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Credit rationing, institutions and local public debt

Roberto Gallardo Del Angel[1] - Universidad Veracruzana, México
Yiwen Xu - Morrison Insurance Brokers Ltd., Canada

Abstract

This work presents a model of credit rationing under the effects of judiciary in- efficiency and criminal extraction. Under low judiciary quality and high criminality, we argue that banks are more likely to lend to the government rather than private enterprises. We argue that credit rationing increased local public debt in Mexico before coming into effect the new law of Financial Discipline for States and Municipalities in 2016. Our scientific objective is explaining the supply of bank loans to the local public sector in Mexico under low institutional quality and credit rationing. We use Panel regression analysis and also applied an Autoregresive Distributed Lag model to obtain the long term growth rates. We also used Clustering analysis in order to classify states in Mexico in terms of their debt, defaults in the industry sector, crime and judicial inefficiency rates. Our empirical analysis shows that judiciary inefficiency and criminality induced higher amounts of bank loans to state governments during the period of 2004 to 2016. We also found that defaults in the industry sector also increased the amount of bank loans to local governments in Mexico, which may explain in part that the rationed credit is redirected to the public sector. We argue that keeping the quality of institutions low may induce higher bank lending to states, so there might be little incentive to improve the judiciary and public safety. The possible solution is to improve judicial efficiency and decrease criminality in order to reduce credit rationing and subsequently ensure local public debt stability in the long term.

JEL Classification: G21, G51, H63.

Keywords: Credit rationing, criminality, judicial efficiency, public debt.

Racionamiento de crédito, instituciones y deuda pública local

Resumen

Este trabajo presenta un modelo de racionamiento del crédito bajo los efectos de la ineficiencia judicial y la extracción criminal. En condiciones de baja calidad judicial y alta criminalidad, argumentamos que es más probable que los bancos presten al gobierno en lugar de a las empresas privadas. Argumentamos que el racionamiento crediticio incrementó la deuda pública local en México antes de la entrada en vigencia de la nueva ley de Disciplina Financiera para Estados y Municipios en 2016. Nuestro objetivo científico es explicar la oferta de crédito bancario al sector público local en México bajo condiciones de baja calidad institucional y racionamiento de crédito. Utilizamos análisis de regresión de panel y también aplicamos un modelo Autorregresivo de Rezagos Distribuidos para obtener las tasas de crecimiento a largo plazo. También utilizamos el análisis de Clusters para clasificar los estados de México en términos de su deuda, morosidad en el sector industrial, índices de delincuencia e ineficiencia judicial. Nuestro análisis empírico muestra que la ineficiencia judicial y la criminalidad indujeron mayores montos de préstamos bancarios a los gobiernos estatales durante el período de 2004 a 2016. También encontramos que los incumplimientos financieros en el sector industrial también aumentaron el monto de los préstamos bancarios a los gobiernos locales en México, lo que puede explicar en parte que el crédito racionado se redirecciona al sector público. Argumentamos que mantener baja la calidad de las instituciones puede inducir mayores préstamos bancarios a los estados, por lo que podría haber pocos incentivos para mejorar el poder judicial y la seguridad pública. La recomendación es mejorar la eficiencia judicial y disminuir la criminalidad para reducir el racionamiento del crédito y asegurar la estabilidad de la deuda pública local en el largo plazo.

Clasificación JEL: G21, G51, H63.

Palabras clave: Racionamiento de crédito, criminalidad, eficiencia judicial, deuda pública.

[1] Corresponding author. Faculty of Economics, Universidad Veracruzana. Email: rogallardouv.mx
ORCID: http://orcid.org/0000-0003-4661-0675
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1. Introduction

In modern societies, almost the entire money in the economy is created by banks issuing credit to households and businesses. Banks offer loans to the public using the deposits they have as liabilities. The creation of credit is very important to fuel technological and economic progress. Credit creation gives us the opportunity to bring forward ideas and innovations, to create profits and accumulate capital. It is thanks to credit that we can bring future income to work and create wealth, and set new income paths that will increase the next generation's welfare. The amount of bank credit in the economy represents the availability of working capital for businesses, and the more expensive it becomes, the more difficult it is to make businesses profitable and increase economic growth in general.

If, for some reason, some entrepreneurs cannot get bank loans at a given interest rate, we say that there is *credit rationing*. From a classical perspective, this is a contradiction because we were thought that at an equilibrium price markets would clear and there would be no unsatisfied demand. Certainly, asymmetric information and moral hazard may play an important role in why banks do not want to lend money to some enterprises or give them less than they require. But there are other reasons why credit rationing exists. In this paper we explore institutional parameters such as judiciary efficiency and criminality as the cause of credit rationing.

(Jaffee and Russell, 1976) is one of the first works to explain credit rationing as a product of asymmetric information, specifically adverse selection. They explained that there are honest and dishonest borrowers. The first type will borrow what they can repay and the second type will default at the minimum cost. In their model, a market equilibrium is divided into two scenarios. In the first, all borrowers are rationed and, in the second, some will be left out of the market after making short-run gains. Perhaps one influential work about credit rationing is (Stiglitz and Weiss, 1981). This work explains credit rationing as an adverse selection problem. (Stiglitz and Weiss, 1981) built a model which explains that banks will separate high risk borrowers using the interest rate. Individuals who are willing to pay a high interest rate are those with the highest probability of default. So, credit will be rationed to those that are willing to pay after a threshold interest rate because it is more plausible that their projects are riskier with a high probability to fail. They accept that excess demand is compatible with an equilibrium rate. Rising interest or increasing collateral may not be a solution because the chances of default increase and the profitability for the banks decreases. However, the solution is to limit the number of loans available.

Another important work on credit rationing is (Jappelli et al., 2005) which introduces institutional variables in the analysis. (Jappelli et al., 2005) explains credit rationing as a result of judiciary inefficiency. They argue that courts may fail to enforce full repayment to banks when borrowers suddenly default. Borrowers might be tempted to default or retain part of the collateral. This may encourage banks to reduce credit. (Safavian and Sharma, 2007) is an empirical analysis that confirms that judiciary efficiency is important for financial markets. They implemented regression analysis to observe how lending is affected by courts' performance. They found that more efficient and speedy courts may improve bank lending, though the important variable might be enforcement of the laws. (Moro et al., 2018) and (Moro et al., 2018) are two empirical works that use regression analysis to prove that efficient courts and property rights protection improves bank lending.

