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**Quantity versus price bank competition and
macroeconomic performance given bank
concentration**

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Performance given Bank Concentration**

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Abstract

This paper elaborates upon the following three theses: First, given bank sector concentration, the other aspect of this sector that matters for the overall economy is that of price vs. quantity competition by itself. Second, the macroeconomic performance of price competition is superior, enhancing the tax base and bank profit, capitalizing additionally the banks upon public debt induced instability, which the policymaker can minimize through Taylor rule. And, third, the ultimate link between banking competition and macroeconomic performance is the bank regulation shaping bank operation in accordance with the financial needs of fiscal policy.

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JEL codes: G21, L11, E32, E44, E63

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Abstract

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1. Introduction

Three are the key propositions regarding the nexus between the bank and the broader financial sector on the one hand, and macroeconomic performance on the other. First, it is well known that financial development corroborates output growth (Levine 2005). The combination of commercial and investment banking services is immaterial as to this trend (Fohlin 2000). Second, it also appears that bank concentration exerts a positive influence on growth under the provision that branch and recently virtual banking ensures for businesses greater access to external funding across the board and that does not increase the volatility of growth in sectors with lower external liquidity needs (Mitchener and Wheelock 2010, Cetorelli and Gambera 2001, Huang et al. 2014, Claessens and Laeven 2005, Hoxfa 2013). The issue of such volatility is of particular concern, because it slows down growth, worsens income distribution, and raises output and employment costs (Aghion et al. 2010, Breen and Garcia-Peñalosa 2005, Benigno and Ricci 2011). And, third, the more competitive the bank system is, the better its macroeconomic performance is, since as Pagano (1993) for instance notes, imperfect bank competition leads to inefficiencies, harming firms' access to credit, and impeding thereby economic growth. This is supposed to be the argument explaining the failure of bank concentration to support growth in less developed countries

But, it is an argument confusing bank concentration with bank competition, and as Schaeck et al. (2009, p. 711) caution “competition and concentration capture different characteristics of banking systems, meaning that concentration is an inappropriate proxy for competition.” For example, Cetorelli and Peretto (2009) use a Cournot

oligopoly to explain the ambiguity of the effect of bank competition on capital accumulation. The market outcome from the interaction of given number of banks may be consistent with a variety of market structures. For example, a Bertrand duopoly may be quasi-competitive as the textbook goes, and a Cournot duopoly may be price-taking *à la* perfect competition but still with market power. At the other end, bank mergers, consolidation fomenting concentration, may be eliminating inefficient banks, improving the banking system via better risk diversification (Mester 2008). Or, it may be the case of an asymmetric oligopoly where dominant and fringe firms coexist, the number of dominant banks does not change with market size, and only the number of fringe banks varies with size change (Dick 2002). So, what really matters for judging the macroeconomic performance of a given bank population, small or large, is whether the variable of interaction is the quantity or the price. This is the topic under investigation by this paper. It is straightforward in conception, addressing what Sutton (1991) considers being the building blocks in modeling the intensity of competition. And yet, the approach is novel, because the literature that does differentiate between concentration and competition has been focusing on the macroeconomic stability effects of the implied difference for the riskiness of bank strategy (Repullo 2004).

It is also novel, because it seeks to assess the nexus between the banking system and macroeconomic performance by distinguishing between quantity and price competition *ceteris paribus*, instead of allowing the number of firms to vary too, as the traditional version of market structure postulates. Nevertheless, to compare our results below with the conclusions reached under the traditional view of market structure, it would be instructive to review briefly these conclusions. Thus, according to Zhang (2007), the output effects of the business cycle persist less, weakening the propagation of the cycle, under intense competition and under Bertrand rather than under Cournot modeling. This contradicts with Smith (1998), who maintains that intense bank competition raises the level of income and reduces the severity of business cycles. This paper claims that business cycles are weaker under quantity competition but income is higher under price competition. Price-cost margins in the market for bank credit, i.e. an environment of price competition, is found to be countercyclical by Mandelman (2006), attributed by him to the increased competition by pro-cyclical foreign-bank entry in a monopolistic environment, and to a borrower hold-up effect in a monopolistically competitive framework by Aliaga-Díaz and Olivero (2010). In either case, real variables become more volatile than in a model with constant margins, i.e. with quantity competition, which is what is found to be the case below, too. Moreover, Naceur and Omran (2010) pinpoint to the importance of regulatory and institutional variables for bank performance, which herein is put at the service of the fiscal-monetary mix desired by the policymaker, acknowledging here too, the key role these variables can assume in attaining the policy goals set.

In what follows, the next section elaborates upon two kinds of banking sector: One, being subject to full control of the interest rates by the monetary authority, and having

its banks competing with regard to quantity; and, the other, with banks being allowed to compete in terms of the lending and deposit rates, and with the monetary authority having control only of the bond rate. The price-taking banking sector is treated within the context of the Monti-Klein version of Cournot interaction under the assumption that different bank population comprises different market structure. And, price-fixing ability is examined next given the size of this population. It is the mentality rather than any special mathematics that make us contemplate quantity and price competition taking for granted bank concentration. It is a mentality prompted by the need to interpret results obtained otherwise in the traditional fashion. Methodologically, bank competition is separated from bank concentration by taking the latter for granted whereas the strand of industrial economics takes the type of bank competition for granted and allows the number of firms to vary. The key result inducing such an approach to the bank sector is that price competition is consistent with more lending relative to quantity competition regardless bank concentration. Nevertheless, no safe comparison can be made with regard to deposits, and to explain this result, Section 3 puts next the bank sector within the context of a macroeconomic model *à la* Freixas and Rochet (2008). The explanation, which is one stemming from public debt considerations under quite complicated algebra, is that price competition raises the tax base, reduces in turn the government budget deficit and lowers subsequently the need to issue bonds absorbed by banks, thus permitting the banks to loan out more. That is, price competition corroborates growth, but it is also found to be doing so at the price of instability, which policy-wise appears to be confronted better by a Taylor rule rather than discretionary intervention. Section 4 wraps up this paper evaluating our macroeconomic results in the light of what is known from the literature on banking and monetary policy. It also includes a brief discussion of our conclusion regarding the significant role of bank regulation as a policy instrument.

