6
Results

6.1.
Banking Industry Competitiveness

6.1.1.
Basic Specifications

In this section, results on the ordered probit maximum likelihood estimation under different specifications will be presented. Table 3 below show these results. Note that different specifications are tested, where one includes only aggregate income in the $\boldsymbol{S}$ vector ($\lambda = 0$) and another will seek to model market size, similar to what was made in Bresnahan and Reiss' original model. The third specification will encompass variables that describe the costs a bank incurs when entering a market.

More precisely, the first specification considers only the model's cutoffs, meaning that $\beta = \eta = \lambda = 0$ and S_0 is a vector of total income for each municipality in the sample. In the second specification, the objective is to allow market size variations, approximating it to the specification considered in Bresnahan and Reiss (1991). However, some adjustments must be made to total income as to incorporate variation in population: total income is divided by population, allowing S_0 to be given by population and the $\boldsymbol{Y}$ vector by population that works in a different town (popwdt), population that commutes to work from a different town (popldt), binary variables indicating positive (posg9600) and negative (negg9600) population growth in the preceding five years. Finally, the final specification models firms' fixed costs, incorporating variables such as: municipality area, population density, distance to state capital and distance to the closest town. Observe that no variable will be considered as a variable profit shifter.

Table 3 Estimates of the Model's Parameters

	J	$\hat{\alpha}$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\gamma}$
Cutoffs	**1**	11.24*** (0.41)	-1.11*** (0.05)	11.35*** (0.39)	-1.49*** (0.06)	11.92*** (0.41)	-1.57*** (0.07)
	2	-3.11*** (0.43)	-1.06*** (0.06)	-3.02*** (0.41)	-1.03*** (0.07)	-3.16*** (0.43)	-1.05*** (0.07)
	3	-1.92*** (0.18)	-0.46*** (0.06)	-2.13*** (0.20)	-0.35*** (0.07)	-2.27*** (0.20)	-0.34*** (0.07)
	4	-1.48*** (0.17)	-0.21*** (0.07)	-1.56*** (0.17)	-0.12 (0.08)	-1.70*** (0.18)	-0.10 (0.08)
	5	-1.06*** (0.15)	-0.28*** (0.10)	-1.06*** (0.15)	-0.22** (0.10)	-1.09*** (0.15)	-0.24** (0.10)
	6	-1.32*** (0.08)	-	-1.26*** (0.08)	-	-1.30*** (0.08)	-
	7	-0.56*** (0.05)	-	-0.52*** (0.05)	-	-0.54*** (0.05)	-
	>7	-0.46*** (0.05)	-	-0.44*** (0.04)	-	-0.46*** (0.05)	-
S	**POPLDT ($\hat{\lambda}_1$)**	-		0.55*** (0.21)		0.71*** (0.21)	
	POPWDT ($\hat{\lambda}_2$)	-		-1.22*** (0.09)		-1.41*** (0.09)	
	POSG9600 ($\hat{\lambda}_3$)	-		1,975.15*** (143.27)		1,854.71*** (141.11)	
	NEGG9600 ($\hat{\lambda}_4$)	-		3,328.51*** (185.48)		2,924.57*** (189.23)	
W	**AREA ($\hat{\eta}_1$)**	-		-		-0.000011** (0.000002)	
	POP. DENSITY ($\hat{\eta}_2$)	-		-		0.000440** (0.00019)	
	ST. CAP. DIST. ($\hat{\eta}_3$)	-		-		0.000807*** (0.00011)	
	CLOS. TOWND. ($\hat{\eta}_4$)	-		-		-0.009608*** (0.00051)	
	Log-Likelihood	-4,637.20		-4,545.19		-4,465.87	

Source: Central Bank of Brazil and Brazilian Institute of Statistics and Geography. Maximum Likelihood estimates for the three different models. Asymptotic standard deviation in parenthesis.

* significant at 10%   ** significant at 5%   *** significant at 1%

Initially, it must be observed that results are very similar to the ones found in Coelho (2007). Moreover, it can be seen that the variable profits cutoffs coefficients are, in general, asymptotically significant. Note also that from the 6th to the 8th bank fixed costs cutoffs are, in every specification, omitted, since they were very close to zero with high standard deviation. Moreover, observe that the cutoffs are relatively robust across specifications and somehow decreasing in absolute value, suggesting convergence on the banks' variable profit as competition intensifies. Note also that while variable profits cutoffs are all significant, the quadriopoly fixed costs coefficient loses significance when more structure is imposed. Finally, there does not seem to be barriers to entry when there are more than six banks.

On the other hand, we should inspect more closely the coefficient on the remaining explanatory variables. The variables on commuting have the expected signals; checking accounts tend to be closer to an individual's workplace, so a bank's market size should grow as more people tend to work in a town different than the one they live in. The opposite is valid in the bank's perspective if people go to work in a different town. Moreover, positive population growth in the second half of the previous decade has a great and significant influence on market size. However, negative growth in the same period has the same kind of impact.

Finally, note that as the town's area increases, bank's fixed costs are greater, which is reasonable, since the farther the bank from the individual, the less likely the individual would be to use all bank products; therefore, profits are reduced. The same is valid for population density, since it is easier to provide for a market in which population is more concentrated. Besides, as in Coelho (2007), the farther the town is from other municipalities, the greater are the costs to manage the branch. Furthermore, the coefficient for isolated towns has the expected signal, while the one for distance from state capital does not.

Furthermore, the entry-thresholds for the banking industry remain to be seen:

Table 4 Entry-Thresholds per firm (in R$ thousands) and ratios for all three different specifications

Panel A: Entry-Thresholds

N	(1)	(2)	(3)
1	987.63***	1,311.39***	1,271.28***
	(77.04)	(93.76)	(103.50)
2	1,336.55***	1,509.46***	1,482.37***
	(44.58)	(55.80)	(60.83)
3	1,415.76***	1,538.94***	1,509.48***
	(65.78)	(76.91)	(81.16)
4	1,503.86***	1,608.20***	1,566.96***
	(75.28)	(81.77)	(86.50)
5	1,699.53***	1,793.88***	1,759.50***
	(100.44)	(107.29)	(111.42)
6	2,214.54***	2,311.30***	2,310.08***
	(129.40)	(133.65)	(140.33)
7	2,489.23***	2,561.16***	2,523.54***
	(151.43)	(156.25)	(162.28)
>7	2,925.01***	2,965.52***	2,868.57***
	(171.22)	(184.24)	(192.52)

Panel B: Entry-Thresholds Ratios

Ratios	(1)	(2)	(3)
s_2/s_1	1.35	1.15	1.17
	(0.11)	(0.09)	(0.09)
s_3/s_2	1.06	1.02	1.02
	(0.05)	(0.05)	(0.05)
s_4/s_3	1.06	1.05	1.04
	(0.06)	(0.06)	(0.06)
s_5/s_4	1.13	1.12	1.12
	(0.08)	(0.07)	(0.07)
s_6/s_5	1.30	1.29	1.31
	(0.03)	(0.03)	(0.03)
s_7/s_6	1.12	1.11	1.09
	(0.03)	(0.03)	(0.03)
$s_{>7}/s_7$	1.18	1.16	1.14
	(0.03)	(0.03)	(0.03)

Source: Central Bank of Brazil and Brazilian Institute of Statistics and Geography. Entry-Thresholds estimates and ratios from all three specifications. Hypothesis testing done only in Panel A.

* significant at 10%　　** significant at 5%　　*** significant at 1%

Observe that the estimated entry-thresholds per firm are increasing, which means banks deepen competition as market grows. Besides, it is worth noting that the thresholds between duopoly and quadriopoly are reasonably close to each other, even when more structure is imposed to the model. In a market with a greater number of players, the dispersion of values enlarges as well as their standard deviations.

In comparison to table 1, it is possible to notice that the proximity of total income per bank is captured by the model as well as the greater dispersion in markets with more than four banks. However, the entry-threshold per firm in markets with more than seven banks is much different to the total income per bank in those markets.

Besides, it is possible to see how competition in the banking sector behaves in panel B. Observe that the competition increases present some non-linearity: relatively decreasing in the beginning, increasing after five banks and decreasing after six. Hypothesis testing for this panel are in the main diagonal in each panel of table 5.

Finally, these estimates allow us to perform the market competition variability test with an equality Wald test for the entry-threshold per firm. Table 5 below summarizes these tests for all specifications and estimates. In order to comprehend these panels, note that the arrows indicate the test's hypothesis for the first column's variable up until the column's entry-threshold in question. In other words, $s_1 \rightarrow s_2$ indicate a test in which the null hypothesis is the equality of s_1 and s_2, while $s_1 \rightarrow s_8$ is a test in which the null hypothesis is $s_1 = s_2 = \cdots = s_8$.