(Hernández and Villagómez, 2013) gives an overview of the Mexican Financial System and introduces the topic of property rights. They point out the importance of judicial efficiency in Mexico despite the fact that there is poor performance in the execution of contracts compared with other countries. Another work that focuses on judiciary efficiency is (Laeven and Majnoni, 2005), which uses cross-section analysis to study the effect of the judiciary's performance on interest rate spreads across countries. They found that courts' efficiency is important to decrease financial costs. (La Porta et al., 2003) analyses *related lending* in Mexico, where banks lend to enterprises where shareholders have a special interest or have some ownership. They discovered that these enterprises usually perform poorly despite borrowing at a lower interest rate, following an extraction pattern similar to looting. (La Porta et al., 2001) is a work that analyses shareholder protection in the French and British judicial systems. They constructed a panel with 49 countries and analyzed the risks of ownership for shareholders and creditors.

Before we proceed to our study, we must clarify the scientific purpose of this research. We are trying to indirectly analyze the effect of some institutional variables that affect property rights, something that has already been advanced theoretically and empirically in some respects. For example, most of the literature points out the importance of the judiciary in protecting banks' collateral when default occurs. These studies explain that credit rationing may increase if the judiciary is inefficient at protecting banks' interests and collateral. Of course, courts also protect other property rights such as profits and returns to businesses and investors. Some authors like (Alchian, 1965) and (Alchian and Demsetz, 1973) state that property rights come from societies' etiquette, social customs and exclusion as well as the enforcement of laws by authorities. It has been noted that developed or high-income countries have a high degree of protection of property rights, with well defined social customs and law enforcement. But many developing countries lack the institutional framework to enforce property laws. Sometimes property rights are not well defined and, in most cases, these developing countries suffer from severe internal conflicts such as widespread criminality, civil wars, and other low-intensity conflicts. In some, there is no central authority that can provide for public safety and enforce the rule of law. In this respect, we decided to approach credit rationing by including criminality as an important variable that effectively decreases appropriations by businesses and households. Crime is an important variable that prevents material development and restricts individuals' functionings. The current literature explains judicial inefficiency as a variable that affects banks from recovering collateral. But criminality directly affects enterprises by extracting investment, capital and profits that otherwise may be used for investment. Furthermore, the level of criminality is affected by police performance, which is under direct jurisdiction of executive powers and usually those in charge of fiscal budgeting.

The first part of the paper is an introduction with some relevant literature on the topic of credit rationing. The second part contains a theoretical framework to describe the behavior of banks, entrepreneurs and government debt. The third part of the paper contains the empirical analysis and the final part contains the conclusions.

2. Theoretical model

2.1 The bank

We built a simplified model of credit rationing which explains the problem of credit contracts under incomplete property rights caused by judicial inefficiency and criminal extraction. We built our model based on (Jappelli et al., 2005) using the similar treatment of judicial inefficiency but we added an extraction parameter in order to simulate entrepreneur's low appropriation of wealth. (Jappelli et al., 2005) explained that the important function of courts is to force borrowers to repay their bank loans when they default. So the judiciary's efficiency parameter θ accounts for the Bank's recovery rate on collateral when the entrepreneur defaults. Hence the total recovery when defaults occurs is θC where $0 < \theta \leq 1$. When perfect enforcement exists, then $\theta = 1$ but when courts are inefficient, $0 < \theta < 1$. The closest θ is to one, the better is the lender's protection.

Additionally, we introduce a parameter δ which accounts for the level of criminality as part of the social environment that affects entreprises and households. We call it an *extraction* parameter because it describes to what extent households or businesses are dispossessed of their wealth by a third party. If total wealth can be defined as the present value of a stream of net income Y and a stock of tangible capital C, the real wealth retained is $\delta(Y + C)$ and $1 - \delta(Y + C)$ is entailed away by criminals. If there is full borrowers' protection, then $\delta = 1$ but if there is extraction, then $0 < \delta < 1$. We think of δ as the extraction made by criminal extortion and robbery, but it can also be interpreted as institutionalized fraud and corruption. In this last respect, this extraction parameter may function as a tax but without any goods or services in return.

Under the assumption of competitive financial markets with risk neutral banks, similarly as in (Jappelli et al., 2005), the opportunity cost of raising funds for bank loans is:

$$(1 + \overline{r})L = p\big((1 + r)L\big) + (1 - p)\delta\theta C$$

Where p is the probability that the entrepreneur's project is successful and therefore the bank loan is repaid. The $(1 + \overline{r})L$ is the total opportunity cost of funds considering a cost $\overline{r}$. The total repayment is $(1 + r)L$ where r is the lending interest rate and L is the loan. In the case of default with probability $(1 - p)$, the bank will be able to collect the collateral $\delta\theta C$ from the borrower. We also assume that the bank can observe the parameter δ so there is no asymmetric information. If there is sufficient collateral in the economy and the financial markets are in equilibrium, then $\overline{r} = r$. The optimal interest rate would be:

$$(1 + r) = \theta\delta\frac{C}{L}$$

Which can also express the total amount of collateral required by the bank to recover its loan in case of default:

$$C^l = \frac{(1 + r)}{\theta\delta}L$$

When there are perfect police enforcement and efficient judiciary $\delta = \theta = 1$, so the collateral is just the repayment of the loan $C^l = (1 + r)L$. However, if the judiciary is of an incompetent nature, then the lower θ the higher the interest rate r as the bank must hedge for credit risk. And if property rights are not entirely enforced by the courts, or one may be able to retain part of this wealth, then collateral must be higher to ensure repayment. The bank may increase the interest rate, but this may also increase the risk of default as the projects become less profitable and therefore decrease the entire banking industry's profitability because $pY < (1 + \overline{r})$, where Y is the yield of the project already approved. The only option left would be to demand for higher collateral for the same loan when δ and θ are less than one.

2.2 The entrepreneur

Let us now consider a borrower with a Von Newmann type utility function. Let us also assume that the individual can affect the probability of success p_i of his project through effort, though we assume that there is no disutility of effort for simplicity (e.g. he enjoys what he does for a living). The entrepreneur faces an extraction parameter δ for his wealth, which affects both the yield of his project and the collateral. If the project is successful, he retains his property (collateral) and the yield, minus the repayment to the bank. In case the project is not successful, he loses his collateral. Under these conditions, the entrepreneur's expected utility is:

$$U_i = p_i[\delta(Y + C_i) - (1 + r)L] + (1 - p_i)[\delta C - \theta C]$$

The first order condition of this problem is:

$$\frac{\partial U_i}{\partial p_i} = \delta(Y + C) - (1 + r)L - \delta C + \theta C = 0$$

In this problem, the borrower's optimal collateral is:

$$C^b = \frac{(1 + r)L - \delta Y}{\theta}$$

From these results we observe that the entrepreneur's collateral is less than the collateral required by the bank $C^b < C^l$. The judicial efficiency parameter θ and the extraction parameter δ worsen the situation by making this collateral larger than it should be in a good institutional environment. Despite this, the entrepreneur is not willing to match the collateral the bank is requesting.