2. Bank Competition

There are N banks, each with some but the same market power. The profit, Π , of the typical bank comes out of lending and deposit services, L and D , respectively. A percentage b of $L + D$ is used to invest in government bonds under the nominal interest rate $r = \rho + \pi$, where ρ is the real interest rate and π is the inflation rate. Of course, $L = \lambda D$, $\lambda > 1$. The balance sheet is: $L + B = B + \lambda D \Rightarrow L + b(L + D) = B + \lambda D \Rightarrow (1 + b)L - B = (\lambda - b)D$ (Martín-Oliver and Salas-Fumás 2010). Hence,

$$\Pi = [r_L - r(1 + b)]L + [r(\lambda - b) - r_D]D \quad (1)$$

where r_L and r_D are the lending and deposit rates. The demand for loans and supply of deposits are given for simplicity by:

$$L = Ar_L^{-\varepsilon} \quad (2)$$

and

$$D = \Gamma r_D^\mu \quad (3)$$

where $\varepsilon > 1$ is the price elasticity of the demand of loans and $\mu < 1$ is the supply elasticity of deposits while A and Γ are positive numbers capturing the impact of bank regulation on bank productivity regarding L and D , respectively; regulation enhancing or diminishing bank productivity directly depending on whether these numbers exceed the unit or not. The assumption that $\varepsilon > 1$ reflects profit maximization under conditions of market power while if $\mu > 1$, an increasing r_D would be accompanied by exponentially increasing deposits.

Suppose now that not only r but r_L and r_D are fixed by the monetary authority, rendering effectively the typical bank a “full” price taker as in a Cournot environment. The rates set by the monetary authority may be derived through the first order conditions from maximizing (1) with respect to L and D :

$$r_L = r(1 + b) \quad (4)$$

and

$$r_D = r(\lambda - b) \quad (5)$$

with

$$r_L > r_D \Rightarrow r(1 + b) > r(\lambda - b) \Rightarrow b > \frac{\lambda - 1}{2}$$

which is true if the percentage invested in bonds exceeds half of the lending over and above $L = D$. The monetary authority makes lending profitable but not before it has secured enough bank funding for itself. Inserting (4) and (5) in (2) and (3), respectively, we obtain:

$$L^* = A[r(1 + b)]^{-\varepsilon} \quad (2')$$

and

$$D^* = \Gamma[r(\lambda - b)]^\mu \quad (3')$$

Assuming Cournot interaction, the total industry quantities are $L^*N/(N + 1)$ and $D^*N/(N + 1)$, with $L^*/2$ and $D^*/2$ under pure monopoly, and just L^* and D^* as N tends to infinity. Inserting (2') and (3') in $L = \lambda D$ yields that λ^* is the solution to the following polynomial:

$$\lambda(\lambda - b)^\mu = \frac{A}{\Gamma r^{\varepsilon + \mu} (1 + b)^\varepsilon} \quad (6)$$

Next, suppose that instead of optimizing over L and D , the bank might be given the option of optimizing over A and B . Inserting (2) and (3) in (1),

$$\Pi = [r_L - r(1 + b)]Ar_L^{-\varepsilon} + [r(\lambda - b) - r_D]\Gamma r_D^\mu \quad (1')$$

in which case:

$$\frac{\partial \Pi}{\partial A} = [r_L - r(1 + b)]r_L^{-\varepsilon} = 0 \quad \text{and} \quad \frac{\partial \Pi}{\partial \Gamma} = [r(\lambda - b) - r_D]r_D^\mu = 0$$

implying again (4) and (5). That is, given all rates fixed by the authority, it is immaterial for the bank if it optimizes directly over the amount it loans out or indirectly over the conditions supplying this amount: Under Cournot interaction, if the bank had the opportunity to shape these conditions by itself, they would be identical to those determined by the monetary authority.

The relevant expression for profit maximization is (1') when the bank does influence the lending and deposit rate (but not r) too, obtaining:

$$\frac{\partial \Pi}{\partial r_L} = 0 \Rightarrow r_L = \frac{\varepsilon r(1 + b)}{(\varepsilon - 1)} \quad (7)$$

and

$$\frac{\partial \Pi}{\partial r_D} = 0 \Rightarrow r_D = \frac{\mu r(\lambda - b)}{(1 + \mu)} \quad (8)$$

with

$$r_L > r_D \Rightarrow \varepsilon(1 + b)(1 + \mu) > \mu(\lambda - b)(\varepsilon - 1) \Rightarrow b > \frac{\mu\lambda(\varepsilon - 1) - \varepsilon(1 + \mu)}{\varepsilon(1 + 2\mu) - \mu}$$

and hence, with a lower b to have $r_L > r_D$ relative to the Cournot case of $b > (\lambda - 1)/2$, as is implied by their comparison, amounting to $-(\varepsilon + \mu\lambda) < (\varepsilon\lambda + \mu)$, which is true. This comparison reveals also that when banks are allowed to follow their own interest rate policy, they exhibit market sensitivity not shared by the monetary authority when it is it that sets the rates; and this is presumable the reason for the lower b , we just found. It is easily checked by comparing (4) and (7), and (5) and (8) that now r_L is higher and r_D lower *vis a vis* the “price-taking” case. To see what this implies for the volume of L and D , inserting (7) and (8) in (2) and (3), respectively, yields:

$$L^{**} = A \left[\frac{\varepsilon r(1 + b)}{(\varepsilon - 1)} \right]^{-\varepsilon} \quad (2'')$$

and

$$D^{**} = \Gamma \left[\frac{\mu r(\lambda - b)}{(1 + \mu)} \right]^\mu \quad (3'')$$

The total quantities are N times L^{**} and D^{**} , and compare with $L^*N/(N + 1)$ and $D^*N/(N + 1)$, respectively, as follows:

$$NL^{**} > \frac{N}{N + 1} L^* \Rightarrow \frac{L^{**}}{L^*} > \frac{1}{N + 1} \Rightarrow \varepsilon N > -1 \quad (9)$$

which is always true, and

$$ND^{**} \geq \frac{N}{N+1} D^* \Rightarrow \frac{D^{**}}{D^*} \geq \frac{1}{N+1} \Rightarrow \mu \geq \frac{1}{N} \quad (10)$$

where we do not use the strict inequality sign because if we did, the assumption that $\mu \leq 1$ would be violated under $N = 1$. It is clear that lending is now much greater than under Cournot interaction, but this may not be the case for D if (10) is not satisfied.