Table 5 Market Competition Variability Test for all three specifications

Panel A: Specification (1)

	$\rightarrow s_2$	$\rightarrow s_3$	$\rightarrow s_4$	$\rightarrow s_5$	$\rightarrow s_6$	$\rightarrow s_7$	$\rightarrow s_{>7}$
s_1	16.83***	20.27***	25.35***	35.87***	112.39***	140.54***	211.76***
s_2	-	1.37	4.41	12.36***	95.32***	126.03***	201.69***
s_3	-	-	1.20	6.33**	94.75***	126.03***	199.38***
s_4	-	-	-	3.27*	94.73***	125.67***	195.49***
s_5	-	-	-	-	94.68***	123.99***	184.93***
s_6	-	-	-	-	-	20.41***	76.91***
s_7	-	-	-	-	-	-	33.19***

Panel B: Specification (2)

	$\rightarrow s_2$	$\rightarrow s_3$	$\rightarrow s_4$	$\rightarrow s_5$	$\rightarrow s_6$	$\rightarrow s_7$	$\rightarrow s_{>7}$
s_1	3.60*	4.13	5.91	11.83**	103.24***	128.67***	172.62***
s_2	-	0.13	1.20	5.95	100.34***	126.86***	172.07***
s_3	-	-	0.60	4.29	100.06***	125.63***	167.93***
s_4	-	-	-	2.60	100.01***	124.99***	164.97***
s_5	-	-	-	-	100.01***	124.04***	158.53***
s_6	-	-	-	-	-	16.92***	55.16***
s_7	-	-	-	-	-	-	25.83***

Panel C: Specification (3)

	$\rightarrow s_2$	$\rightarrow s_3$	$\rightarrow s_4$	$\rightarrow s_5$	$\rightarrow s_6$	$\rightarrow s_7$	$\rightarrow s_{>7}$
s_1	4.26**	4.80*	6.32*	12.63**	117.08***	136.85***	165.41***
s_2	-	0.12	0.93	5.89	112.16***	132.90***	162.28***
s_3	-	-	0.43	4.37	111.42***	131.07***	157.83***
s_4	-	-	-	2.93*	111.11***	129.97***	154.70***
s_5	-	-	-	-	111.04***	128.85***	149.65***
s_6	-	-	-	-	-	12.37***	39.86***
s_7	-	-	-	-	-	-	18.35***

Wald Statistics for the Market Competition Variability Tests for all specifications.
* significant at 10% ** significant at 5% *** significant at 1%

A closer inspection of table 5 shows that the equality null hypothesis is broadly rejected, except in markets with two to four banks. When market size and fixed costs are modeled, it is not possible to reject anymore the equality up to five banks entry-threshold per firm. This means that under these controls, the competition structures in these markets are very similar, regardless of the number of banks[16].

Nevertheless, there is still enough evidence to suggest competition variability in the banking industry, especially in markets with more than five banks, so that the number of banks is a good proxy for competition variability. Therefore, the number of banks in a given city should be an adequate instrument for credit in a growth regression.

Besides, note that a certain non-linearity is captured in the relationship between number of banks and the entry-threshold per firm. While in the beginning there is a difference in the thresholds, there is equality in the middle and a relative greater growth in these values in markets with five banks onward. Due to this

[16] Note that Bresnahan & Reiss (1991) suggest that although these hypotheses tests are dependent, their increase is due to greater competition. This dependence can also be inducing the equality in entry threshold per firm.

fact, it is necessary to incorporate this non-linearity in the instrument when estimating the growth regression. Observe that this fact also helps to identify the parameter of interest.

6.1.2. Results for the model with Variable Profits shocks

Assume that the shocks to which banks undergo can be discriminated. In other words, firms are subject not only to variable profits shocks but also to fixed costs shocks. An example of the former can be the specific remuneration of bank officers in each town: unobservables that affect bank profits and are intensified as market size increases. In order to incorporate this to the model, suppose that the variable profit equation, (7), includes a shock component common to the firms, ε. Suppose also that these shocks follow an i.i.d. normal distribution with zero mean and σ_ε^2 variance.

$$L_N(D, \boldsymbol{Q}) = \alpha_1 + \sum_{n=2}^{N} D_n \cdot \alpha_n + \beta \cdot \boldsymbol{Q} + \varepsilon \qquad (7')$$

Observe now that we have a compound error denoted by $\varsigma = S \cdot \varepsilon + \xi$. As in Bresnahan and Reiss (1990), this additional assumption of homogenous variable shock introduces heteroscedasticity into the ordered probit, since the compound error conditional variance is given by $\sigma_\varsigma^2 = S^2\sigma_\varepsilon^2 + 1$.

Estimating this model, the following results are found for all previous specifications:

Table 6 Estimates of the Heteroscedastic Model's Parameters

		(1)		(2)		(3)	
	J	$\hat{\alpha}$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\gamma}$
Cutoffs	1	14.94*** (0.60)	-1.45*** (0.06)	15.06*** (0.65)	-2.05*** (0.09)	15.56*** (0.65)	-2.13*** (0.09)
	2	-1.28** (0.61)	-1.73*** (0.12)	-1.26** (0.59)	-1.91*** (0.15)	-1.30** (0.61)	-1.90*** (0.14)
	3	-1.82*** (0.50)	-1.14*** (0.14)	-1.81*** (0.51)	-1.22*** (0.16)	-2.07*** (0.52)	-1.12*** (0.16)
	4	-1.38*** (0.47)	-1.08*** (0.22)	-1.37*** (0.48)	-1.16*** (0.27)	-1.48*** (0.49)	-1.10*** (0.26)
	5	-	-2.40*** (0.19)	-	-2.63*** (0.20)	-	-2.56*** (0.19)
	6	-1.63*** (0.63)	-2.28*** (0.61)	-1.78*** (0.61)	-2.25*** (0.66)	-1.92*** (0.62)	-2.05*** (0.64)
	7	-	-3.13*** (0.38)	-	-3.43*** (0.41)	-	-3.29*** (0.39)
	>7	-1.14* (0.67)	-2.32** (1.16)	-1.41** (0.65)	-2.00 (1.23)	-1.35** (0.67)	-2.02* (1.22)
S	POPLDT ($\hat{\lambda}_1$)	-		1.81*** (0.60)		1.43*** (0.54)	
	POPWDT ($\hat{\lambda}_2$)	-		-0.22 (0.34)		-0.82*** (0.32)	
	POSG9600 ($\hat{\lambda}_3$)	-		2,378.75*** (260.93)		2,151.06*** (246.94)	
	NEGG9600 ($\hat{\lambda}_4$)	-		3,535.70*** (285.33)		3,019.70*** (271.33)	
W	ÁREA ($\hat{\eta}_1$)	-		-		-0.000012*** (0.000004)	
	POP. DENSITY ($\hat{\eta}_2$)	-		-		0.000524** (0.000227)	
	ST. CAP. DIST. ($\hat{\eta}_3$)	-		-		0.001145*** (0.000153)	
	CLOS. TOWND. ($\hat{\eta}_4$)	-		-		-0.011228*** (0.001247)	
$\hat{\sigma}^2_\varepsilon$		15.88*** (2.39)		14.96*** (2.14)		14.31*** (2.00)	
Log-Likelihood		-4,401.10		-4,293.13		-4,239.94	

Source: Central Bank of Brazil and Brazilian Institute of Statistics and Geography.
Maximum Likelihood estimates for all three models with variable profits shocks.
Asymptotic standard deviations in parenthesis.
* significant at 10% ** significant at 5% *** significant at 1%

Observe firstly that strong evidences of variable profits shocks were found. Besides, in contrast to the homoscedastic model, there is a reasonable difference in firms' cutoffs: we found before that there were no barriers to entry in markets with more than six banks, while here all of them are significant. Variable profits remain constant when there are five or seven banks. Also, decreasing cutoffs occur only up to four banks.

On the other hand, the variables' coefficients from specifications (2) and (3) presented no change in sign. Only the commuters variables showed some difference: those that migrated from outside to work increase in greater scale the market size, while those who migrated outside to work tend to affect in smaller scale. Finally, observe again that in contrast to the homoscedastic model, standard deviations are relatively larger in this case.