2.3 The credit contract

In order to write down a credit contract, the bank will require that the entrepreneur commit to a certain level of collateral. In our analysis, the collateral requested would be:

$$C^l = \frac{C^b}{\delta} + \frac{Y}{\theta}$$

In the scenario of judiciary efficiency and public safety $\delta = \theta = 1$, the bank will require the entrepreneur to provide a collateral C_b plus access to the project yield Y in case of default $C^l = C^b + Y$. Once the project is accepted and the collateral agreed, the bank will sign a contract. The collateral and the yield will serve as an assurance of future repayment in case the project failed.

But in our world there is judicial inefficiency $0 < \theta < 1$ as well as crime $0 < \delta < 1$, so the bank will demand a higher collateral from borrowers. In extreme cases, we may observe that the limit of C^l when the quality of the judiciary tends to zero $\theta \to 0$ is infinity ∞, and the limit of C^l when $\theta \to 0$ is also infinity ∞. This is to say, there is no way to set up a credit contract when the extraction is extremely high or the judiciary is extremely inefficient, because the collateral needed to hedge credit risk is just too high. No bank may be willing to lend credit in a situation when property is completely extracted and the judiciary is extremely incompetent. The supply of credit to the private sector will collapse and the entire financial system will be in jeopardy. Although this situation appears to be very extreme, it is not completely unrealistic in some parts of the world. It is difficult for businesses to work in areas where organized crime or corruption are rampant, because the yield of any good project along with the stock of collateral may be easily extracted. The judiciary may offer no protection to creditors and possibly nothing would be repaid.

There are some actions the bank may take in order to improve its position. One thing might be to avoid doing business in rural and isolated areas where criminality is high, and to limit operations in towns and cities where the judiciary is famous for being incompetent. Another thing the bank may do is to separate those entrepreneurs into two types: A first group of entrepreneurs that have enough power to protect their wealth and possessions, and a second group that is weak and cannot protect their businesses. Only those politically connected, powerful and influential people will receive credit, while those who do not have enough strength to protect their wealth will be rationed.

This sorting is not an easy task as it may sound. This sorting mechanism seems to be a problem of *adverse selection*, where individuals willing to pay a high interest rate $\frac{(1+r)}{\theta\delta}$ are the riskiest because they know that their probability of repaying is very low. If both parameters δ and θ are unknown to the bank, then sorting is difficult. In special, the parameter δ is perhaps only known to the borrower and unknown to the bank. In this situation, a high interest rate may serve as an indication that the borrower is riskier than others who prefer a low interest rate. This is somehow a similar selection mechanism as in (Stiglitz and Weiss, 1981). But increasing the interest rate or the collateral will only lead to a situation where only the riskiest projects will be profitable, making the chances of default more plausible.

But in reality, even if δ is known to the bank, many entrepreneurs do not realize how weak they are until they have been extracted by criminal groups or by corrupt bureaucrats. The government is likely to know the true values of δ and θ but it might be in its best interest to ignore these parameters rather than correct them, keeping them as low as possible perhaps unintended. Because keeping these parameters low may encourage banks to supply more credit to the government. During times of low values of δ and θ, it would be easier ofr the government to borrow

money from banks, even though at a higher cost. For the banks, lending to the government is also good business as loans can be unsecured and credit risk is low.

2.4 Private savings

Consider now the individual's decision on his portfolio of savings. If the individual is not an entrepreneur, he/she must decide either to lend his money to private entrepreneurs or to the Government. His consumption when young and when old are:

$$X_t = Y_t - L_t - T_t - P\,B_t$$

$$X_{t+1} = \frac{1+r}{\delta\theta}\,L_t + B_t - T_{t+1}$$

Where X_t is individual consumption, Y_t is total income from different sources, L_t is the lending to private entrepreneurs, T_t are taxes, B_t are government bonds and P is the price of bonds. Using the above life-time income we cannot determine the optimal amount of lending to entrepreneurs or to the Government for any particular individual. But we cannot accept an arbitrage condition either, so the present value condition that allows positive amounts of private lending and government borrowing is:

$$\frac{1+r}{\delta\theta} = \frac{1}{P}$$

But under this condition, the intitutional parameters $0 < \delta, \theta < 1$ will push the bond yield upwards. In the presence of crime and judicial inefficiency the price of the bond also needs to drop in order to maintain this no-arbitrage condition. This means that the government will always pay a higher cost when borrowing under low institutional quality.

One way to determine the optimal amount of private lending and government bonds is to construct an optimal portfolio where overall returns are maximized subjected to a level of systemic risk. Let be the aggregate optimal two-assets portfolio be:

$$S_t^* = L_t^* + D_t^*$$

Where L_t^* and D_t^* are optimal amount of lending to the private and public sector respectively. Once the amount of private lending and government borrowing (bonds) are optimal, we can observe that, as long as the total amount of savings is stable in the economy, there is a trade-off between private investment and government debt. But as we explained in the previous section, there is credit rationing and bank lending to the private sector will not be optimal. If an individual deposits his savings in the bank, the bank will not lend money to entrepreneurs but rather it will prefer to lend it to the government. This will benefit the government as there are more available funds for public spending, but on the other hand, the government is borrowing at a higher cost because the price P is lower under in the presence of δ and θ.

We must also mention that banks in Mexico avoid high-risk investments usually under prudential regulation. Safe and sound investments are required and government bonds are in a strong position in the bank's assets. For example, the Mexican Pension Funds (AFORE) are limited in their ability to invest in risky stocks in national and international markets. In this form, regulators may indirectly have a say in the allocation of credit to the public sector. Because the banking system is regulated, federal agencies may benefit from larger bank investments and loans. However, in this paper we explore the position of local governments rather than federal agencies.

2.5 Public debt financing

Since the start of this century and before law of Financial Discipline for States and Municipalities of 2016, banks increased lending to state governments and Municipalities in Mexico. During this period of increasing local government debt, the parameters δ and θ may have played a part in this problem, with important consequences in terms of macroeconomic stability. We have already observed that credit is rationed for those that are unlucky enough to be living under inefficient courts and under extracting conditions. That the bank may only lend to those that are willing to provide enough collateral and repay at a cost $\frac{(1+r)}{\theta\delta}$, which is the real cost given the present institutional and security conditions.