Relationship (9) indicates that lending is higher relative to any market structure with non-price competition. Monopoly too, being always some version of the textbook treatment of it, i.e. of finding really the price corresponding to half the perfectly competitive market, it is “quantity driven”. But, may the higher lending be attributed to a higher loan multiplier, λ^{**} , which by (2'') and (3'') comes now out of the solution to:

$$\lambda(\lambda - b)^\mu = \frac{A(\varepsilon - 1)^\varepsilon (1 + \mu)^\mu}{\Gamma r^{\varepsilon + \mu} (1 + b)^\varepsilon} ? \quad (6')$$

The answer is negative: The denominators of (6) and (6') are the same. Hence, $\lambda^{**} > \lambda^*$ iff $(\varepsilon - 1)^\varepsilon (1 + \mu)^\mu > 1$ or the same, iff:

$$\mu > (\varepsilon - 1)^{-\frac{\varepsilon}{\mu}} - 1.$$

and the right-hand side of this inequality exceeds one because:

$$(\varepsilon - 1)^{-\frac{\varepsilon}{\mu}} - 1 > 1 \Rightarrow \frac{1}{2^{\frac{\mu}{\varepsilon \varepsilon}}} > 0$$

which is true; the value of μ is immaterial. If, for example, $\mu = 1$, one obtains that $\lambda^* = (b + \sqrt{b^2 + 4\Omega})/2$, and $\lambda^{**} = (b + \sqrt{b^2 + 4\Omega'})/2$, where Ω and Ω' represent the right-hand side of (6) and (6'), respectively. Hence, $\lambda^{**} > \lambda^*$ iff $\Omega' > \Omega$: So, Even if $D^{**} > D^*$ the multiplier definitely decreases and the only way to rationalize the higher lending is to attribute it to the decline of b , of the investment in government bonds, which has been found to be lower if banks are let free to choose their pricing policy. A lower b implies in turn more lending to finance business fixed investment, higher output, and larger tax base, mitigating the need to issue bonds to cover a government budget deficit. And, either from (2') or from (2''), $\partial L / \partial b < 0$. Two things are clear: One, that interest-rate leverage raises presumably the relative profitability of lending. If the bank was asked if it wants (i) its market power to be influencing r_L and r_D or (ii) independence in shaping the conditions surrounding loan supply given r_L and r_D but not both, the bank would prefer the former, because simply is more profitable. And, the second point is that the bank sector has to be examined within the context of the overall economy as well, in a macroeconomic framework.

A macroeconomic approach encompassing the above bank sector considerations is required *a fortiori* since market power is advantageous even if seen in the dynamic context of a business cycle. The spread under quantity competition is $r_L - r_D = [(1 + 2b) - \lambda]r$ and can change value only if the policymaker wants to change r (and/or b, λ). But, under price competition, this spread,

$$r_L - r_D = \left[\frac{\varepsilon(1 + b)(1 + \mu) - \mu(\lambda - b)(\varepsilon - 1)}{(\varepsilon - 1)(1 + \mu)} \right] r$$

is controlled by the banking sector. Even if r was following the same course over time, $r = \vartheta + \theta \sin t$, its fluctuations would be more intense under price competition, because

$$\frac{\varepsilon(1 + b)(1 + \mu) - \mu(\lambda - b)(\varepsilon - 1)}{(\varepsilon - 1)(1 + \mu)} > 2b \Rightarrow \varepsilon(\lambda - b) + \mu(1 + b) > -2b$$

which is true; t is presumably time. Much more serious fluctuations are obtained when $r_L^{-\varepsilon} = \vartheta_L + \theta_L \sin t$ and $r_D^{\mu} = \vartheta_D + \theta_D \sin t$ where $0 < \vartheta, \theta < 1$. Profit is now:

$$\Pi = \Psi + \Phi \sin t \quad (1'')$$

where $\Psi = \{[r_L - r(1 + b)]A\vartheta_L + [r(\lambda - b) - r_D] \Gamma \vartheta_D\}$ and $\Phi = \{[r_L - r(1 + b)]A\theta_L + [r(\lambda - b) - r_D] \Gamma \theta_D\}$ one obtains:

$$\frac{d\Pi}{dt} = \Phi \cos t \quad (11)$$

which becomes zero when $\Phi = 0 \Rightarrow$

$$r_L A \theta_L - r_D \Gamma \theta_D = r(1 + b) A \theta_L - r(\lambda - b) \Gamma \theta_D \quad (12)$$

These results are illustrated through Figures 1 and 2. The former diagram depicts with the blue line the difference:

$$r_L - r_D = (\vartheta_L + \theta_L \sin t)^{-\frac{1}{\varepsilon}} - (\vartheta_D + \theta_D \sin t)^{\frac{1}{\mu}},$$

with all *thetas* set at 0.5 and with both exponents set at 1.5; it also depicts (1'') with $\Psi = 1$ and two values of Φ , 1.7 and 0.3, green and red lines respectively, to illustrate the increasing stability of Π as the condition given by (12) is approached. The second

diagram provides an illustration in terms of (11) and the time derivative of (12).

Figure 1

Figure 2

The condition $\Phi = 0$ reflects the case of having the fluctuating difference $r_L - r_D$ under the full control of monetary authority indirectly by manipulating r and b properly. A similar more or less stability, a $\Phi \approx 0$, would have been produced if the policymaker was controlling this difference directly by not allowing r_L and r_D themselves to vary much over the course of the business cycle. The green line is suggestive of either case. But, in any case, it is clear that for the bank, instability is more profitable than stability as the standard proposition of microeconomic theory would predict (see e.g. Varian 1992, p. 43). The areas between the green and red line minus those below the “zero-axis” in Figure 1, exceed those associated with the red line relative to its steady state. It is clear in general that the discussion should be taken to the macroeconomic level.

3. Macroeconomic Performance

Money, M , serves only as a store of value, issued only to facilitate the people deposit their savings with the bank:

$$\frac{M}{P_{-1}(1 + \pi)} = D \quad (13)$$

where P is the current price level with the subscript “-1” indicating the last period so that: $P = P_{-1}(1 + \pi)$. If c is the marginal propensity to consume and τ is the average tax rate, these savings consist of what is left from consumption $C = c(1 - \tau)Y$, where Y is total income. Banks use them in turn to finance business investment in the form of business loans; investment is identical to lending:

$$Y = c(1 - \tau)Y + L + G \quad (14)$$

where G is government expenditure. Banks absorb also the bonds, $B = b(L + D)$, issued by the government only in connection with the budget deficit, $G - \tau Y$:

$$\frac{b(L + D) - b_{-1}(L_{-1} + D_{-1})}{r} = P_{-1}(1 + \pi)(G - \tau Y) \quad (15)$$

Finally, the nominal bond rate is shaped by the Phillips curve:

$$\pi = h(Y - \hat{Y}) \quad (16)$$

where h is some positive constant and $\hat{Y}$ is steady state output. The macroeconomic system (13) through (16) contains four endogenous variables, r, b, Y , and π , and the exogenous variables G, τ, M, b_{-1} , and P_{-1} . (16) may be simplified by setting $\hat{Y} = yY$, $y > 0$, so that:

$$\pi = h(1 - y)Y \quad (16')$$

with $y > 1$ in case of contraction and $y < 1$ above steady state. The quantity and price competition versions of the system appear in the Appendix through (A1) – (A2) – (A3) and (A1') – (A2') – (A3'), respectively, plus always (16').