Table 7 Entry-Thresholds per firm (in R$ thousands) and ratios from the heteroscedastic model

Panel A: Entry-Thresholds per firm

N	(1)	(2)	(3)
1	969.82***	1,359.41***	1,294.17***
	(78.30)	(110.69)	(116.39)
2	1,164.11***	1,434.55***	1,386.96***
	(100.01)	(130.27)	(123.55)
3	1,214.85***	1,438.61***	1,387.65***
	(105.57)	(121.77)	(115.03)
4	1,289.42***	1,491.25***	1,430.98***
	(144.31)	(169.51)	(159.02)
5	1,490.55***	1,688.89***	1,624.87***
	(165.59)	(189.63)	(176.99)
6	1,901.51***	2,115.48***	2,052.00***
	(315.10)	(343.30)	(328.78)
7	2,135.32***	2,367.13***	2,286.08***
	(349.83)	(379.07)	(362.06)
>7	2,520.52***	2,802.50***	2,685.57***
	(529.56)	(577.11)	(558.05)

Panel B: Entry-Thresholds Ratios

Razões	(1)	(2)	(3)
s_2/s_1	1.20	1.06	1.07
	(0.10)	(0.09)	(0.09)
s_3/s_2	1.04	1.00	1.00
	(0.07)	(0.07)	(0.07)
s_4/s_3	1.06	1.04	1.03
	(0.09)	(0.09)	(0.09)
s_5/s_4	1.16	1.13	1.14
	(0.02)	(0.02)	(0.02)
s_6/s_5	1.28	1.25	1.26
	(0.16)	(0.15)	(0.16)
s_7/s_6	1.12	1.12	1.11
	(0.03)	(0.03)	(0.03)
$s_{>7}/s_7$	1.18	1.18	1.17
	(0.19)	(0.18)	(0.19)

Source: Central Bank of Brazil and Brazilian Institute of Statistics and Geography. Entry-Thresholds per firm and ratios estimates for all three specifications with variable profits shocks. Asymptotic standard deviations in parenthesis. Hypothesis testing done only in Panel A.

* significant at 10% ** significant at 5% *** significant at 1%

Note that changes here are more apparent in terms of magnitude for the entry-threshold for towns with more than seven banks. This has been attenuated by the existence of shocks to variable profits. Nonetheless, similar behavior to the homoscedastic model was seen as well as large standard deviations, as in the model's cutoffs. Besides, inspection of panel B shows that the relationship between entry-thresholds remains the same, despite the large standard deviations. Also, evidences of non-linearity in entry are still clear.

Table 8 Market Competition Variability Test for the Heteroscedastic Model

Panel A: Specification (1)

	$\to s_2$	$\to s_3$	$\to s_4$	$\to s_5$	$\to s_6$	$\to s_7$	$\to s_{>7}$
s_1	4.37**	6.05**	7.01*	32.64***	33.21***	38.02***	38.18***
s_2	-	0.36	1.24	32.31***	32.95***	37.99***	38.16***
s_3	-	-	0.49	32.26***	32.86***	37.99***	38.16***
s_4	-	-	-	32.20***	32.82***	37.42***	37.58***
s_5	-	-	-	-	2.88*	14.44***	15.35***
s_6	-	-	-	-	-	14.18***	15.02***
s_7	-	-	-	-	-	-	0.97

Panel B: Specification (2)

	$\to s_2$	$\to s_3$	$\to s_4$	$\to s_5$	$\to s_6$	$\to s_7$	$\to s_{>7}$
s_1	0.42	0.52	0.80	28.65***	29.44***	36.16***	36.42***
s_2	-	0.00	0.22	28.42***	29.19***	35.45***	35.69***
s_3	-	-	0.18	28.41***	29.16***	35.45***	35.69***
s_4	-	-	-	28.28***	29.06***	34.61***	34.85***
s_5	-	-	-	-	2.67	14.32***	15.20***
s_6	-	-	-	-	-	13.97***	14.75***
s_7	-	-	-	-	-	-	1.03

Panel C: Specification (3)

	$\to s_2$	$\to s_3$	$\to s_4$	$\to s_5$	$\to s_6$	$\to s_7$	$\to s_{>7}$
s_1	0.67	0.78	0.98	30.16***	31.09***	37.17***	37.43***
s_2	-	0.00	0.15	30.00***	30.91***	36.64***	36.88***
s_3	-	-	0.13	30.00***	30.89***	36.64***	36.88***
s_4	-	-	-	29.83***	30.76***	35.80***	36.05***
s_5	-	-	-	-	2.76*	13.58***	14.43***
s_6	-	-	-	-	-	13.13***	13.86***
s_7	-	-	-	-	-	-	0.88

Wald Statistics for the Market Competition Variability Tests for all specifications with shocks to variable profits.
* significant at 10% ** significant at 5% *** significant at 1%

As made apparent by the standard deviations' size, the Wald statistics lost their significance. Nevertheless, despite the fact that monopoly's entry-threshold per firm is not different than the ones from markets with up to four banks anymore, markets with five banks requires a significantly different market size per bank. In addition, $s_{>7}$ is no longer different than s_7.

Note also that despite this significance loss, there still is variability in market size per firm and non-linearity in the behavior of these thresholds.

6.1.3. Regional Results

It is important to analyze how competition varies in different regions of the country: some regions can present greater bank competitiveness, while others may be more cartelized. For this inquiry, a model for each region will be estimated under specification (3). Notice that there is a substantial decrease in the number of observations for each region, especially in the northern and center-westerner regions where the number of municipalities are reduced to a bit less than 400.

Table 9 Regional Parameter Estimates under specification (3)

	J	SOUTH $\hat{\alpha}$	SOUTH $\hat{\gamma}$	SOUTHEAST $\hat{\alpha}$	SOUTHEAST $\hat{\gamma}$	CENTER-WEST $\hat{\alpha}$	CENTER-WEST $\hat{\gamma}$	NORTHEAST $\hat{\alpha}$	NORTHEAST $\hat{\gamma}$	NORTH $\hat{\alpha}$	NORTH $\hat{\gamma}$
Cutoffs	**1**	18.46***	-1.55***	10.93***	-0.87***	10.64***	-0.46*	16.80***	-2.19***	10.54***	-2.74***
		(1.21)	(0.19)	(0.31)	(0.13)	(1.29)	(0.26)	(0.83)	(0.14)	(1.27)	(0.28)
	2	-2.91**	-1.31***	-	-2.27***	-3.38***	-0.85***	-7.06***	-0.73***	-5.51***	-
		(1.36)	(0.17)		(0.08)	(1.21)	(0.19)	(0.90)	(0.16)	(0.95)	
	3	-4.46***	-0.80***	-3.56***	-	-2.15***	-0.42**	-1.66**	-0.53**	-	-
		(0.92)	(0.21)	(0.21)		(0.67)	(0.19)	(0.66)	(0.21)		
	4	-4.16***	-	-1.78***	-	-1.27***	-0.39*	-1.21	-0.50	-	-
		(0.42)		(0.15)		(0.45)	(0.22)	(0.75)	(0.32)		
	5	-2.41***	-	-1.93***	-	-	-	-	-	-	-
		(0.25)		(0.14)							
	>5	-1.98***	-	-1.09***	-	-	-	-	-	-	-
		(0.19)		(0.12)							
S	**POPLDT ($\hat{\lambda}_1$)**	1.34*		-0.09		4.28***		4.52***		12.04***	
		(0.72)		(0.25)		(1.19)		(1.66)		(9.13)	
	POPWDT ($\hat{\lambda}_2$)	-0.90***		-0.90***		-3.17***		-4.33***		17.14***	
		(0.32)		(0.20)		(0.40)		(0.51)		(6.78)	
	POSG9600 ($\hat{\lambda}_3$)	-1,061.15***		1,442.85***		784.99		405.79		-1,486.59	
		(265.38)		(378.86)		(1,159.89)		(490.50)		(2,156.87)	
	NEGG9600 ($\hat{\lambda}_4$)	-331.93		2,731.07***		672.16		1,560.77***		742.85	
		(327.63)		(591.52)		(1,153.25)		(544.22)		(1,923.91)	
W	**AREA ($\hat{\eta}_1$)**	-0.000012		-0.000030**		-0.000056***		0.000011		0.000017**	
		(0.000069)		(0.000014)		(0.000017)		(0.000027)		(0.000007)	
	POP. DENSITY ($\hat{\eta}_2$)	-0.000027		0.000231		0.002515		-0.000218		-0.000079	
		(0.000470)		(0.000358)		(0.005547)		(0.000706)		(0.003187)	
	ST. CAP. DIST. ($\hat{\eta}_3$)	0.001350***		0.001489***		-0.000643		0.000355		0.00043	
		(0.000308)		(0.000230)		(0.000418)		(0.000280)		(0.000396)	
	CLOS. TOWND ($\hat{\eta}_4$)	-0.005740		-0.016257***		-0.014444***		-0.005374***		0.000894	
		(0.005774)		(0.004900)		(0.003492)		(0.001958)		(0.002345)	
Log-Likelihood		-827.93		-1.257.88		-388.13		-922.32		-147.69	
Observations		909		1352		398		1429		361	

Source: Central Bank of Brazil and Brazilian Institute of Statistics and Geography. Maximum likelihood estimates for the regional model under specification (3), with asymptotic standard deviations in parenthesis.