In an economy where macroeconomic stabilization is done by the monetary authorities, governments and public companies are left to decide by themselves the way they are going to manage their fiscal deficit. The government usually cooperates with monetary authorities in order to set up macroeconomic objectives such as inflation, interest rates, economic growth rate, public debt and deficit, among other variables. But sometimes they are left free to manage the government deficit using debt financing through bonds and direct borrowing at some level. Let us assume now that the banks will channel the rationed credit into direct loans to the public sector, which is considered a safe borrower. The total credit TC in the economy comprises loans to entrepreneurs plus loans to the public sector at any given period:

$$TC_t = \frac{(1+r)}{\delta\theta}(L_t + D_t)$$

We are now only interested in the public debt and assume that debt financing is done through direct loans from banking institutions to the Government and other public enterprises[2]. The outstanding public debt D_t in period t will be:

$$D_t = \frac{(1+r)}{\delta\theta}D_{t-1} + G_t - T_t$$

[2] Some public debt may be unsecured (uncollateralized), but the government is a special economic agent. We assume that the government has an infinite life and cannot default on its debt, at least in the long term. Some local government may be able to bail out Federal Government when they have a weak fiscal position

Where G_t is the government expenditure in period t and T_t are taxes in period t. Under this identity, the increase in the public debt is simply:

$$\triangle D_t = \underbrace{\frac{1+r-\delta\theta}{\delta\theta} D_{t-1}}_{\text{debt service}} + \underbrace{G_t - T_t}_{\text{primary deficit}}$$

In this equation we observe that the cost of servicing the public debt increases well above the interest rate r when institutional quality is low. If we express the total public debt as percentage of the total national product we obtain:

$$\frac{D_t}{Y_t} = \frac{(1+r)}{\delta\theta}\frac{Y_{t-1}}{Y_t}\frac{D_{t-1}}{Y_{t-1}} + \frac{G_t - T_t}{Y_t}$$

Here the term $d_t = \frac{D_t}{Y_t}$ is the percentage of debt with respect to national income. For simplicity assume that the growth of the national product is $\frac{Y_t}{Y_{t-1}} \simeq (1+g)$, where g is the GDP growth rate. Therefore, the previous equation can be rewritten as:

$$d_t = \frac{(1+r)}{\delta\theta(1+g)} d_{t-1} + \overline{f}$$

Where $\overline{f} = \frac{G_t - T_t}{Y_t}$ is the long term primary deficit as a percentage of GDP, which may be considered constant in our analysis. If we move one period the previous equation we have:

$$d_{t+1} - \frac{(1+r)}{\delta\theta(1+g)} d_t = \overline{f}$$

And the solution to this equation is:

$$d_t = \left(d_0 - \frac{\overline{f}\delta\theta(1+g)}{\delta\theta(1+g)-(1+r)}\right)\left(\frac{(1+r)}{\delta\theta(1+g)}\right)^t + \frac{\overline{f}\delta\theta(1+g)}{\delta\theta(1+g)-(1+r)}$$

Where d_0 is the initial level of public debt; the first term on the right shows how the public debt will move over time, and the second term is the inter-temporal equilibrium of the public debt.

2.6 Stability of public Debt

Let us first assume an initial scenario where the macroeconomic situation is of high interest rates, low judiciary quality, high criminality and low economic growth $(1+r) > \delta\theta(1+g)$. In this situation, the public debt will be unstable and will tend to grow over time without restraint. This is a

very dangerous situation which cannot be stopped even when the primary deficit is eliminated $G_t = T_t$. We observe that the parameters δ and θ may deteriorate the situation of public debt, making it unmanageable over time with an upward drift, making it more difficult to service. Under this scenario, macroeconomic stability will be more difficult to maintain for monetary authorities because the real cost of money is drifting upward due to institutional parameters outside of its domain. Credit will be rationed in the private sector and production may decrease, making it safer for banks to keep lending to the government instead of entrepreneurs.

Now let us imagine the other possible scenario where the interest rate is low, the judiciary is more efficient, criminality is low and economic growth is relatively high $(1 + r) < \delta\theta(1 + g)$. Under this scenario, the public debt may be stable over time until an inter-temporal equilibrium is reached. Macroeconomic stability will be easier to attain for the Central Bank and better economic performance may follow.

Although the Central Bank has a say in the stability of the interest rates, we know that only the government can influence the levels of δ and θ. Even in the situation where loans to the government are unsecured, and given a monetary stabilization policy, the only possibility for convergence is that the government makes a true effort to keep institutional quality high. If courts become more efficient and crime rates are low, the government may contribute greatly to macroeconomic stability and economic growth.

Additionally, if the government makes additional efforts to enforce fiscal discipline and eliminate the primary deficit over time, say $\overline{f} = 0$, then it may be able to force the public debt to converge toward zero eventually. In other words, the complete elimination of public debt in the long term may depend on high institutional quality along with a sufficiently large growth rate of the economy.

3. Empirical analysis

3.1 Data

In Mexico, only the Federal Government can issue bonds, although in very few cases local governments are allowed to issue debt on the financial markets. During the 2000's and 2010's the usual way to finance local government deficits was direct borrowing from commercial banks. Using state level data in order to analyze state government debt is one possible way to measure the effect of institutional variables and credit rationing. The amount of bank credit for the public sector has increased steadily since NAFTA was signed in 1994. Bank credit to state governments increased during the period of 1994 to 2005, perhaps because the amount of credit to the industry decreased and also because of federal regulations. After 2005 the amount of credit to industry recovered but stalled with the financial crisis of 2008. During the financial crisis of 2008 bank credit to the industry did not grow but bank loans to state governments more than doubled. We must also recall that this period was also important in terms of large gains from oil revenue. Despite unexpected and additional fiscal revenues, bank credit to the states increased at a similar rate compared to the industry. From the period 2008 to 2016 the bank credit to state governments had similar growth to

that of the industry sector until Federal regulators issued laws to limit government borrowing. The figure 1 shows the relative growth of bank credit for the industry and the state governments.

