocco, Mozambique, Namibia, Nigeria, Rwanda, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe. Again, the sample selection is dictated by the availability of the data

Table 3: The quality of institutional setting on the protection of creditor rights and bank risk-taking

	Column 2		Column 3	
	Rule of law		Control of corruption	
	Coef.	Robust Std. Err	Coef.	Robust Std. Err
<i>ROA</i>	-0.645***	0.273	-0.643***	0.274
<i>SKILL</i>	0.165***	0.053	0.165***	0.052
<i>MARSHAR</i>	-0.028*	0.017	-0.027*	0.017
<i>SP</i>	1.051	0.858	1.250	0.897
<i>LNGDP</i>	-0.721***	0.286	-0.754***	0.293
<i>INFLA</i>	0.006***	0.001	0.006***	0.001
<i>CAPRQ</i>	0.259**	0.119	0.290***	0.113
<i>OFFPR</i>	-0.102	0.073	-0.187***	0.072
<i>PRI</i>	0.335	0.210	0.317	0.214
<i>INSUR</i>	-0.223	0.568	-0.428	0.537
<i>FREE</i>	-0.032**	0.018	-0.031*	0.019
<i>SHAR</i>	0.552	0.464	0.706	0.458
<i>ENFOR</i>	-1.736***	0.575	-1.947***	0.473
<i>LEG</i>	-0.615	0.663	-0.152	0.754
<i>Within R-square</i>		0.2216		0.2250
<i>Between R-square</i>		0.2724		0.2657
<i>Overall R-square</i>		0.2425		0.2423
<i>No. of Obs.</i>		2180		2174
<i>No. of countries</i>		20		20

Note: Dependent variable is the ratio of loan loss provision over total loans. The estimation is based on a random-effect model. The column 2 contains the results when the enforcement of legal rights is measured by Rule of Law index and the column 3 reports the results when the enforcement of legal rights is measured by Control of Corruption index. The heteroskedasticity-robust standard errors are clustered at the country level. *, **, *** indicates statistical significance at the 10%, 5%, and 1% levels, respectively. Time dummy is included in the estimation while are not reported. The number of observations in the case when the enforcement of legal right is measured by the Rule of Law index is larger since the Rule of law indicator is available for Rwanda, Burundi, and Lesotho in 1995 and 1996 while Corruption Control Index is not.

Table 4: The quality of institutional setting on the protection of creditor rights and bank asset-allocation

	Column 2		Column 3	
	Rule of law		Control of corruption	
	Coef.	Robust Std. Err	Coef.	Robust Std. Err
<i>MAR</i>	0.127***	0.049	0.144***	0.047
$\hat{RISK}_{ji(t-1)}$	-0.345*	0.195	-0.348*	0.195
<i>FIX</i>	1.101***	0.249	1.123***	0.251
<i>CAP</i>	-0.186***	0.039	-0.184***	0.037
<i>MARSHAR</i>	0.312***	0.103	0.348***	0.093
<i>LIQ</i>	-0.023*	0.014	-0.023*	0.015
<i>LNGDP</i>	1.213	2.185	1.834	2.121
<i>INFLA</i>	-0.012***	0.003	-0.013***	0.003
<i>CAPRQ</i>	-0.912	0.750	-0.874	0.633
<i>OFFPR</i>	0.206	0.725	0.584	0.659
<i>PRI</i>	-0.751	1.020	-1.387	0.895
<i>FREE</i>	0.073***	0.029	0.079***	0.027
<i>SHAR</i>	8.665***	2.232	8.525***	2.008
<i>ENFOR</i>	6.483***	2.692	8.286***	2.615
<i>LEG</i>	12.531***	4.350	10.543***	3.836
<i>Within R-square</i>		0.2416		0.2627
<i>Between R-square</i>		0.1213		0.1472
<i>Overall R-square</i>		0.2078		0.2417
<i>No. of Obs.</i>		1514		1515
<i>No. of countries</i>		20		20

Note: Dependent variable is the ratio of total loans over total earning assets. The estimation is based on a random-effect model. The column 2 contains the results when the enforcement of legal rights is measured by Rule of Law index and the column 3 reports the results when the enforcement of legal rights is measured by Control of Corruption index.

$\hat{RISK}_{ji(t-1)}$ in column 2 and column 3 is the predicted value corresponding to column 2 and 3 in Table 3 respectively. The predicted values that are smaller than zero are trimmed in the second stage analysis.

The heteroskedasticity-robust standard errors are clustered at the country level. *, **, *** indicates statistical significance at the 10%, 5%, and 1% levels, respectively. Time dummy is included in the estimation while are not reported.

Table 5: The estimated results of the first-stage analysis based on the unbalance data of commercial banks in 34 countries.