* significant at 10% ** significant at 5% *** significant at 1%

Note that, initially, the southern region has some differentiation in monopoly variable profits and insignificant barriers to entry when there are over four banks. For the southeastern region, barriers to entry disappear when there are at least three banks, but with relative variation in variable profits. The northeast region, on the other hand, presents profits differentiation up to three banks and the center-west up to four. Finally, it was only possible to compare municipalities with only one bank or those with more in the northern region. Note that total profits vary in the latter region.

Nonetheless, it is possible to compare the explanatory variables signal. It is possible to observe that workers who commute to town bring an impulse to the municipality’s total income in every region with the exception of the southeast, as in the model with regional homogeneity. The same happens to commuters from the municipality, with the exception of the northern region, where total income is increasing in this variable. With respect to population growth in the previous decade, the region most similar to the regional homogenous model is the southeast, while in the other regions these parameters are mostly insignificant.

Moreover, cost variables are mostly insignificant, with heterogeneity in the parameters signals. The northeastern and northern regions do not have the expected signal for town's area, since its increase would diminish fixed costs. Conversely, population density completely loses significance when estimating a different model for each region. Observe also that the unexpected signal in distance to state capital comes from the southeastern and southern regions and the fall in profits due to isolated markets comes from the northern and southern regions.

The second step here requires analyzing the entry-threshold per firm behavior for each region.

Table 10 Regional Entry-Thresholds per firm (in R$ thousands) and ratios

Panel A: Entry-Thresholds per firm

N	SOUTH	SOUTHEAST	CENTER-WEST	NORTHEAST	NORTH
1	670.46***	623.36***	1,087.49***	1,308.14***	2,255.77***
	(167.17)	(197.91)	(387.71)	(155.08)	(488.86)
2	830.15***	1,381.63***	1,468.19***	1,507.72***	2,258.13***
	(112.75)	(119.17)	(313.93)	(149.50)	(487.57)
3	1,007.82***	1,357.78***	1,665.42***	1,429.03***	-
	(129.01)	(119.45)	(291.35)	(195.26)	
4	1,219.71***	1,337.04***	1,774.87***	1,452.95***	-
	(150.76)	(126.42)	(322.34)	(247.33)	
5	1,518.08***	1,622.62***	-	-	-
	(176.42)	(161.95)			
>5	2,226.81***	1,952.97***	-	-	-
	(323.95)	(192.51)			

Panel B: Entry-Thresholds Ratios

	SOUTH	SOUTHEAST	CENTER-WEST	NORTHEAST	NORTH
s_2/s_1	1.24	2.22	1.35	1.15	1.00
	(0.25)	(0.54)	(0.37)	(0.14)	(0.08)
s_3/s_2	1.21	0.98	1.13	0.95	-
	(0.17)	(0.02)	(0.21)	(0.13)	
s_4/s_3	1.21	0.98	1.07	1.02	-
	(0.04)	(0.02)	(0.18)	(0.19)	
s_5/s_4	1.24	1.21	-	-	-
	(0.05)	(0.04)			
$s_{>5}/s_5$	1.47	1.20	-	-	-
	(0.10)	(0.04)			

Source: Central Bank of Brazil and Brazilian Institute of Statistics and Geography. Regional entry-thresholds per firm and ratios under specification (3). Asymptotic standard deviations in parenthesis. Hypothesis testing done only in Panel A.

* significant at 10% ** significant at 5% *** significant at 1%

Note that despite having an increasing entry-threshold per firm pattern for the southern, southeastern and center-westerner, standard deviations are relatively larger. Observe, however, that the northern and northeastern regions do not present such variability. Besides, inspection of panel B reveals that the mean ratios present the non-linearity mentioned above, especially in the southeastern region. The center-westerner region shows decreasing competition intensification and the northeastern a bit non-linear. Observe that for the latter regions, inference is a bit more complicated due to the high standard deviations.

Finally, note from the market competition variability tests presented below, there is greater variation in the southern region from four banks onward, while they are more homogenous in the southeast between two and five banks. For the remaining regions, there is no heterogeneity in the level of competition. In the center-west, it is worth pointing out the relatively low numbers of municipalities as the key issue for the standard deviation's high estimate.

Table 11 Regional Market Competition Variability Test

Panel A: Southern Region

	$\to s_2$	$\to s_3$	$\to s_4$	$\to s_5$	$\to s_6$
s_1	1.40	4.60	28.10***	63.10***	64.63***
s_2	-	2.00	22.71***	54.99***	56.95***
s_3	-	-	21.24***	54.99***	56.66***
s_4	-	-	-	27.33***	35.69***
s_5	-	-	-	-	15.01***

Panel B: Southeastern Region

	$\to s_2$	$\to s_3$	$\to s_4$	$\to s_5$	$\to s_6$
s_1	47.80***	50.36***	50.37***	92.25***	161.65***
s_2	-	0.61	1.43	24.64***	55.21***
s_3	-	-	0.43	24.09***	54.86***
s_4	-	-	-	23.90***	54.48***
s_5	-	-	-	-	24.14***

Panel C: Center-Westerner Region

	$\to s_2$	$\to s_3$	$\to s_4$
s_1	1.56	2.74	3.58
s_2	-	0.50	0.94
s_3	-	-	0.14

Panel D: Northeastern Region

	$\to s_2$	$\to s_3$	$\to s_4$
s_1	1.32	1.32	1.34
s_2	-	0.16	0.16
s_3	-	-	0.01

Panel E: Northern Region

	$\to s_2$
s_1	0,00

Wald statistics from the regional model's, under specification (3), market competition variability test.
* significant at 10% ** significant at 5% *** significant at 1%

Notice, however, even though there is not enough competition in some of the regions, 67% of the sample's credit stock is focused on the southern and southeastern region. Therefore, the lack of competition in some areas ends up being mitigated by the amount of credit there.

6.1.4.
Private Banks Competition

An additional feature that should be investigated is the source of competition. Is the competition arising from solely private banks competition or do public banks have a role in this competition. Coelho (2007) employ the Bresnahan and Reiss model to analyze whether public banks are competitive and find evidence that this is indeed true. In this section a similar exercise is going to be made; however, tests on equality of private banks per firm entry-thresholds are going to be performed. This particular exercise lets us model only the private banks sector, taking public banks entry as given. The same assumption is made in Coelho (2007), in which a more detailed explanation on the matter of exogenous public bank entry can be found. Moreover, some alterations on the profit function will be incorporated. Firstly, denote the private banks profit function in market j with N_{priv} private banks and N_{pub}public banks as $\overline{\Pi}^{N_{pri}}_{N_{pri},N_{pub},j}(S_j, \boldsymbol{Q}_j, \boldsymbol{W}_j)$. All other variables remain the same. The profit function is given by equation (6') below.

$$\overline{\Pi}^{N_{priv}}_{N_{priv},N_{pub},j}\left(S_j, \boldsymbol{Q}_j, \boldsymbol{W}_j\right) = S_j \cdot L_{N_{priv},N_{pub},j}\left(\boldsymbol{Q}_j\right) - F_{N_{priv},N_{pub},j}(\boldsymbol{W}_j) \qquad (6')$$

In addition, greater changes will be made to the variable profit and fixed cost functions. The cutoffs now will be distinguished for private and public banks.

$$L_{N_{priv},N_{pub},j}\left(D_{priv}, D_{pub}, \boldsymbol{Q}\right) =$$

$$\alpha_1^{priv} + \sum_{n=2}^{N_{priv}} D_{priv,n} \cdot \alpha_n^{priv} + \sum_{m=1}^{N_{pub}} D_{pub,m} \cdot \alpha_m^{pub} + \beta \cdot \boldsymbol{Q}, \qquad (7'')$$

and

$$F_N = \sum_{n=1}^{N} \widetilde{D}_{n,priv} \cdot \gamma_n^{priv} + \sum_{n=1}^{N} \widetilde{D}_{n,pub} \cdot \gamma_n^{pub} + \eta \cdot \boldsymbol{W} \qquad (8)$$

One observation, however, must be made here. When discriminating the number of banks between private and public banks, there is a considerable reduction on the number of observations. Instead of estimating a model for seven banks and more, as done previously, it must be considered here only markets with one or more private banks, along with up to two or more public banks. On this note, the estimated model yields the following results.