Our focus is on whether b is less under price competition relative to quantity competition. In either case, it is impossible to solve them as they are. But, some basic insight may be obtained by setting $\varepsilon = 2$ and $\mu = 1$, and by postulating initial conditions of zero previous government borrowing, i.e. $b_{-1} = 0$, and either a balanced budget, $G - \tau Y = 0$, or a $\pi = -1 \Rightarrow Y = (1 + h)/hy$, which might be defined to be trough output. At the trough, we have a liquidity trap, because from (A1), $M/0 = \infty$. Under these circumstances, (A3) gives one root to be $\bar{b} = 0$, which presumably should be the case when $b_{-1} = 0 = G - \tau Y$, the two complex roots:

$$\bar{b}' = \frac{27\mathbb{F}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 12(-1 \mp \sqrt{3}i) - 18\mathbb{F}^{\frac{1}{3}}}{54\mathbb{F}^{\frac{1}{3}}} \quad (17)$$

and the real root:

$$\bar{b}'' = \frac{27\mathbb{F}^{\frac{2}{3}} + 12 - 9\mathbb{F}^{\frac{1}{3}}}{27\mathbb{F}^{\frac{1}{3}}}, \quad (17')$$

where $i = \sqrt{-1}$, and:

$$\mathbb{F} = \frac{\sqrt{A(32\Gamma r^3 + 27A)}}{23^{\frac{3}{2}}\Gamma r^{\frac{3}{2}}} + \frac{27A + 16\Gamma r^3}{54\Gamma r^3}.$$

And, from (A3') a replication of these roots of $b, \bar{b}$, is obtained, with $\mathbb{F}$ being replaced by:

$$\mathbb{J} = \frac{\sqrt{64N\Gamma r^4 + 27NA}}{23^{\frac{3}{2}}N\Gamma r^{\frac{5}{2}}} + \frac{27A + 32\Gamma r^4}{108\Gamma r^3}.$$

The complex roots might be thought of capturing countercyclical discretionary policymaking while the real root may be interpreted to be the case of pro-cyclical inflation targeting rule when the government starts deficit spending to confront depression once it has reached its trough, having the government done nothing before. In either case, provisions are being made as to the regulatory environment of the banks too, to accommodate this government intervention concern, since $A \neq A_{-1}$ and $\Gamma \neq \Gamma_{-1}$.

So, the difference in the government borrowing regime between quantity and price competition has to be seen under these policy considerations and certainly, on whether policy is discretionary or (Taylor) rule based. Methodologically, the comparison should be attempted taking for granted the character of the policy. It is shown in the Appendix that $\bar{b}'' > \bar{b}''$ and thereby $\bar{b}' > \bar{b}'$. The percentage of bank's assets devoted to bond purchases is less under price competition regardless policy regime given $\varepsilon = 2$, $\mu = 1$, $b_{-1} = 0$, and $\pi = -1$. To see next if this is the case because such competition implies higher tax base, we must proceed to solve for Y , which as is shown in the Appendix proves to be a formidable task. Nevertheless, an insight may be obtained by looking at the derivative of Y with respect to b . Under quantity competition:

$$\frac{\partial Y}{\partial b} = - \frac{(4x + 4)a\mathfrak{B} + (2b^4 - 2b^2 - 2b + 2)\mathfrak{G} + (4b^3 + 12b^2 + 12b + 4)a^2}{(b^3 - 3b^2 + 3b - 1)\mathfrak{B}}$$

where

$$\mathfrak{B} = a^2 \sqrt{(b^4 - 2b^2 + 1)\mathfrak{G} + (-b^4 + 4b^3 - 6b^2 + 4b - 1)\mathfrak{K} + (b^4 + 4b^3 + 6b^2 + 4b + 1)}$$

$$a = [1 - c(1 - \tau)]$$

$$\mathfrak{K} = \frac{4(NA)^2(P_{-1}N\Gamma)^4[h(1 - y)]^2}{(N + 1)^2[M(N + 1)]^4}$$

$$\mathfrak{G} = \frac{4NA(P_{-1}N\Gamma)^2[h(1 - y)]^2G}{(N + 1)[M(N + 1)]^2}$$

This derivative, which obtains from (A5'), is clearly negative; a lower b implies a higher Y . All in the economy will benefit from a shift from quantity to price bank competition. This is shown to be the case under any policy regime because b is not replaced in the calculations by its solved values (17) and (17').

The policy environment matters in so far as stability is concerned. The Appendix shows that the interest rate spreads under quantity and price competition and Taylor rule are more stable relative to the spreads under discretionary policy. It also shows that their derivative with respect to the number of banks is always negative, since an increase in N decreases quite plausibly the profit margin regardless competition type and policy regime. Nevertheless, a policy concern for the spread and hence, N , is plausible under mainly price competition as the presence of bank population in $\mathbb{J}$ but not $\mathbb{F}$ suggests. In any case, it is interesting is that an attempt to control the spread by manipulating this population is fully a matter of bank regulation too, as follows. From $\partial(r_L - r_D)/\partial N = 0$, one obtains the equations:

$$9\mathbb{F}^{\frac{2}{3}} + 4 = 3\mathbb{F}^{\frac{1}{3}}$$

$$9\mathbb{F}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 4(-1 \mp \sqrt{3}i) = 6\mathbb{F}^{\frac{1}{3}}$$

for the case of quantity competition, and

$$12\mathbb{J}^{\frac{1}{3}} + 45\mathbb{J}^{\frac{2}{3}} + 20 = 0$$

$$24\mathbb{J}^{\frac{1}{3}} + 45\mathbb{J}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 20(-1 \mp \sqrt{3}i) = 0$$

under price competition. Recall that both, $\mathbb{F}$ and $\mathbb{J}$, are complicated functions of r . Consequently, the unknown in these equations is r . For example, the first equation really is:

$$\begin{aligned} & 9 \left\{ \frac{\sqrt{A(32\Gamma r^3 + 27A)}}{23^{\frac{3}{2}}\Gamma r^{\frac{3}{2}}} + \frac{27A + 16\Gamma r^3}{54\Gamma r^3} \right\}^{\frac{2}{3}} + 4 \\ & = 3 \left\{ \frac{\sqrt{A(32\Gamma r^3 + 27A)}}{23^{\frac{3}{2}}\Gamma r^{\frac{3}{2}}} + \frac{27A + 16\Gamma r^3}{54\Gamma r^3} \right\}^{\frac{1}{3}} \end{aligned} \quad (18)$$

which only numerically can be solved. In practice, it means that the policymaker has to be aware of the values of A and Γ , i.e. of bank regulation, and identify next those values, which in combination with the desirable r , satisfy (18). But, controlling $r_L - r_D$ *per se* is not a sensible policy, because the spread should be let shaped by the fiscal-monetary mix behind $\bar{b}$'s or $\bar{\bar{b}}$'s, as deemed appropriate by the government.