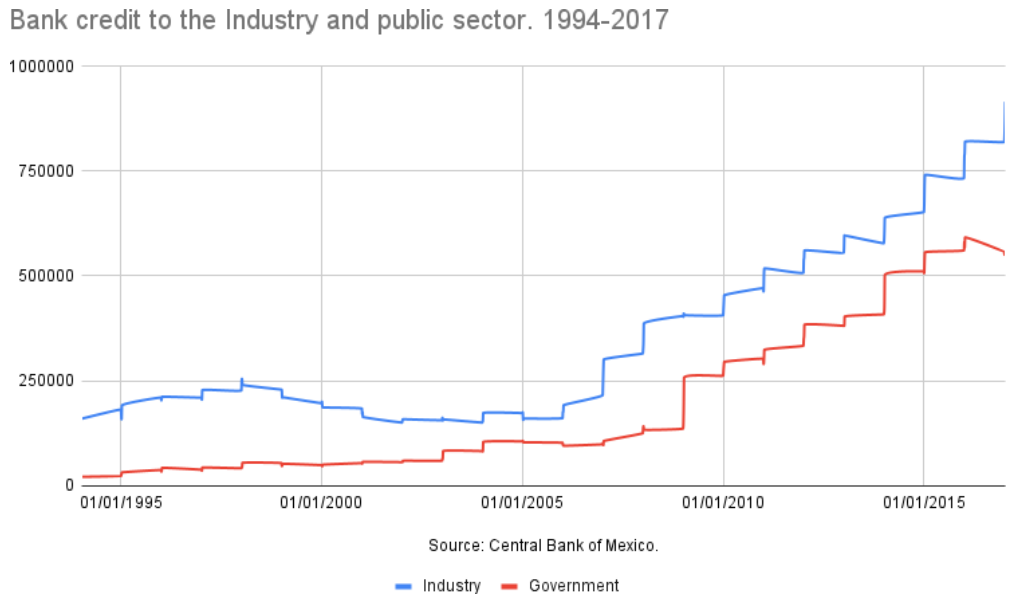

Figure 1. Bank Credit for Industry and State Governments 1994-2017
Source: Own elaboration.

The theoretical analysis implies that at least some of the rationed credit will be redirected to the public sector. We decided to approach the effect of credit rationing on public debt using aggregate state-level data. We decided to use the amount of direct bank lending to state governments as the dependent variable, using data provided by the Central Bank of Mexico (Banxico). Information about criminality was obtained from the Mexican National Security Council, which is an intergovernmental organization that over- sees the national security policy. Information about courts' efficiency was collected from the Federal Judicial Council (Consejo de la Judicatura Federal) which is the management branch overseeing all federal courts in Mexico. Data on bank defaults in the industrial sector was obtained from Banxico and used as a proxy for credit rationing. The tertiary-education graduation ratio was used to control for the demand for public goods, as tertiary education has an important effect on household income and intergenerational transfers. We constructed a panel for 32 states and for a period of 13 years, from 2004 to 2016. We chose this period because of the favorable economic conditions in the economy due to the high price of oil until the new Law of Financial Discipline for Federal Entities and Municipalities was issued in 2016. In order to account for systematic risk, we included a price variable like the Interbank Interest Rate (TIIE) for a 91-day term, which is also provided by Banxico. Rather than using daily or 28 days rates, the 91 term rate captures better the systematic risks in the economy.

3.2 Panel regression

We want to estimate the effect of credit rationing on government borrowing in the presence of low judicial quality and lack of safety for entrepreneurs. The theoretical model implies that credit rationing produces higher levels of state government's debt. We may think of government debt as a function of aggregate income and private lending:

$$D = f(Y, L)$$

The variable Y represents the economic robustness in terms of capacity of the local economy, which is necessary to support a certain level of taxation. L represents the investment and capital formation. Government debt is inversely related to private lending $\frac{\partial}{\partial} < 0$because fewer private savings for entrepreneurs means more financial resources are available for the government once the total savings are realized. We also include the institutional parameters that negatively affect the amount of public debt, so we may rewrite the functional form:

$$D = f(Y, L, \theta, \delta)$$

We expect that public debt will be high when institutional parameters are low $\frac{\partial D}{\partial \delta} < 0, \frac{\partial D}{\partial \theta} < 0$. A functional form may be:

$$lnDebt_{i,t} = \beta_0 + \beta_1 lnGDP_{i,t} + \beta_2 lnCrime_{i,t} + \beta_3 lnCourt_{i,t} + \beta_4 lnDefault_{i,t} + \beta_5 TertiaryEd_{i,t} + \beta_6 TIIE91_{i,t} + a_i + \epsilon_{i,t}$$

Most variables are in logarithms, previously deflacted by a price index with a 2018 base. $lnDebt_{i,t}$ are the bank loans to the state government i at time t in real terms while $lnGDP_{i,t}$ is the state level real GDP. The $lnCrime_{i,t}$ contains all crimes reported to the police in every state i. The $lnCourt_{i,t}$ are the Federal courts' pending cases every year. $lnDefault_{i,t}$ is the amount of defaulted bank loans by the industry sector and $TertiaryEd_{i,t}$ is the graduation rate (number of graduates per 100 students) in the tertiary level of efucation (college and university). The price variable $TIIE91_{i,t}$ is the interbank interest rate for a 91 days term, which we expect may capture some systematic risks. Information about crime was obtained from the Mexican National System of Public Security; the data about bank loans and defaults come from the Mexican Central Bank (Banxico); information about court cases was obtained from the Mexican Federal Judiciary Council (Consejo de la Judicatura), which is the organization in charge of all Federal courts in the country. Information about State GDP and tertiary education was obtained from the Mexican National Institute of Statistics, Geography and Informatics (INEGI). In this functional form the a_i represents a non-observed characteristics that are initially correlated with the explanatory variables and are common for all states. Here the estimate β_2 captures the information on criminality δ and β_3 captures the effect of judiciary efficiency θ. Although in our theoretical model $\frac{\partial D}{\partial \theta} < 0$ and $\frac{\partial D}{\partial \delta} < 0$, we use the information on crime and courts'

pending cases, so we expect that β_2 and β_3 will be positive because we are not using them as inverse variables: The more crime and pending cases the higher the state debt to private banks.

An alternative model combines the institutional parameters as an interactive variable ln(Crime $*$ Courts):

$$lnDebt_{i,t} = \beta_0 + \beta_1 lnGDP_{i,t} + \beta_2 ln(Crime_{i,t} * Court_{i,t}) + \beta_3 lnDefault_{i,t} + \beta_4 TertiaryEd_{i,t} + \beta_5 TIIE91_{i,t} + a_i + \epsilon_{i,t}$$

Here we espect that β_2 may be also positive and statistically significant in order to validate our hypothesis and also observe a possible interaction between the two institutional parameters. Another important estimate is the β_3 which describes the effect of credit rationing on public debt. We expect that higher default by private industries will lead to a higher borrowing by the Government. We also expect that β_4 may be positive, because we expect that higher education may also mean higher intergenerational transfers and higher public debt. Because higher public debt may be accompanied by public deficit, we expect that the deficit may increase when the GDP is not growing, so the β_1 must be negative. Table 1 shows the results of the panel regressions, with fixed and random effects. The estimates for the variable $lnDefault$ on industry loans is positive and highly significative, this means that banks are relocating credit from the private to the public sector. All estimates are statistically significant in the fixed effect models, with the only exception being the interbank interest rate; and the real State GDP being significant in all but one random effect model. Both institutional parameters are significant when regressed individually or in an interactive variable. The default on industry loans is also significant which may confirm that private loans are being redirected to public debt, as suggested.