Table 12 Private Bank Model estimates for all three specifications

		(1)		(2)		(3)	
	J	$\hat{\alpha}$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\gamma}$
	Private Banks						
Cutoffs	**1**	5.64*** (0.24)	-1.15*** (0.04)	5.79*** (0.29)	-1.68*** (0.07)	6.00*** (0.30)	-1.90*** (0.08)
	>1	-	-1.24*** (0.04)	-	-1.30*** (0.04)	-	-1.33*** (0.04)
	Public Banks						
	1	-0.62** (0.26)	-0.40*** (0.07)	-1.10*** (0.29)	-0.30*** (0.09)	-1.10*** (0.30)	-0.34*** (0.09)
	2	-	-	-	-	-	-
	>2	-1.43*** (0.11)	-	-1.07*** (0.11)	-	-1.14*** (0.12)	-
S	**POPLDT ($\hat{\lambda}_1$)**	-		0.90 (0.60)		0.81 (0.58)	
	POPWDT ($\hat{\lambda}_2$)	-		-1.84*** (0.19)		-1.92*** (0.19)	
	POSG9600 ($\hat{\lambda}_3$)	-		6,223.11*** (365.04)		5,914.88*** (354.67)	
	NEGG9600 ($\hat{\lambda}_4$)	-		6,899.26*** (399.91)		6,118.86*** (405.71)	
W	**AREA ($\hat{\eta}_1$)**	-		-		-0.000004 (0.000003)	
	POP. DENSITY ($\hat{\eta}_2$)	-		-		0.000411* (0.000221)	
	ST. CAP. DIST ($\hat{\eta}_3$)	-		-		0.001116*** (0.000137)	
	CLOS. TOWND. ($\hat{\eta}_4$)	-		-		-0.004996*** (0.000911)	
Log-Likelihood		-2,837.63		-2,722.60		-2,681.90	

Source: Central Bank of Brazil and Brazilian Institute of Statistics and Geography. Estimates from all three different specifications, with asymptotic standard deviations in parenthesis.

* significant at 10% ** significant at 5% *** significant at 1%

Observe the following features of this model. Firstly, it is still possible to see a decreasing pattern on fixed costs parameters for private banks. However, regarding private banks profits, this pattern is not observable on the public banks parameters' estimates. Also, the presence of the first public bank decreases private banks profits (variable profit and fixed costs). The second public bank has no effect, but markets with more than two public banks do decrease private banks variable profits. Lastly, the signs for all independent variables present no change from the previous estimates. To verify the competitiveness of the private banking industry, the usual per firm entry threshold will be performed.

Table 13 Private Banks Entry Threshold per firm (in R$ thousands) and Competition Variability Test

Panel A: Entry Thresholds

Private Banks		Public Banks: 0	1	2	>2
Specification (1)					
	1	2,037.73***	3,094.70***	3,094.70***	4,323.20***
		(146.64)	(184.76)	(184.76)	(276.00)
	>1	2,121.33***	2,785.72***	2,785.72***	3,891.56***
		(131.78)	(119.49)	(119.49)	(186.48)
Specification (2)					
	1	2,904.23***	4,216.16***	4,216.16***	5,458.57***
		(247.68)	(303.63)	(303.63)	(407.58)
	>1	2,573.86***	3,491.97***	3,491.97***	4,520.98***
		(190.91)	(185.89)	(185.89)	(249.76)
Specification (3)					
	1	2,750.15***	4,116.48***	4,147.80***	5,490.31***
		(261.13)	(335.34)	(886.37)	(448.28)
	>1	2,454.53***	3,364.97***	3,349.88***	4,478.25***
		(190.07)	(199.74)	(382.90)	(267.84)

Panel B: Per firm Entry Thresholds ratio

Ratios	Public Banks: 0	1	2	>2
Specification (1)				
S_2/S_1	1.04*	0.90***	0.90***	0.90***
	(0.02)	(0.03)	(0.03)	(0.03)
Specification (2)				
S_2/S_1	0.89***	0.83***	0.83***	0.82***
	(0.02)	(0.02)	(0.02)	(0.02)
Specification (3)				
S_2/S_1	0.89***	0.82***	0.81***	0.82***
	(0.03)	(0.03)	(0.08)	(0.03)

Source: Central Bank of Brazil and Brazilian Institute of Statistics and Geography. Estimates from all three different specifications, with asymptotic standard deviations in parenthesis. Significance tests performed on Panel A and Competition Variability Test performed on Panel B.

* significant at 10% ** significant at 5% *** significant at 1%

Note that, on Panel A, in all specifications the per firm entry threshold seems to decrease as private banks enter, given the number of public banks. Also, given the number of private banks, this per firm entry-threshold seems to be increasing. This scenario can portray anti-competitiveness in the private banks' behavior and a competitive one for public banks. However, it must be noted that a broader investigation can be made on this matter and taking public bank entry as endogenous is a crucial matter.

On Panel B, it is possible to see that indeed that per firm entry threshold is different across specifications, although Panel A suggests they are decreasing rather than increasing. It is also suggested that the increasing behavior is due to public banks presence, ensuring that there is competitiveness on the banking sector.

6.2. Growth Regression

As previously shown, the number of banks in a given town can be a good indicator of market competition variability, being, therefore, an adequate instrument for the stock of credit in the municipality. Note also that a non-linear behavior was seen in this variation. This subsection will present the results for the growth regression aimed in this text. But firstly let us look at the equation being estimated. Recall equations (1) and (2) shown above and let us rewrite them in logs.

$$\log(Income\ per\ Capita_i) = \mu_1 \cdot \log(Credit_i) + \mu_2 \cdot X_i + \varepsilon_i \qquad (1')$$

$$\log(Credit_i) = \varphi_1 \cdot \log(Income\ per\ Capita_i) + f(N_i) + \varphi_2 \cdot Y_i + \nu_i \qquad (2')$$

The objective equation from this article is $(1')$, the one that posits the direct relationship between credit and income per capita. These results will be given as the 2nd stage regression, since in the first stage the simultaneity will be eliminated by the instruments, the number of banks and the competition non-linearity given by $f(N_i)$. Different methods will be employed for the estimation of equation $(2')$ and will be explained later on. These results, naturally, will be given in the 1st stage estimation.

Many regressions will be presented, each including control variables. The first set of controls encompass a vector with two education variables: the first indicates the percentage of the population with less than four years of education (Less4) and the second, eight years (Less8); plus a vector with the Gini coefficient, in order to capture the municipalities' income distribution, and its population. The second set includes geographical controls: a vector of latitude and longitude, distance to the state's capital and distance to Sao Paulo.

Moreover, in order to compare the bias induced by the credit stock endogeneity, OLS and 2SLS results will be presented in the odd and even columns, respectively.

6.2.1.
1st Stage Results

As mentioned previously, there is a non-linear behavior in the number of banks that must be acknowledged when estimating the parameters. Thus, two different manners of estimating will be presented: a linear parametric one, using the number of banks up to quadratic form, and a non-parametric, smoothing the residuals from the regression of $\log(Credit)$ on the covariates on the number of banks, using a Loess/RLoess[17] procedure. Below are presented the parametric first stage regression, with and without the instrument.

Table 14 Parametric and Non-Parametric 1st Stage Estimates

	Total Credit (in log)					
	Parametric			Non-Parametric		
	(2)	(4)	(6)	(2)	(4)	(6)
Constant	-24.82***	-24.89***	-55.17***	-7.34***	-1.94	-57.19***
	(0.53)	(4.41)	(5.57)	(0.36)	(5.49)	(6.91)
N	16.45***	14.74***	13.56***	-	-	-
	(0.81)	(0.91)	(0.93)			
N^2	-1.08***	-1.03***	-0.97***	-	-	-
	(0.11)	(0.11)	(0.11)			
Less4	-	-0.07***	-0.01	-	-0.15***	-0.03
		(0.02)	(0.02)		(0.02)	(0.02)
Less8	-	-0.15***	-0.04	-	-0.99***	-0.65***
		(0.05)	(0.05)		(0.05)	(0.05)
Gini	-	-4.97	8.16*	-	-3.55	20.03***
		(4.14)	(4.31)		(5.30)	(5.24)
Population (in log)	-	2.23***	3.97***	-	9.12***	10.79***
		(0.37)	(0.41)		(0.34)	(0.35)
Latitude	-	-	-0.11	-	-	-0.29***
			(0.07)			(0.08)
Longitude	-	-	0.005	-	-	-0.09*
			(0.04)			(0.05)
State's Capital Distance	-	-	0.002	-	-	0.006***
			(0.002)			(0.002)
São Paulo SP Dist.	-	-	-0.005***	-	-	-0.007***
			(0.001)			(0.001)
Adjusted R^2	0.5930	0.5983	0.6131	0.0000	0.3935	0.4450

Source: Central Bank of Brazil, Brazilian Institute of Statistics and Geography, Institute for Applied Economics Research and Atlas of Human Development in Brazil. 1st stage OLS estimates, with robust standard-errors in parenthesis. 4,920 observations.