4. Concluding Remarks

In sum, lending is higher under price rather than quantity competition independently of the matter of bank concentration. The reason is that price contest leads to higher growth, raising the tax base, decreasing in turn the government budget deficit and weakening subsequently the need to issue bonds absorbed by banks, thus permitting the banks to loan out more. This comes at the cost of higher instability, which might be moderated by the adoption of a Taylor rule rather than through discretionary policymaking. The assumptions of the macroeconomic model, having produced these results could have been more realistic. In particular, money could have been allowed to be issued to cover part ω of the deficit, lessening the need to take recourse to government borrowing. Relationship (15) above could have been: $(M - M_{-1}) + (B - B_{-1})/r = P_{-1}(1 + \pi)(G - \tau Y)$, with $(M - M_{-1}) = \omega P_{-1}(1 + \pi)(G - \tau Y) + D$ and $(B - B_{-1})/r = (1 - \omega)P_{-1}(1 + \pi)(G - \tau Y) - D$. Such an approach would allow money to be used for transaction purposes as well and introduce into the discussion the role of loan collateral. Goodfriend and McCallum (2007) find that when loan production depends upon both collateral and loan-monitoring inputs, the difference between the cost of funds raised externally and the opportunity cost of funds internal to the borrowing firm, can be either pro- or counter-cyclical depending on model parameterization. Also, shocks to banking productivity or collateral effectiveness call for large policy responses. Consequently, the issue of loan collateral is very important in the discussion the role of banking in monetary policy. Unfortunately, this paper cannot handle this matter, because the algebra would become completely unmanageable. We cannot even take the derivative $\partial Y/\partial N$ to verify or reject through its sign the proposition that bank concentration corroborates growth regardless stage of growth, which would be a very important conclusion.

Yet, we can still discuss our macroeconomic results in connection with some related findings from literature which is indirectly relevant to the topic in hand. For example, Kocherlakota (2000) argues that credit constraints can become a source of serious instability. Logically, the presence of such constraints is more likely under quantity competition, since prices respond faster than quantities to disequilibrium. This might be viewed as one more reason for the weaker macroeconomic performance of quantity competition, and as a reason adding to the otherwise small instability associated with this competition type. Another source of greater instability, identified by Cooley et al. (2004), is the lower enforceability of a loan contract. Enforceability becomes a problem as default risks mount, which is expected to be the case under the increased instability accompanying price competition. And, Diamond and Rajan (2006) differentiate between real (e.g., foreign exchange denominated) and nominal deposits, in favor of the latter as a means of confronting the adverse output effects originating in the different timing between real deposits and lending. It is perhaps the neglect of the factor of two deposits types which can explain why Section 2 could not say whether deposits are greater under price competition. This conclusion is inferred through the next section's result that output is greater under price competition and presumably, so should deposits be in line with the higher lending. Nevertheless, judging from Diamond and Rajan (2006), the case really is of price-competition

induced higher nominal deposits, enabling subsequently the higher lending and greater output.

In any case, the final point is that bank regulation comes up to be indispensable companion to bond rate manipulation. Regulation that may take on many forms like countercyclical bank leverage regulation (Christensen 2011) suffices to have stabilization properties. Regulation, because Goodhart et al. (2004) are only a few among the many of our contemporaries who alert authorities to the instability risks run if the policymaker does not keep track of the developments in the operation environment of the banking and the broader financial system. Even more so when these developments include rapid financial innovation as very properly Mishkin (2015) pinpoints to the student of monetary economics. Only if the regulatory system is prudential and its implementation full, banking reforms can help the overall economic policy, which by the way is where developing economies stumble (Thankom and Turner 2003).

The whole matter has to be seen from the viewpoint of social welfare as well. Ashraf et al. (2011) argue that between micro-prudential bank regulation conflicts with macro stability only during depression, because “banks provide a ‘financial stabilizer’ that in some respects can more than counteract the more familiar financial accelerator”. No such stabilizer has been identified here and a bank regulation tied to Taylor manipulation of the bond rate is both micro- and macro-prudential over the whole course of the cycle. Could it be that regulation conflicts with discretionary policymaking during depression? This is, indeed, so, because simply regulation facilitating increased government borrowing would crowd out the private investment needed to recover from depression. In our analysis, depression has been associated with liquidity trap considerations, with infinite money hoarding, aided by price competition. Would-be instability is exogenous, but it could have been countered better if quantity competition was the case regardless bank concentration. So, the content of bank regulation under discretionary policy should be full interest rate control toward quantity competition and accommodation of government borrowing given this type of competition, of smaller borrowing relative to what price competition conditions would dictate. But, note that quantity competition does not promote output growth as much as price competition does, and the lost difference might as well have been the outcome of higher government borrowing under price competition. The choice between the two types of competition becomes a matter of cost-benefit calculation, but the fact remains that regulation conflicts with discretionary policymaking during depression.

Appendix

Under quantity bank competition, i.e. under $D = D^*N/(N + 1)$ and $L = L^*N/(N + 1)$, the system becomes:

$$\frac{M}{P_{-1}(1+\pi)} = \frac{N\Gamma[r(\lambda-b)]^\mu}{N+1}, \quad (A1)$$

$$Y = c(1-\tau)Y + \frac{NA}{(N+1)[r(1+b)]^\varepsilon} + G, \quad (A2)$$

and

$$\frac{bQN}{N+1} - \frac{b_{-1}Q_{-1}N_{-1}}{N_{-1}+1} = P_{-1}(1+\pi)(G-\tau Y) \quad (A3)$$

where:

$$Q = \left[\frac{A + \Gamma r^{\varepsilon+\mu}(1+b)^\varepsilon(\lambda-b)^\mu}{r^{\varepsilon+1}(1+b)^\varepsilon} \right]$$

while Q_{-1} is as Q but with A_{-1} , Γ_{-1} , and b_{-1} . The system becomes complete with (16') Four more exogenous variables come up: A_{-1} , Γ_{-1} , N , and N_{-1} . That is, we allow for changes in the bank market structure and regulatory environment.