Table 1. Fixed and Random Effects regressions on Bank loans to State Governments

Bank credit to States				
	Fixed Model 1	Fixed Model 2	Random Model 1	Random Model 2
lnGDP	−4.622***	−4.489***	−0.108	0.013
	(0.902)	(0.891)	(0.316)	(0.302)
lnCrime	0.48**		0.728***	
	(0.245)		(0.2)	
lnCourts	0.215*		0.398***	
	(0.12)		(0.115)	
ln(Crime*Courts)		0.117***		0.214***
		(0.046)		(0.039)
Tertiary Educ.	1.481*	1.542**	1.434*	1.486**
	(0.773)	(0.769)	(0.756)	(0.755)
lnDefault	0.154**	0.155**	0.224***	0.229***
	(0.064)	(0.064)	(0.063)	(0.063)
TIIE91	−1.806	−2.353	−7.28***	−7.908***
	(2.163)	(2.085)	(1.919)	(1.866)
Constant	25.433***	25.436***	−1.661	−1.607

	(5.197)	(5.281)	(1.731)	(1.714)
Observations	416	416	416	416
R2 Withing	0.285	0.283	0.233	0.232
R2 Between	0.262	0.285	0.592	0.592
R2 Overall	0.116	0.128	0.467	0.463

Note: ∗ p<0.1; ∗∗p <0.05; ∗∗∗p <0.01; N=32, T=13 (2004-2016).
Standard errors in parenthesis. Hausman test rejects H0 of inconsistency. Fixed effects are preferred

Because this analysis is about the supply of bank loans to state government, we may also be confronted with the possibility of endogenity. We decided to perform a panel Instrumental Variable (IV) regression in order to account for endogeneity. Table 2 shows the results for the IV panel regressions and confirms the results found in the previous Fixed and Random effects regressions. The Hausman test confirms that IV random effects are the best estimates in our analysis. The estimate for the interest rate variable $TIIE91$ is statistically significant and larger than in previous models. The estimate in loans default variable confirms the positive feedback between credit rationing and bank loans to states. The variable of Tertiary Education was dropped as is is not significant but instead it was used as an instrument.

Table 2. IV Panel regressions on Bank loans to State Governments

Bank credit to States				
	IV FE Model 1	IV FE Model 2	IV RE Model 1	IV RE Model 2
lnGDP	−3.571***	−3.415***	−0.039	0.153
	(1.145)	(1.081)	(0.333)	(0.312)
lnCrime	0.385		0.66***	
	(0.254)		(0.205)	
lnCourts	0.261**		0.413***	
	(0.13)		(0.118)	
ln(Crime*Courts)		0.126***		0.211***
		(0.047)		(0.04)
lnDefault	0.138**	0.134**	0.202***	0.196***
	(0.069)	(0.068)	(0.072)	(0.072)
TIIE91	−7.561**	−8.208***	−11.54***	−12.565***
	(3.421)	(3.042)	(2.714)	(2.501)
Constant	21.073***	20.565***	−1.031	−1.063
	(6.371)	(6.255)	(1.608)	(1.595)
Observations	416	416	416	416
R2 Withing	0.268	0.265	0.222	0.219
R2 Between	0.239	0.25	0.614	0.611
R2 Overall	0.086	0.088	0.473	0.466

Note: ∗ p<0.1; ∗∗p <0.05; ∗∗∗p <0.01; N=32, T=13 (2004-2016)
Standard errors in parenthesis.Hausman test cannot reject H0 of inconsistency. Random effects are preferred.

3.3 ARDL regression

We also run a *Autoregressive Distributed Lag* (ARDL) model using the Pooled Mean Group (PMG) technique. This regression does not fix short-term estimates across groups but constrains the long-run estimates to be the same across groups, and also corrects the endogenous regressors problem. Using this model we may capture the effect of long term growth rates of independent variables during the period of analysis, which is an important information considering that we are analysing the dynamic aspects of public debt. Before we run this model we performed a Levin, Lin, Chu Unit root test and found that all variables were stationary at I(0) not I(1). However, this first generation test does not consider cross-sectional dependency. We performed a Pesaran Cross-sectional Augmented Dickey-Fuller (CADF) test and found that the tertiary education variable may not be estationary, so we changed the variable and used the logarithm of tertiary education rate which resulted to be stationary. We also performed a Pedroni test to ensure that all variables are cointegrated at least at I(1). The long terms growth rates are shown in Table 3, where the $lnCrime$ estimate is not statistically significant although the interactive estimate is. Before running the ARDL regression we also made sure that problems such as panel heterokedasticity and serial correlation were not present.

Table 3. ARDL regressions on Bank loans to State Governments
(Long term rates)

	Bank credit to States	
	PMG A	PMG B
lnGDPpc	−1.949***	−1.566***
	(0.287)	(0.231)
lnCrime	0.044	
	(0.074)	
lnCourts	0.104**	
	(0.048)	
ln(Crime*Courts)		0.057***
		(0.018)
lnTertiary	−0.709**	0.613*
	(0.296)	(0.323)
lnDefatult	0.191***	0.127***
	(0.025)	(0.027)

Note: ∗ p<0.1; ∗∗ p<0.05; ∗∗∗ p<0.01.
Standard errors in parenthesis.

3.4 Clustering Analysis

Additionally, we use Cluster analysis, which is a Machine Learning algorithm that does not require supervision. The idea is to observe for states that may be similar in terms of debt, credit rationing and institutional parameters. We use a KMeans algorithm which minimizes the total within-cluster variation to obtain k number of clusters with similar attributes. This within-cluster variation is defined as the sum of squared Euclidean distances between states and a centroid. Therefore, we want to minimize:

$$\sum_{k=1}^{k} \sum_{x_i \in S_k} (x_i - \mu_k)^2$$

Where x_i is the observation i in the cluster S_k and μ_k is the mean of all observations in the cluster S_k. We use the silhouette method to see how well all observations fit in each cluster and the optimal number of clusters suggested is four. Figure 5 at the end of this paper shows the silhouette graph. Figure 6 shows a plot using Principal Components Analysis with the four clusters. Mexico City is one cluster with only one element because it is the state with the larger per capita debt, larger criminality and larger default rate in the industrial sector, as can be seen in Figure 2 at the end of this paper. We also observe from the two main components graph that the state of Campeche (bottom number 4 in the largest cluster) though considered in cluster or group three, it has the largest DGP per capita, with the best institutional quality and the lower debt per capita, so it may be considered a separate group by itself. So we decided to try another clustering method in order to observe this difference.