* significant at 10% ** significant at 5% *** significant at 1%

A closer inspection of table 12 shows that the parametric 1st stage corroborates empirically the existence of a non-linearity of the amount of credit in the number of banks. It is possible to see that the number of banks is very significant in this regression with low standard deviation, besides the fact that the increase in the amount of credit is decreasing in the number of banks.

These facts have a very interesting interpretation. The first suggests we have a good instrument for the amount of credit. The second clearly indicates how competitive banks are in the credit market. As the number of banks increase to 7 or 8, credit stock will be increasing. Afterwards, it is decreasing in the number of banks. This means that while financial institutions enter smaller markets,

[17] This procedure employs local weighted least square regressions using a 2nd order polynomial. The RLoess procedure gives less weight to outliers.

competition intensifies and the equilibrium credit stock increases. Besides, panel B from table 4 corroborates this relationship, since a 90% confidence interval rationalizes this competition's negative acceleration: up to seven banks competition intensifies and the amount of credit grows more rapidly as more banks enter a given market[18].

Note also that this result can be related to the literature on banking: for markets with only a few banks, competition is beneficial for credit dissemination and, in markets with many banks, competition act in detriment of financial deepening. The first fact is related to the conclusions in Cetorelli and Gambera (2001), Guzman (2000) and Claessens and Laeven (2005), while the second is closer to Petersen and Rajan (1995). Note that in some cases we have to assume credit is positively associated to economic growth, which is not an unreasonable assumption in this case, as it will be soon shown.

Finally a criticism to the presentation of the result can arise, since the possible correlation between the instrument and the explanatory variables may cause the illusion that the gain of including the number of banks is very high. Nonetheless, the non-parametric 1st stage regression requires that a regression of credit on controls be done. In this case, comparison of this stage's adjusted fit shows a minimum gain of 16% when including the instrument.

Note also that these results are robust to inclusion of different control sets.

6.2.2.
2nd Stage Results

Table 13 below shows the results for the 2nd stage, with both the parametric and non-parametric first stage[19]. Note that the income per capita-credit elasticity is positive in all cases, which indicates that increases in the volume of credit bring positive economic growth. Observe that even though this elasticity is very small, when considering point distributional changes, the increase can be much greater. Suppose, for example, that there is an increase in the log of credit of one standard deviation. In this case, income per capita would have a 31.91-

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[18] Observe that, as the estimated Bresnahan and Reiss's (1991) model merged markets with more than seven banks, nothing can be inferred for these markets based on this model.

[19] Lowess and RLowess smoothing were implemented. In this case local weighted regressions are made with a 1st order polynomial. Results remain the same.

47.91% growth in the parametric case and a 6.69-33.44% increase in the non-parametric case. If a change from the town in the 25th percentile is made to the 75th, an increase of 64.86-97.39% in income per capita would be observed in the

Table 15 Growth Regression Estimates

	(1)		(2)		(3)		(4)		(5)		(6)	
Method	OLS	Parametric 2SLS	Loess 2SLS	Rloess 2SLS	OLS	Parametric 2SLS	Loess 2SLS	Rloess 2SLS	OLS	Parametric 2SLS	Loess 2SLS	Rloess 2SLS
Constant	5,01***	5,06***	4,92***	4,90***	11,23***	11,25***	11,19***	11,18***	9,29***	9,67***	9,05***	9,03***
	(0,01)	(0,01)	(0,01)	(0,01)	(0,17)	(0,17)	(0,18)	(0,18)	(0,25)	(0,26)	(0,25)	(0,25)
Total Credit (in log)	0,0129***	0,0189***	0,0143***	0,0132***	0,0075***	0,0143***	0,0053***	0,0043***	0,0060***	0,0126***	0,0035***	0,0026***
	(0,0004)	(0,0005)	(0,0004)	(0,0003)	(0,0004)	(0,001)	(0,0004)	(0,0004)	(0,0005)	(0,001)	(0,0005)	(0,0004)
Less4	-	-	-	-	-0,01***	-0,004***	-0,006***	-0,006***	-0,002***	-0,002***	-0,002***	-0,002***
					(0,001)	(0,001)	(0,001)	(0,001)	(0,001)	(0,001)	(0,001)	(0,001)
Less8	-	-	-	-	-0,05***	-0,04***	-0,05***	-0,06***	-0,04***	-0,04***	-0,05***	-0,05***
					(0,001)	(0,001)	(0,001)	(0,002)	(0,002)	(0,001)	(0,002)	(0,002)
Gini	-	-	-	-	0,38***	0,41***	0,39***	0,40***	0,84***	0,71***	0,93***	0,94***
					(0,15)	(0,15)	(0,15)	(0,15)	(0,13)	(0,13)	(0,14)	(0,14)
Population (in log)	-	-	-	-	-0,25***	-0,31***	-0,19***	-0,18***	-0,19***	-0,26***	-0,14***	-0,13***
					(0,01)	(0,02)	(0,01)	(0,01)	(0,02)	(0,02)	(0,02)	(0,01)
Latitude	-	-	-	-	-	-	-	-	-0,01***	-0,01***	-0,02***	-0,02***
									(0,002)	(0,002)	(0,002)	(0,002)
Longitude	-	-	-	-	-	-	-	-	0,01***	0,01***	0,01***	0,01***
									(0,001)	(0,001)	(0,002)	(0,002)
State's Capital Distance	-	-	-	-	-	-	-	-	-0,0002**	-0,0001***	-0,0001*	-0,0001*
									(0,00004)	(0,00005)	(0,00005)	(0,00005)
São Paulo SP Dist.	-	-	-	-	-	-	-	-	-0,00005**	-0,00001	-	-
									(0,00002)	(0,00002)	(0,00002)	(0,00002)
Adjusted R²	0.2130	0.1661	0.2104	0.2119	0.6116	0.5759	0.5992	0.5975	0.6414	0.6106	0.6327	0.6307

Source: Central Bank of Brazil, Brazilian Institute of Statistics and Geography, Institute for Applied Economics Research and Atlas of Human Development in Brazil. OLS and 2SLS growth regression estimates, with robust standard deviations in parenthesis for the OLS and Parametric 2SLS's estimator. For the Non-Parametric 2SLS estimators, standard deviations were bootstrapped. 4,920 observations.

* significant at 10% ** significant at 5% *** significant at 1%

parametric case and 13.60-67.98% in the non-parametric[20].

On the other hand, consider the bias in the OLS estimator. While the parametric 1st stage regression brings a downward bias, in which the effect of credit in income is underestimated, the non-parametric 1st stage exhibits the opposite result when controlled. Thus, it can be seen that the identification strategy was successful, since the reduced form should incorporate the fact that economic growth is associated to a larger amount of credit, which means the OLS coefficient should be higher than 2SLS's.

Finally, note that most variables present the expected signal, except for the Gini coefficient, which suggests towns with greater income inequality are associated with greater income per capita. This, however, must be reflecting a reality of poorer municipalities, in which everyone can be in a precarious situation so that income inequality is very small.

Besides, increase in years of education are associated with higher income per capita, meaning that human capital is a key variable for economic development. Also, the southern and westerner the municipality, its income per capita will be greater in average. Municipalities further from their state's capital have significantly lower income per capita in the non-parametric case as well as those further from Sao Paulo. Lastly income per capita-population elasticity suggests increases in total income are associated to the greater number of residents, except that it is lower than population expansion, reducing, therefore, income per capita.

6.2.3.
Robustness: Conditional Convergence

Generally, growth regressions in a time series context include the endogenous variable lagged in order to verify if there is per capita income convergence. This means that developing countries, i.e. those with lower per capita income, would grow at faster rates than developed countries, given their

[20] In this specification, municipalities with zero credit were included, adding a small value in credit in order to take the natural logarithm. When excluding these observations, the one standard deviation changes to 38.90-69.99% in the parametric case and 26.79-36.90% in the non-parametric. A move from the 25th to the 75th percentile is equivalent to an increase of 58.07-104.49% in the parametric case and 40.00-55.08% in the non-parametric. It must be noted that credit coefficients and standard deviations are larger in this case.

characteristics. In a cross-section analysis, the inclusion of this variable can also be made in a certain way. In order to infer the effects of financial deepening on economic growth, per capita earnings in 1991 can be included in order to capture not only a convergence relationship but also any other pre-existing condition in the municipalities analyzed. Conditional convergence can be found if the estimated parameter is between zero and one, since the dependent variable is not expressed in growth terms.