Under price competition, relations (13), (14), and (15), become in view of (2'') and (3''):

$$\frac{M}{P_{-1}(1+\pi)} = \frac{N\Gamma[\mu r(\lambda-b)]^\mu}{(1+\mu)^\mu}, \quad (A1')$$

$$Y = c(1-\tau)Y + \frac{NA(\varepsilon-1)^\varepsilon}{[\varepsilon r(1+b)]^\varepsilon} + G, \quad (A2')$$

and

$$bGN - b_{-1}G_{-1}N_{-1} = P_{-1}(1+\pi)(G-\tau Y) \quad (A3')$$

where:

$$G = \frac{A(\varepsilon-1)^\varepsilon(1+\mu)^\mu + \Gamma[\mu r(\lambda-b)]^\mu[\varepsilon r(1+b)]^\varepsilon}{r[\varepsilon r(1+b)]^\varepsilon(1+\mu)^\mu}$$

while G_{-1} is as G but with A_{-1} , Γ_{-1} , and b_{-1} . The system become again complete with (16').

Next, if $\bar{b}'' > \bar{b}''$ holds, i.e. if

$$\frac{27\mathbb{F}^{\frac{2}{3}} + 12 - 9\mathbb{F}^{\frac{1}{3}}}{27\mathbb{F}^{\frac{1}{3}}} > \frac{27\mathbb{J}^{\frac{2}{3}} + 12 - 9\mathbb{J}^{\frac{1}{3}}}{27\mathbb{J}^{\frac{1}{3}}}$$

then

$$\begin{aligned}
\frac{27\mathbb{F}^{\frac{2}{3}} - 9\mathbb{F}^{\frac{1}{3}}}{27\mathbb{F}^{\frac{1}{3}}} &> \frac{27\mathbb{J}^{\frac{2}{3}} + 12 - 9\mathbb{J}^{\frac{1}{3}}}{27\mathbb{J}^{\frac{1}{3}}} \Rightarrow \frac{27\mathbb{F}^{\frac{1}{3}} - 9}{27} > \frac{27\mathbb{J}^{\frac{2}{3}} + 12 - 9\mathbb{J}^{\frac{1}{3}}}{27\mathbb{J}^{\frac{1}{3}}} \Rightarrow \\
27\mathbb{F}^{\frac{1}{3}} - 9 &> \frac{27\mathbb{J}^{\frac{2}{3}} + 12 - 9\mathbb{J}^{\frac{1}{3}}}{\mathbb{J}^{\frac{1}{3}}} \Rightarrow 27\mathbb{F}^{\frac{1}{3}} - 9 > 27\mathbb{J}^{\frac{1}{3}} - 9 + \frac{12}{\mathbb{J}^{\frac{1}{3}}} \Rightarrow \\
27\mathbb{F}^{\frac{1}{3}} - 27\mathbb{J}^{\frac{1}{3}} &> \frac{12}{\mathbb{J}^{\frac{1}{3}}} \Rightarrow 9\left(\mathbb{F}^{\frac{1}{3}} - \mathbb{J}^{\frac{1}{3}}\right) > \frac{4}{\mathbb{J}^{\frac{1}{3}}} \Rightarrow \mathbb{J}^{\frac{1}{3}}\left(\mathbb{F}^{\frac{1}{3}} - \mathbb{J}^{\frac{1}{3}}\right) > \frac{4}{9}
\end{aligned}$$

which is true given that $\mathbb{J} > 0$ and

$$\begin{aligned}
\mathbb{F} - \mathbb{J} &= 108Nr^{\frac{3}{2}}\sqrt{A(32\Gamma r^3 + 27A)} + 23^{\frac{3}{2}}N(27A) + 23^{\frac{3}{2}}N(32\Gamma r^3)(1-r) \\
&\quad - 108r^{\frac{1}{2}}\sqrt{N(64\Gamma r^4 + 27A)} > \frac{4}{9} \Rightarrow \\
243Nr^{\frac{3}{2}}\sqrt{A(32\Gamma r^3 + 27A)} &+ 23^{\frac{3}{2}}N(27A)\left(\frac{9}{4}\right) + 23^{\frac{3}{2}}N(72\Gamma r^3)(1-r) \\
&> 1 + 243r^{\frac{1}{2}}\sqrt{N(64\Gamma r^4 + 27A)}
\end{aligned}$$

which is also true, because even

$$\begin{aligned}
243Nr^{\frac{3}{2}}\sqrt{A(32\Gamma r^3 + 27A)} &> 243r^{\frac{1}{2}}\sqrt{N(64\Gamma r^4 + 27A)} \Rightarrow \\
r\sqrt{NA}\sqrt{32\Gamma r^3 + 27A} &> \sqrt{64\Gamma r^4 + 27A} \Rightarrow \\
32NA\Gamma r^5 + 27NA^2r^2 &> 64\Gamma r^4 + 27A \Rightarrow 32\Gamma r^4(NAr - 2) + 27A(NAr^2 - 1) > 0
\end{aligned}$$

when $2 > \sqrt{NA}$.

Let us next examine whether or not $\bar{b}' > \bar{\bar{b}}' \Rightarrow$

$$\begin{aligned}
\frac{27\mathbb{F}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 12(-1 \mp \sqrt{3}i) - 18\mathbb{F}^{\frac{1}{3}}}{54\mathbb{F}^{\frac{1}{3}}} &> \frac{27\mathbb{J}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 12(-1 \mp \sqrt{3}i) - 18\mathbb{J}^{\frac{1}{3}}}{54\mathbb{J}^{\frac{1}{3}}} \Rightarrow \\
\frac{27\mathbb{F}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) - 18\mathbb{F}^{\frac{1}{3}}}{\mathbb{F}^{\frac{1}{3}}} &> \frac{27\mathbb{J}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 12(-1 \mp \sqrt{3}i) - 18\mathbb{J}^{\frac{1}{3}}}{\mathbb{J}^{\frac{1}{3}}} \Rightarrow \\
27\mathbb{F}^{\frac{1}{3}}(-1 \pm \sqrt{3}i) - 18 &> 27\mathbb{J}^{\frac{1}{3}}(-1 \pm \sqrt{3}i) - 18 + \frac{12(-1 \mp \sqrt{3}i)}{\mathbb{J}^{\frac{1}{3}}} \Rightarrow
\end{aligned}$$