We performed Hierarquical Cluster Analysis in order to construct groups using a different algorithm and added another cluster to capture additional information. This method uses the *nearest neighbor* algorithm to classify data and determine how close or far is a point from other points in a R^n space. We use the Euclidean distance $\sqrt{\sum_i (a_i - b_i)^2}$ as the metric, with complete linkage clustering. The main idea is to start considering each point as a cluster itself, then the algorithm start looking for another point with a minimum distance $min\{d(a,b): a \in A, b \in B\}$. The clusters are formed maximizing the distance among other clusters until all points are accounted in each single cluster. This the classification is shown Figure 3 and a dendrogram is plotted in figure 4 with those five groups separated by red rectangles. We still observe that Mexico City is the state with the highest per capita debt, with high default on loans (industry sector) and, on the other hand, Campeche is by itself the best positioned state with better economic conditions and better institutional quality.

4. Conclusions

In this analysis we used institutional variables to explain credit rationing and also argued that banks were redirecting credit to state governments. We also argue that the public sector may be benefiting when institutional variables are of low quality, therefore there is little incentive to improve them. We also argue that not only protection of banks or creditors is important, but protection of businesses from extraction of their income and property. As in some other studies, judicial efficiency and protection of creditors are important variables that affect credit supply, but we also argue that protection of property and income of households and businesses is also be important.

With respect to the relationship between credit rationing and the public sector, we performed a panel analysis on bank loans to state governments during the period 2004 to 2016. We use loan defaults in the industry sector as a proxy for credit rationing assuming banks reduce the supply of loans to entrepreneurs when defaults are high. Interestingly, when the defaults on industry loans are high, the amount of bank loans to the states increase. The estimates we obtained in all our models seem to confirm this fact.

We also found that crime, as a proxy of extraction of assets and income, is also statistically significant in determining the level of bank loans to the state governments. We also confirmed that the efficiency of courts might also be an important factor that induces a higher supply of loans to state governments. In our analysis, the interaction between judiciary inefficiency and criminality is statistically significant, as shown in our interactive term. Our regression analysis confirms that credit rationing, and intuitional variables such as judiciary inefficiency and criminality induced higher State debt during the period before the enforcement of the law of Financial Discipline for States and Municipalities.

The clustering analysis allows us to observe differences among states in terms of state government borrowing, bank defaults, crime and courts efficiency for the year 2016. This analysis helps us to observe which states are highly indebted, those that have high default levels, and those with high crime and judicial inefficiency. For example, Mexico City seems to be an outlier with highly indebted and high default amounts in per capita terms, and also high crime and average judicial efficiency. On the other hand, Campeche seems to be the state with a much better economic position, low debt per capita and high institutional quality.

In summary, bank loans to the public sector are facilitated because of credit rationing in the private sector. If there are little prospects for private projects, lending to the public sector becomes attractive (e.g. during the 2008 financial crisis). Furthermore, because of the fact that there is high extraction due to crime and scant creditors' protection (courts' inefficiency), there is more than an incentive from banks to lend money to local governments. However, this borrowing practice has some unintended consequences. The first one may be that governments might not be induced to improve institutional quality. The second is that higher borrowing by the public sector, without any clear economic plan or goal, might be unsustainable in the long run; which is the reason why the law of fiscal discipline was created.

Additionally, lending to the government, although an easy alternative, has more drawbacks. Because of the crowding out effect on private investment, the probability of successful projects may be limited in a loans market which is already rationed. So we expect that economic growth rate may be affected by higher government expenditure if the public investment multiplier is too low. If we

add the judiciary inefficiency and high extraction, then we not only expect credit rationing but also unstable public debt levels over time, making it more difficult to have economic growth.

So it is in the best interest of entrepreneurs, banks and the government that these two parameters δ and θ remain as close to one as possible because these institutional costs affect the entire society. The costs associated with judiciary inefficiency and criminality may be affecting the long term economic stability. The possible recommendation might be, among others: better training for security forces and judicial employees, with better education and economic incentives along with career service.

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Anexos

Figure 2. KMean Cluster analysis: State Mean values by group 2016

Group	States	GDP	Debt	Crime rate	Courts	Default
1	Chis, Gue, Hid, Mich, Oax, Pue, SLP, Tlax, Ver, Yuc, Zac	$97,760.08	$1,620.88	889.72	52.23	351.81
2	Coah, Mor, Nay, Sin, Son, Tams	$162,077.00	$5,557.00	1,334.13	215.92	1,745.05
3	Ags, BC, BCS, Camp, Col, Chih, Dgo, Gto, Jal, EdoMex, NL, Qro, QRoo, Tab	$216,692.31	$3,875.07	1,882.95	64.96	998.13
4	CDMX	$361,970.82	$31,706.37	1,982.64	80.00	8,739.17

State debt, GDP and defaults are in Millions of real Mexican pesos in per capita terms. Crime rate and innefficiency rates are per 100 thousands inhabitants.

Figure 3. Hierarquical clustering analysis: State Mean values by group 2016

Group	States	GDP	Debt	Crime rate	Courts	Default
1	Rest of States	$135,895.19	$2,827.44	1,327.37	59.82	$833.14
2	BC, BCS, Coah, Mor, Son, Tams	$181,574.11	$5,832.37	2,180.14	166.66	$1,405.07
3	Campeche	$753,463.53	$1,957.60	229.97	45.34	$541.56
4	CDMX	$361,970.82	$31,706.37	1,982.64	80	$8,739.17
5	Nayarit	$113,017.68	$3,439.75	312.73	358.25	$180.02

State debt, GDP and defaults are in Millions of real Mexican pesos in per capita terms. Crime rate and innefficiency rates are per 100 thousands inhabitants.