Table 16 Growth Regression Estimates with convergence control

Method	OLS	Rloess 2SLS	OLS	Rloess 2SLS	OLS	Rloess 2SLS
Constant	1.30*** (0.07)	1.13*** (0.06)	6.45*** (0.29)	5.87*** (0.28)	6.28*** (0.29)	5.70*** (0.27)
Total Credit (in log)	0.0033*** (0.0004)	0.0027*** (0.0005)	0.0056*** (0.0004)	0.0023*** (0.0004)	0.0050*** (0.0005)	0.0014*** (0.0005)
p. Cap. Earnings - 1991 (in log)	0.84*** (0.02)	0.88*** (0.02)	0.53*** (0.02)	0.60*** (0.02)	0.52*** (0.03)	0.56*** (0.03)
Demographic Controls	NO		YES		YES	
Geographic Controls	NO		NO		YES	
Adjusted R²	0.5890	0.5883	0.6796	0.6701	0.6847	0.6753

Source: Central Bank of Brazil, Brazilian Institute of Statistics and Geography, Institute for Applied Economics Research and Atlas of Human Development in Brazil. OLS regression ran with robust standard deviation, while the non-parametric 2SLS standard deviations were bootstrapped (5,000 replications). 4,001 observations.

* significant at 10% ** significant at 5% *** significant at 1%

Observe initially that the control inclusion did not alter the result that the OLS parameter is greater than 2SLS's in the non-linear first stage case. Besides, note that there was a significant attenuation of the coefficient[21]. Now an increase of one standard deviation in the log of credit will increase per capita income between 3.38% and 6.40% and a move from the municipality in the 25th percentile to the 75th means an increase of 7.34-13.90%.

Note also that the coefficient of per capita earnings in 1991 is between zero and one. If the dependent variable were in growth terms, this coefficient would be negative, meaning that municipalities with greater earnings per capita in 1991 would have lower income per capita growth. Thus, there are evidences for

[21] The first stage results did not present any significant change.

conditional convergence in Brazilian municipalities and this inclusion attenuated the credit-per capita income elasticity[22].

6.2.4. Transmission Mechanism

The analysis done here so far can raise the question of which sectors are affected more by financial deepening. Do increases in the equilibrium credit affect more industrial or agropecuary production? This section will provide some insights of how loans affect the value added in GDP of three different sectors in the economy: industrial, agropecuary and services. In addition, those values were summed in order to make a comparison of each sector across the aggregate. Finally, it must be observed that the first stage regression is omitted, since it is the same from initial analysis.

Table 17 Financial Deepening Impact on different industries

	GDP - added value - agregate - per capita (in log)		GDP - added value - industrial - per capita (in log)		GDP - added value - agropecuary - per capita (in log)		GDP - added value - services- per capita (in log)	
Method	OLS	Rloess 2SLS	OLS	Rloess 2SLS	OLS	Rloess 2SLS	OLS	Rloess 2SLS
Constant	6.15***	5.91***	6.23***	5.94***	-0.23	-0.46	5.71***	5.45***
	(0.27)	(0.27)	(0.40)	(0.39)	(0.33)	(0.34)	(0.25)	(0.24)
Total Credit (in log)	0.0049***	0.0012***	0.0062***	0.0022***	0.0071***	0.0061***	0.0052***	0.0011***
	(0.0005)	(0.0005)	(0.0007)	(0.0008)	(0.0007)	(0.0008)	(0.0004)	(0.0004)
Demographic Controls	YES		YES		YES		YES	
Geographic Controls	YES		YES		YES		YES	
Adjusted R^2	0.5728	0.5649	0.5390	0.5347	0.4980	0.4927	0.5919	0.5778

Source: Central Bank of Brazil, Brazilian Institute of Statistics and Geography, Institute for Applied Economics Research and Atlas of Human Development in Brazil. OLS regression ran with robust standard deviation, while the non-parametric 2SLS standard deviations were bootstrapped (5,000 replications). 4,920 observations.

* significant at 10% ** significant at 5% *** significant at 1%

Note the upward bias persists in the OLS regression in all cases. Moreover, the impact of credit is larger in the agropecuary sector. An increase of one standard deviation amounts to a 15.35% increase in this sector's added value. The services sector presents an increase approximately 82% smaller and the industrial,

[22] Results were robust to exclusion of municipalities with no stock of credit. An increase of one standard deviation in the log of credit would bring an increase of 14.06-18.64% in per capita income with a non-parametric first stage. A move from the 25th percentile to the 75th would cause an increase of 20.81-27.59%.

64%. Observe also that the impact on the aggregate is closer to the service sector[23].

Finally, since the stock of credit presents correlation with these variables, as shown above, it is necessary to entertain the idea that there is an omitted variable bias in the previous regressions. Therefore, these will be included as covariates in the growth regression and the results are presented below.

Table 18 Growth Regression with industry controls

Method	OLS	Rloess 2SLS	OLS	Rloess 2SLS	OLS	Rloess 2SLS
Constant	3.25*** (0.11)	2.67*** (0.10)	5.80*** (0.12)	5.61*** (0.12)	5.16*** (0.14)	5.01*** (0.14)
Total Credit (in log)	0.0047*** (0.0004)	0.0029*** (0.0005)	0.0025*** (0.0002)	0.0021*** (0.0002)	0.0019*** (0.0002)	0.0015*** (0.0002)
p. Cap. Industry GDP (in log)	0.22*** (0.01)	0.24*** (0.01)	0.03*** (0.01)	0.03*** (0.007)	0.01 (0.01)	0.01 (0.007)
p. Cap. Service GDP (in log)	-0.16*** (0.02)	-0.11*** (0.02)	0.67*** (0.02)	0.70*** (0.02)	0.71*** (0.02)	0.73*** (0.02)
p. Cap. Agropec. GDP (in log)	0.16*** (0.01)	0.16*** (0.01)	0.08*** (0.01)	0.08*** (0.006)	0.05*** (0.006)	0.05*** (0.006)
Demographic Controls	NO		YES		YES	
Geographic Controls	NO		NO		YES	
R^2 ajustado	0.3790	0.3737	0.8512	0.8493	0.8583	0.8573

Source: Central Bank of Brazil, Brazilian Institute of Statistics and Geography, Institute for Applied Economics Research and Atlas of Human Development in Brazil. OLS regression ran with robust standard deviation, while the non-parametric 2SLS standard deviations were bootstrapped (5,000 replications). 4,920 observations.

* significant at 10% ** significant at 5% *** significant at 1%

Observe that again the inclusion of these new variables attenuated the credit coefficient. Here an increase of one standard deviation in the log of credit will amount to an increase of 3.80-11.91%, while a move from the 25th percentile to the 75th will be equivalent to a 7.73-24.21% increase. Besides, note per capita is affected more by changes in services production, while the same change in industrial production tends to be insignificant[24].

[23] The bias tends to turn downward as municipalities with no credit are excluded for the agropecuary and industry sectors. The agropecuary sector still presents the largest impact (58.75% in a one standard deviation increase). The industrial sector impact is approximately 22% smaller and services, 51%.

[24] The first stage regression is again unchanged with the inclusion of these covariates. Credit coefficients tend to be positive but insignificant when including demographic. Changes of one standard deviation in the log of credit, excluding municipalities with no credit, represent an increase of 3.63-10.04% on average, while a move from the 25th to the 75th percentile increases income per capita in 5.42-14.98%.

6.2.5. Alternative Competition Non-Linearity Specification

Another question that can be raised is whether the results are induced by the non-parametric regression performed above: the first stage regression is a non-parametric fit of the residuals on the number of bank. These residuals are obtained from a preliminary regression of credit stock on all controls except the number of banks. An alternative specification for the first stage regression can be implemented in this case. Instead of trying to non-parametrically fit the data, it is possible to include several dummy variables for the number of banks so that these parameters reflect the nature of the data, without imposing a lot of structure in the regression.