$$\mathbb{J}^{\frac{1}{3}}\left(\mathbb{F}^{\frac{1}{3}} - \mathbb{J}^{\frac{1}{3}}\right) > \frac{4(-1 \mp \sqrt{3}i)}{9(-1 \pm \sqrt{3}i)} \Rightarrow \mathbb{J}^{\frac{1}{3}}\left(\mathbb{F}^{\frac{1}{3}} - \mathbb{J}^{\frac{1}{3}}\right) \pm 0i > \frac{(\sqrt{3}i \pm 1)^2}{9},$$

which is true as a lexicographic, of course, total order, because it has already been shown that $\mathbb{J}^{\frac{1}{3}}\left(\mathbb{F}^{\frac{1}{3}} - \mathbb{J}^{\frac{1}{3}}\right) > 0$.

To order Y 's, we start with $\bar{b}''$ and $\bar{\bar{b}}''$. Inserting $\bar{b}''$ in (A1) and solving for r :

$$\begin{aligned} r &= \frac{M(N+1)}{P_{-1}(1+\pi)N\Gamma(\lambda-b)} \\ &= \frac{M(N+1)27\mathbb{F}^{\frac{1}{3}}}{P_{-1}(1+\pi)N\Gamma\left[9\mathbb{F}^{\frac{1}{3}}\left(1+3\lambda\mathbb{F}^{\frac{1}{3}}\right)-27\mathbb{F}^{\frac{2}{3}}-12\right]} \end{aligned} \quad (A4)$$

Replacing the r and b in (A2) by (A4) and (17'), respectively, one obtains the following quadratic equation in Y ,

$$Y^2\mathcal{U}[2h(1-y)]^2 - Y\{1-c(1-\tau)-2\mathcal{U}h(1-y)\} + (\mathcal{U}+G) = 0$$

with roots

$$Y = \frac{\mathcal{V} \pm \sqrt{\mathcal{V}^2 - 4\mathcal{U}[2h(1-y)]^2(\mathcal{U}+G)}}{2\mathcal{U}[2h(1-y)]^2} \quad (A5)$$

where

$$\begin{aligned} \mathcal{U} &= \frac{NA\left\{27\mathbb{F}^{\frac{1}{3}}P_{-1}N\Gamma\left[9\mathbb{F}^{\frac{1}{3}}\left(1+3\lambda\mathbb{F}^{\frac{1}{3}}\right)-27\mathbb{F}^{\frac{2}{3}}-12\right]\right\}^2}{(N+1)\left[M(N+1)729\mathbb{F}^{\frac{2}{3}}+27\mathbb{F}^{\frac{2}{3}}+12-9\mathbb{F}^{\frac{1}{3}}\right]^2}, \\ \mathcal{V} &= \{1-c(1-\tau)-2\mathcal{U}h(1-y)\} \end{aligned}$$

Repeating the same procedure for the case of price competition, in which case,

$$r = \frac{2M}{P_{-1}(1+\pi)N\Gamma(\lambda-b)} = \frac{2M27\mathbb{J}^{\frac{1}{3}}}{P_{-1}(1+\pi)N\Gamma\left[9\mathbb{J}^{\frac{1}{3}}\left(1+3\lambda\mathbb{J}^{\frac{1}{3}}\right)-27\mathbb{J}^{\frac{2}{3}}-12\right]} \quad (A6)$$

these results are duplicated as:

$$Y = \frac{\mathcal{Z} \pm \sqrt{\mathcal{Z}^2 - 4\mathcal{W}[2h(1-y)]^2(\mathcal{W}+G)}}{2\mathcal{W}[2h(1-y)]^2} \quad (A7)$$

with

$$\mathcal{W} = \frac{NA \left\{ 27\mathbb{J}^{\frac{1}{3}} P_{-1} N \Gamma \left[9\mathbb{J}^{\frac{1}{3}} \left(1 + 3\lambda\mathbb{J}^{\frac{1}{3}} \right) - 27\mathbb{J}^{\frac{2}{3}} - 12 \right] \right\}^2}{4 \left[M1458\mathbb{J}^{\frac{2}{3}} + 27\mathbb{J}^{\frac{2}{3}} + 12 - 9\mathbb{J}^{\frac{1}{3}} \right]^2},$$

$$\mathcal{Z} = \{1 - c(1 - \tau) - 2\mathcal{W}h(1 - y)\}$$

We have to show that

$$\frac{\mathcal{Z} \pm \sqrt{\mathcal{Z}^2 - 4\mathcal{W}[2h(1 - y)]^2(\mathcal{W} + G)}}{2\mathcal{W}[2h(1 - y)]^2} > \frac{\mathcal{V} \pm \sqrt{\mathcal{V}^2 - 4\mathcal{U}[2h(1 - y)]^2(\mathcal{U} + G)}}{2\mathcal{U}[2h(1 - y)]^2}$$

or that

$$\begin{aligned} 2\mathcal{U}\mathcal{Z} \pm 2\mathcal{U}\sqrt{\mathcal{Z}^2 - 4\mathcal{W}[2h(1 - y)]^2(\mathcal{W} + G)} \\ > 2\mathcal{W}\mathcal{V} \pm 2\mathcal{W}\sqrt{\mathcal{V}^2 - 4\mathcal{U}[2h(1 - y)]^2(\mathcal{U} + G)}, \end{aligned}$$

which would be true for sure iff: $2\mathcal{U}\mathcal{Z} > 2\mathcal{W}\mathcal{V} \Rightarrow \mathcal{U}\mathcal{Z} > \mathcal{W}\mathcal{V} \Rightarrow$

$$\begin{aligned} & \frac{NA \left\{ 27\mathbb{F}^{\frac{1}{3}} P_{-1} N \Gamma \left[9\mathbb{F}^{\frac{1}{3}} \left(1 + 3\lambda\mathbb{F}^{\frac{1}{3}} \right) - 27\mathbb{F}^{\frac{2}{3}} - 12 \right] \right\}^2 \{1 - c(1 - \tau) - 2\mathcal{W}h(1 - y)\}}{(N + 1) \left[M(N + 1)729\mathbb{F}^{\frac{2}{3}} + 27\mathbb{F}^{\frac{2}{3}} + 12 - 9\mathbb{F}^{\frac{1}{3}} \right]^2} \\ & > \frac{NA \left\{ 27\mathbb{J}^{\frac{1}{3}} P_{-1} N \Gamma \left[9\mathbb{J}^{\frac{1}{3}} \left(1 + 3\lambda\mathbb{J}^{\frac{1}{3}} \right) - 27\mathbb{J}^{\frac{2}{3}} - 12 \right] \right\}^2 \{1 - c(1 - \tau) - 2\mathcal{U}h(1 - y)\}}{4 \left[M1458\mathbb{J}^{\frac{2}{3}} + 27\mathbb{J}^{\frac{2}{3}} + 12 - 9\mathbb{J}^{\frac{1}{3}} \right]^2} \end{aligned}$$