	Column 2		Column 3	
	Rule of law		Control of corruption	
	Coef.	Robust Std. Err	Coef.	Robust Std. Err.
<i>ROA</i>	-0.707***	0.184	-0.639***	0.214
<i>SKILL</i>	0.101	0.065	0.123	0.053
<i>MARSHAR</i>	0.001	0.012	-0.002	0.013
<i>SP</i>	2.196*	1.333	2.001*	1.233
<i>LNGDP</i>	-0.279	0.221	-0.368	0.254
<i>INFLA</i>	0.002***	0.001	0.002***	0.001
<i>CAPRQ</i>	0.147	0.143	0.172	0.140
<i>OFFPR</i>	0.024	0.058	-0.062	0.063
<i>PRI</i>	0.094	0.183	0.021	0.192
<i>INSUR</i>	-0.286	0.569	-0.004	0.507
<i>FREE</i>	-0.036***	0.014	-0.031**	0.015
<i>SHAR</i>	0.345	0.702	0.858	0.687
<i>ENFOR</i>	-1.565***	0.610	-1.379***	0.512
<i>LEG</i>	1.675	1.106	1.665	1.186
<i>Within R-square</i>	0.2174		0.1747	
<i>Between R-square</i>	0.1591		0.2701	
<i>Overall R-square</i>	0.2141		0.1893	
<i>No. of obs.</i>	3416		3361	
<i>No. of countries</i>	34		34	

Note: Dependent variable is the ratio of loan loss provision over total loans. The estimation is based on a random-effect model. The column 2 contains the results when the enforcement of legal rights is measured by Rule of Law index and the column 3 reports the results when the enforcement of legal rights is measured by Control of Corruption index.

The 34 countries include Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African, Chad, Congo democratic republic Cote dlvoire, Egypt, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Madagascar, Malawi, Mali, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe. The sample selection is guided by the availability of the data.

The heteroskedasticity-robust standard errors are clustered at the country level. *, **, *** indicates statistical significance at the 10%, 5%, and 1% levels, respectively. Time dummy is included in the estimation while are not reported.

The number of observations in the case when the enforcement of legal right is measured by the Rule of Law index is larger since the Rule of law indicator is available for Rwanda, Burundi, Mauritania, Benin, Cape Verde, Djibouti, Lesotho, and Swaziland in 1995 and 1996 while Corruption Control Index is not.

Table 6: The estimated results of the second-stage analysis with the default risks of banks derived from Table 5.

	Column 2		Column 3	
	Rule of law		Control of corruption	
	Coef.	Robust Std. Err	Coef.	Robust Std. Err.
<i>MAR</i>	0.120**	0.051	0.142***	0.049
$\hat{RISK}_{ji(t-1)}$	-0.345**	0.183	-0.351*	0.207
<i>FIX</i>	1.129***	0.245	1.121***	0.240
<i>CAP</i>	-0.191***	0.038	-0.183***	0.037
<i>MARSHAR</i>	0.330***	0.106	0.363***	0.090
<i>LIQ</i>	-0.024*	0.015	-0.024*	0.015
<i>LNGDP</i>	1.516	2.129	1.860	2.100
<i>INFLA</i>	-0.012***	0.003	-0.014***	0.003
<i>CAPRQ</i>	-0.916	0.719	-0.952	0.606
<i>OFFPR</i>	0.047	0.658	0.522	0.591
<i>PRI</i>	-0.996	0.932	-1.413*	0.810
<i>FREE</i>	0.082***	0.030	0.080***	0.027
<i>SHAR</i>	7.963***	2.136	8.245***	2.035
<i>ENFOR</i>	5.694**	2.766	8.374***	2.389
<i>LEG</i>	12.385***	4.550	10.949***	3.849
<i>Within R-square</i>		0.2535		0.2722
<i>Between R-square</i>		0.1177		0.1414
<i>Overall R-square</i>		0.1996		0.2208
<i>No. of Obs.</i>		1562		1581
<i>No. of countries</i>				20

Note: Dependent variable is the ratio of total loans over total earning assets. The estimation is based on a random-effect model. The column 2 contains the results when the enforcement of legal rights is measured by Rule of Law index and the column 3 reports the results when the enforcement of legal rights is measured by Control of Corruption index.

$\hat{RISK}_{ji(t-1)}$ in column 2 and column 3 is the predicted value corresponding to column 2 and 3 in Table 5 respectively. The predicted values that are smaller than zero are trimmed off in the second stage analysis.

We can only use commercial banks in 20 countries in our second stage analysis since those are countries that have data for "risk free" treasury bill interest rate at which short-term government securities are issued or traded in the market and other key variables of interest.

The heteroskedasticity-robust standard errors are clustered at the country level. *, **, *** indicates statistical significance at the 10%, 5%, and 1% levels, respectively. Time dummy is included in the estimation while are not reported.