This specification requires only a few adjustments. Take the following first stage equation:

$$\log(Credit_i) = \beta_0 + \beta_1 \cdot 1\{N_i = 1\} + \beta_2 \cdot 1\{N_i = 2\} + \beta_3 \cdot 1\{N_i = 3\} + \beta_4 \cdot 1\{N_i = 4\} + \beta_5 \cdot 1\{N_i = 5\} + \beta_6 \cdot 1\{N_i = 6\} + \beta_7 \cdot 1\{N_i = 7\} + \beta_8 \cdot 1\{N_i > 7\} + \gamma \cdot X_i + \epsilon_i, \quad (11)$$

where X are the regression controls, $1\{\cdot\}$ is an indicator function that takes the value one when the given number of banks is found in the data and $\{\epsilon_i\}_{i=1}^{N}$ is a sequence of i.i.d shocks. However, it is much more appealing to interpret the parameters as a how competition affects credit. In other words, does the inclusion of another bank affect more or less than the inclusion of the previous one? In order to interpret them in that way, define:

$$\theta_{ab} = \beta_a - \beta_b, \quad (12)$$

where θ_{ab} is the marginal effect on the credit unconditional mean when a bank enters a market that had b banks and now has a banks. Reorganizing the equation, we have:

$$\log(Credit_i) = \beta_0 + \beta_1 \cdot \left(\sum_{j=1}^{7} 1\{N_i = j\} + 1\{N_i > 7\}\right) +$$

$$\theta_{21}\left(\sum_{j=2}^{7} 1\{N_i = j\} + 1\{N_i > 7\}\right) + \theta_{32}\left(\sum_{j=3}^{7} 1\{N_i = j\} + 1\{N_i > 7\}\right) +$$

$$\theta_{43}\left(\sum_{j=4}^{7} 1\{N_i = i\} + 1\{N_i > 7\}\right) + \theta_{54}\left(\sum_{j=5}^{7} 1\{N = j\} + 1\{N_i > 7\}\right) +$$

$$\theta_{65}\left(\sum_{j=6}^{7} 1\{N_i = i\} + 1\{N_i > 7\}\right) + \theta_{76}(1\{N_i = 7\} + 1\{N_i > 7\}) +$$

$$\theta_{87} \cdot 1\{N_i > 7\} + \gamma \cdot X_i + \epsilon_i, \qquad (13)$$

This setup allows us not only to make an intuitive interpretation of the first stage results, but also permits us to incorporate the competition non-linearity differently. In addition, two minor controls were substituted in this specification: instead of using the latitude and longitude of each individual municipality, state dummies were included. These controls allow us to accommodate any shock intrinsic to a state, such as a specific regulation or a natural shock (floods, for example).

Table 19 below shows this section's results. Parametric results are included for comparison purposes. While the results for the parametric 1st stage remain the same, the inclusion of dummy variables paints a relatively similar picture: the unconditional credit mean varies as the first three banks enter and this effect is decreasing. When the 4th bank enters, the picture is a bit different across specifications: the inclusion of controls tends to nullify the statistical significance of the parameters up to the 7th bank. Only when there are more than seven banks the unconditional mean is statistically significant. In addition, this variation is indeed non-linear. Also, note that these results do relate to the literature of increasing credit as competition varies; however, it presents a weak relationship to the Bresnahan and Reiss's model main estimates: it varies considerably with the inclusion of the first bank and second banks (where competition does vary), but also when the competition should not (third bank). Also, when competition varies with the inclusion of the fifth bank onward, the model only predicts that credit varies only when there are more than seven banks. If the competition varies as it should, this variation should happen more often. However, what the dummy model is predicting can be interpreted a bit differently: credit might be increasing

Table 19 1st stage results with dummies for the number of banks

	Total Credit (in log)					
	Parametric			Dummies		
	(2)	(4)	(6)	(2)	(4)	(6)
Constant	-24.82***	-24.89***	-22.14***	-35.99***	-45.37***	-40.09***
	(0.53)	(4.41)	(6.02)	(0.04)	(2.52)	(2.64)
N	16.45***	14.74***	13.79***	-	-	-
	(0.81)	(0.91)	(0.91)			
N^2	-1.08***	-1.03***	-0.96***	-	-	-
	(0.11)	(0.11)	(0.11)			
$\hat{\theta}_{10}$	-	-	-	44.30***	44.03***	44.31***
				(0.41)	(0.42)	(0.41)
$\hat{\theta}_{21}$	-	-	-	6.82***	6.37***	6.30***
				(0.42)	(0.43)	(0.42)
$\hat{\theta}_{32}$	-	-	-	0.65***	0.40*	0.62**
				(0.21)	(0.24)	(0.28)
$\hat{\theta}_{43}$	-	-	-	0.46	0.37	0.53
				(0.30)	(0.30)	(0.36)
$\hat{\theta}_{54}$	-	-	-	0.77***	0.40	0.41
				(0.24)	(0.28)	(0.37)
$\hat{\theta}_{65}$	-	-	-	0.21**	-0.04	0.50
				(0.08)	(0.12)	(0.37)
$\hat{\theta}_{76}$	-	-	-	0.26***	0.33**	0.26
				(0.09)	(0.14)	(0.46)
$\hat{\theta}_{>7,7}$	-	-	-	0.95***	0.42*	1.01**
				(0.09)	(0.22)	(0.46)
Less4	-	-0.07***	-0.02	-	-0.02**	-0.005
		(0.02)	(0.02)		(0.01)	(0.01)
Less8	-	-0.15***	-0.12**	-	0.01	-0.04**
		(0.05)	(0.05)		(0.02)	(0.02)
Gini	-	-4.97	3.13	-	4.98**	2.25
		(4.14)	(4.50)		(2.00)	(2.17)
Population (in log)	-	2.23***	3.00***	-	0.75***	0.50**
		(0.37)	(0.43)		(0.18)	(0.21)
State's Capital	-	-	0.001	-	-	-0.0006
			(0.002)			(0.0007)
São Paulo SP Dist.	-	-	-0.003**	-	-	-0.00004
			(0.001)			(0.0006)
State Dummies	NO	NO	YES	NO	NO	YES

Source: Central Bank of Brazil, Brazilian Institute of Statistics and Geography, Institute for Applied Economics Research and Atlas of Human Development in Brazil. 1st stage regression estimates, with robust standard deviations in parenthesis. 4,920 observations.

* significant at 10%   ** significant at 5%   *** significant at 1%

in very narrow steps and this variation is only captured when there are many banks in the market, justifying the relative large increase in the unconditional mean when the eighth, ninth, etc… bank in the market enters. Under this light, the dummy results are more tightly related more with the Bresnahan and Reiss's model results.

Table 20 2nd Stage Results with dummies for the number of banks

	(1)	(2)		(3)	(4)		(5)	(6)	
Method	OLS	Parametric 2SLS	Dummies 2SLS	OLS	Parametric 2SLS	Dummies 2SLS	OLS	Parametric 2SLS	Dummies 2SLS
Constant	5.01***	5.06***	5.02***	11.23***	11.25***	11.24***	11.09***	11.24***	11.11***
	(0.01)	(0.01)	(0.01)	(0.17)	(0.17)	(0.17)	(0.24)	(0.24)	(0.24)
Total Credit (in log)	0.0129***	0.0189***	0.0143***	0.0075***	0.0143***	0.0084***	0.0061***	0.0133***	0.0068***
	(0.0004)	(0.0005)	(0.0004)	(0.0004)	(0.001)	(0.0004)	(0.0004)	(0.001)	(0.0005)
Less4	-	-	-	-0.01***	-0.004***	-0.005***	-0.001**	-0.001	-0.001**
				(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Less8	-	-	-	-0.05***	-0.04***	-0.05***	-0.04***	-0.04***	-0.04***
				(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Gini	-	-	-	0.38***	0.41***	0.39***	1.06***	0.94***	1.05***
				(0.15)	(0.15)	(0.15)	(0.14)	(0.14)	(0.14)
Population (in log)	-	-	-	-0.25***	-0.31***	-0.25***	-0.22*	-0.30***	-0.23***
				(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)
State's Capital Distance	-	-	-	-	-	-	-0.0001*	-0.0001***	-0.0001*
							(0.00004)	(0.00005)	(0.00004)
São Paulo SP Dist.	-	-	-	-	-	-	-0.0003***	-0.0003***	-0.003***
							(0.00004)	(0.00004)	(0.00004)
State Dummies	NO	NO	NO	NO	NO	NO	YES	YES	YES
Adjusted R²	0.2130	0.1661	0.2105	0.6116	0.5759	0.6110	0.6669	0.6309	0.6665

Source: Central Bank of Brazil, Brazilian Institute of Statistics and Geography, Institute for Applied Economics Research and Atlas of Human Development in Brazil. 2nd stage regression estimates, with robust standard deviations in parenthesis. 4,920 observations.

* significant at 10% ** significant at 5% *** significant at 1%

On the other hand, table 20 shows results that go completely in the opposite direction of the ones presented previously. Instead of presenting an upward bias as is expected, the OLS estimates clearly show a downward bias. Note however that it decreases as more covariates are included in the regression. Observe also that this more flexible non-linearity portrays a clear decrease from the Parametric 2SLS estimate. In this case, the picture painted here is simple: as the inclusion of a more flexible setup for the non-linearity, the 2SLS parameter estimate tends to decrease, being this case an intermediate case of flexibility and the Non-Parametric case the most flexible one.