To prove this, is the formidable task, which is why has prompted in the text the ordering of Y 's based on the sign of $\partial Y / \partial b$. In the case of quantity competition, proceeding to solve for Y using (A4) but not (17'), (A5) becomes

$$Y = \frac{[1 - c(1 - \tau)] \pm \sqrt{[1 - c(1 - \tau)]^2 - 4\mathbb{B}}}{\frac{2NA[P_{-1}N\Gamma(\lambda - b)]^2[h(1 - y)]^2}{(N + 1)[M(N + 1)(1 + b)]^2}} \quad (A5')$$

where

$$\mathbb{B} = \frac{4(NA)^2[P_{-1}N\Gamma(\lambda - b)]^4[h(1 - y)]^2}{(N + 1)^2[M(N + 1)(1 + b)]^4} + \frac{4NA[P_{-1}N\Gamma(\lambda - b)]^2[h(1 - y)]^2G}{(N + 1)[M(N + 1)(1 + b)]^2}$$

Next, given the spreads

$$r_L - r_D = [(1 + 2b) - \lambda]r$$

$$r_L - r_D = \left(\frac{4 - \lambda + 5b}{2} \right) r$$

substituting b 's yields under quantity competition

$$r_L - r_D = \frac{2M(N+1) \left(27\mathbb{F}^{\frac{2}{3}} + 12 - 9\mathbb{F}^{\frac{1}{3}} \right) + (1-\lambda)M(N+1)27\mathbb{F}^{\frac{1}{3}}}{P_{-1}(1+\pi)N\Gamma \left[9\mathbb{F}^{\frac{1}{3}} \left(1 + 3\lambda\mathbb{F}^{\frac{1}{3}} \right) - 27\mathbb{F}^{\frac{2}{3}} - 12 \right]}$$

$$r_L - r_D = \frac{2 \left[27\mathbb{F}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 12(-1 \mp \sqrt{3}i) - 18\mathbb{F}^{\frac{1}{3}} \right] M(N+1) + M(1-\lambda)(N+1)54\mathbb{F}^{\frac{1}{3}}}{P_{-1}(1+\pi)N\Gamma \left[18\mathbb{F}^{\frac{1}{3}}(1+3\lambda) - 27\mathbb{F}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) - 12(-1 \mp \sqrt{3}i) \right]}$$

while under price competition

$$r_L - r_D = \frac{5M \left(27\mathbb{J}^{\frac{2}{3}} + 12 - 9\mathbb{J}^{\frac{1}{3}} \right) + (4-\lambda)M27\mathbb{J}^{\frac{1}{3}}}{P_{-1}(1+\pi)N\Gamma \left[9\mathbb{J}^{\frac{1}{3}} \left(1 + 3\lambda\mathbb{J}^{\frac{1}{3}} \right) - 27\mathbb{J}^{\frac{2}{3}} - 12 \right]}$$

$$r_L - r_D = \frac{5M \left[27\mathbb{J}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 12(-1 \mp \sqrt{3}i) - 18\mathbb{J}^{\frac{1}{3}} \right] + M(4-\lambda)54\mathbb{J}^{\frac{1}{3}}}{P_{-1}(1+\pi)N\Gamma \left[18\mathbb{J}^{\frac{1}{3}}(1+3\lambda) - 27\mathbb{J}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) - 12(-1 \mp \sqrt{3}i) \right]}$$

with the first in order of presentation spread referring in either competition case to Taylor rule, and the second spread to discretionary monetary policy. The corresponding derivatives with respect to N are:

$$\frac{\partial(r_L - r_D)}{\partial N} = - \frac{2M \left(27\mathbb{F}^{\frac{2}{3}} + 12 - 9\mathbb{F}^{\frac{1}{3}} \right) + (1-\lambda)M27\mathbb{F}^{\frac{1}{3}}}{P_{-1}(1+\pi)\Gamma \left[18\mathbb{J}^{\frac{1}{3}}(1+3\lambda) - 27\mathbb{J}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) - 12(-1 \mp \sqrt{3}i) \right] N^2} < 0$$

$$\frac{\partial(r_L - r_D)}{\partial N} = - \frac{2M \left[27\mathbb{F}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 12(-1 \mp \sqrt{3}i) - 18\mathbb{F}^{\frac{1}{3}} \right]}{P_{-1}(1+\pi)\Gamma \left[36\mathbb{F}^{\frac{1}{3}} - 27\mathbb{F}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) - 12(-1 \mp \sqrt{3}i) \right] N^2} < 0$$

$$\frac{\partial(r_L - r_D)}{\partial N} = - \frac{2 \left[27\mathbb{F}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 12(-1 \mp \sqrt{3}i) - 18\mathbb{F}^{\frac{1}{3}} \right] M + M(1-\lambda)54\mathbb{F}^{\frac{1}{3}}}{P_{-1}(1+\pi)\Gamma \left[18\mathbb{F}^{\frac{1}{3}}(1+3\lambda) - 27\mathbb{F}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) - 12(-1 \mp \sqrt{3}i) \right] N^2} < 0$$

and

$$\begin{aligned} & \frac{\partial(r_L - r_D)}{\partial N} \\ &= - \frac{5M \left[27\mathbb{J}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) + 12(-1 \mp \sqrt{3}i) - 18\mathbb{J}^{\frac{1}{3}} \right] + M(4 - \lambda)54\mathbb{J}^{\frac{1}{3}}}{P_{-1}(1 + \pi)\Gamma \left[18\mathbb{J}^{\frac{1}{3}}(1 + 3\lambda) - 27\mathbb{J}^{\frac{2}{3}}(-1 \pm \sqrt{3}i) - 12(-1 \mp \sqrt{3}i) \right] N^2} \\ & < 0 \end{aligned}$$

Finally, it is too difficult technically to obtain the derivative $\partial Y / \partial N$ to see through its sign the impact of bank concentration on output.

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