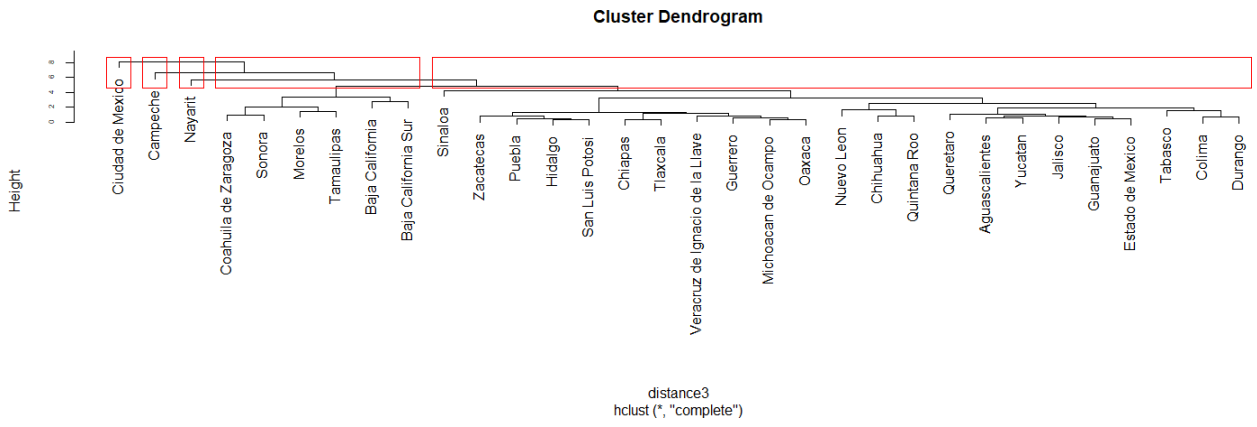

Figure 4. Dendrogram for 32 States 2016

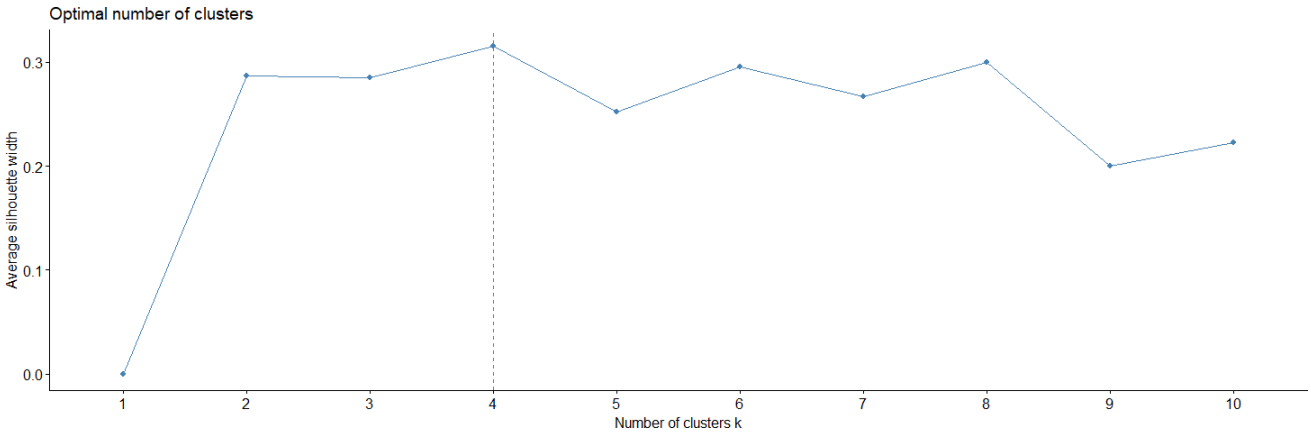

Figure 5. Silhouette Method for Optimal Number of clusters 2016

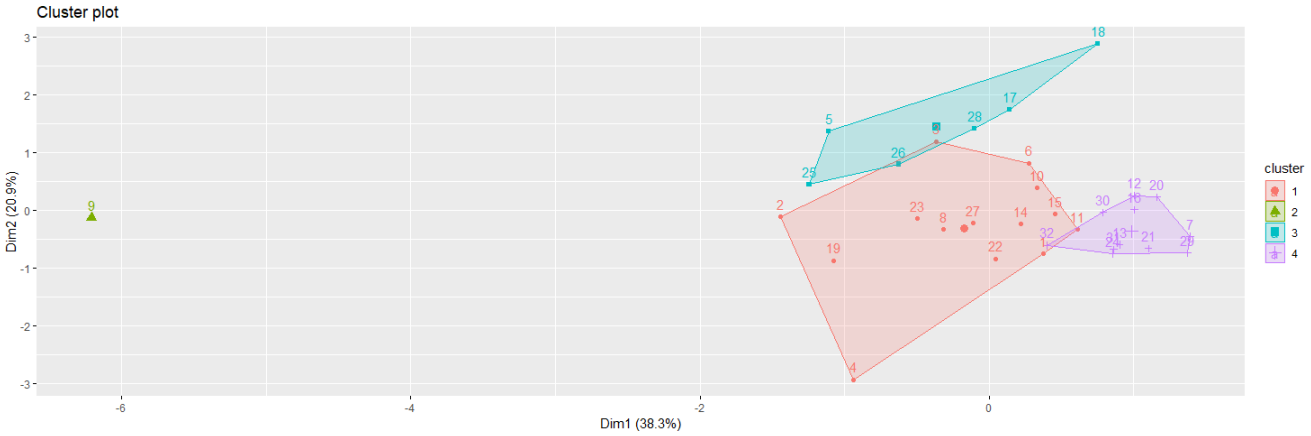

Figure 6. Two Main Principal Components 2016

Table 4. Summary Statistics for Panel Variables

Variable		Mean	Std. Dev.	Min	Max
lnDebt	overall	3.422	1.012	-2.955	5.458
	between		0.838	0.052	5.094
	within		0.584	0.416	6.112
lnGDP	overall	5.654	0.351	5.025	6.593
	between		0.353	5.057	6.542
	within		0.040	5.435	5.882
lnCrime	overall	4.524	0.428	3.102	5.512
	between		0.420	3.249	5.419
	within		0.107	3.732	5.018
lnCourts	overall	3.414	0.423	2.358	4.671
	between		0.361	2.691	4.207
	within		0.230	2.729	3.912

lnDefault	overall	2.601	0.799	-0.185	4.653
	between		0.620	1.539	4.247
	within		0.515	0.663	3.983
Tertiary Educ.	overall	0.623	0.059	0.485	0.871
	between		0.041	0.558	0.714
	within		0.044	0.510	0.818
TIIE 91	overall	0.060	0.020	0.033	0.096
	between		0.000	0.060	0.060
	within		0.020	0.033	0.096