An Empirical Analysis of Bank Branching: Portugal 1989–1991

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Abstract

We consider a simple oligopoly model in which firms (banks) choose the number of sales outlets (branches). The model is applied to data from Portuguese bank branching in the late 80s. The estimated results help in explaining the patterns of branch network expansion in that period, especially the differences between incumbents' and entrants' behavior.

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1 Introduction

Entry into Portuguese banking was liberalized in the mid-eighties. In the ensuing years, the total number of bank branches increased dramatically (about 75% between 88 and 92). This increase resulted both from entry by new banks and from expansion by incumbents. Incumbent banks, mostly publicly owned, expanded mainly in rural areas, whereas entrants (private banks) expanded mainly in urban areas.

These empirical facts raise a number of interesting questions: Why did incumbent banks expand as much as they did? Why did the pattern of expansion differ so much between incumbent/public and entrant/private banks? At a more theoretical and general level, how to model the choice of the number of branches in an oligopoly context?

In a companion paper (Cabral and Majure (1993)), we have proposed a general model of oligopoly competition between multi-product, or multi-location, firms. In the present paper, we estimate an adapted version of that model with data from Portuguese banks.

We begin, in Section 2, by briefly presenting the theoretical model. One of the interesting issues here is the strategic nature of the variable "number of branches." It turns out that this variable can be either a strategic substitute or a strategic complement. The second possibility is especially appealing as it might explain, in principle, the expansionary pattern of incumbent banks in response to entry liberalization.

In Section 3, we review in greater detail some of the stylized facts of the Portuguese banking sector in the late 80s. The empirical model is presented in Section 4. In this model, we assume that banks adjust their number of branches in a Cournot-like tatonnement process (i.e., choices in each period correspond to the reaction curve applied to the rivals' choices in the previous period). The model is estimated by nonlinear least squares.

The empirical results are discussed in Sections 5 and 6. The results suggest that the geographical differences between the incumbents' and the entrants' expansion

patterns stem from differences in relative efficiency (entrants relatively more efficient in urban areas) and from the different degrees of customer loyalty (rural customers more loyal than urban customers). The results also reveal that the strategic variable "number of branches" is a strategic substitute for some banks and a strategic complement for some other banks. However, the pattern of strategic complementarity is not sufficient to explain the large expansion by incumbent banks.

Section 7 concludes the paper.

2 A model of branching

In this section, we present a brief description of the theoretical model to be estimated with data from Portuguese banking.[1] We assume that the market is characterized by a fixed number, N, of identical locational nodes and a mass of consumers, one per node. Consumers —depositors, in our specific application— are located both at the nodes and along the paths which connect the nodes. Banks, on the other hand, can only locate their branches at the nodes.[2] Conceptually, these nodes are meant to represent something like shopping areas or street corners abstracted from the immense complexities of a realistic street system.

Depositor preferences are lexicographic: each depositor attempts to minimize transportantion costs. Therefore, if some bank is located at the node nearby the depositor's address, then the depositor goes to some bank located at that node. If no bank is located at that node, then the depositor travels to another node according to some pre-determined preference ordering, until a served node is found. These preference orderings for second-, third-, etc. choices are uniformly distributed across depositors and are *independent of location*.[3] Intuitively, the idea is that a depositor first looks for a branch located close to his home address. If no branch is found, then he will look for a branch close to work; and then close to his child's school; etc. The idea is that there is little correlation between place of residence and place of work, etc.[4]

Each of the m banks simultaneously decide how many branches to have, n_i, and allocate these to one node each. Since our main focus is on the choice of the *number* of branches, we make the location choice as simple as possible. Specifically, we assume that location is a random process, with each node being given equal probability (given the constraint that not more than one branch is allocated to any given node).[5]

Unfortunately, it is not possible to determine exact reaction functions and equilibrium values in general. However, by assuming that the values n_i are large and treating them as a continuous variable (a reasonable assumption in the large number case), the analysis becomes significantly simpler.

Denote by $n = (n_i, n_{-i})$ the vector of number of branches per bank and by $E_i(n_{-i})$ bank i's expected revenue from a branch located at a given node which is originated from the depositors located at that node. $E_i(n_{-i})$ can, in principle, be a very complex function; for now, it suffices to assume that it is decreasing in each n_j, $j \neq i$.

The number of depositors *served* at each node is greater than the number of depositors *located* at each node. This is so because there are nodes which remain unserved. The fraction of such nodes is given by

$$P(n) = \prod_{k=1}^{m} \left(1 - \frac{n_k}{N}\right),$$

The total expected revenue per branch for bank i is then

$$E_i + E_i\left(\frac{P}{1-P}\right) = E_i\left(\frac{1}{1-P}\right).$$

Assuming that bank i's cost of opening a new branch is a constant c_i, bank i's total expected profit is

$$\Pi_i(n) = n_i E_i\left(\frac{1}{1-P}\right) - c_i n_i. \qquad (1)$$

Equation (1) illustrates the tradeoffs to branching in this model. The first and last n_i represent the usual tradeoff between the revenue from an additional branch and its cost. The revenue per branch, which is given by E_i times the term in brackets, is a decreasing function of n_i. Additional branches take customers away from existing branches. Some of these customers will switch between branches of

the same firm, and so they will not be a contribution to revenue. The larger a firm's network is, the more of the customers it gets at a new branch will be transfers of this sort, and the lower will be the contribution to revenue.

The general profit function of Equation (1) is concave in n_i. We can thus use the first order condition to derive a reaction function. Let

$$P_{-i} = \prod_{k \neq i}^{m} \left(1 - \frac{n_k}{N}\right).$$

It can be shown that bank i's reaction function is then given by

$$n_i^r(n_{-i}) = N\left[\frac{P_{-i} - 1 + \sqrt{\frac{E_i}{c_i}(1 - P_{-i})}}{P_{-i}}\right].$$

Based on the reaction function we can now say something about the strategic nature of n_i. For very low values of n_{-i}, P_i is close to one and the optimum $n_i^r(n_{-i})$ is very low. The idea is that if there are few competing branches, than it is enough for bank i to open a few branches in order to attract a large fraction of depositors (recall that we assume all depositors "buy" a fixed amount regardless of how much they have to travel).[6] If, on the other extreme, n_{-i} is very large, then both E_i and P_i are low and the optimum $n_i^r(n_{-i})$ is again, low. The intuition is that if there are many rival branches already opened then the expected revenue from opening an additional branch is very low.

To summarize: the optimum number of branches is very low if the number of rival branches is either very low or very high (although for different reasons). This in turn implies that n_i is a strategic complement for low values of n_{-i} and a strategic substitute for high values of n_{-i}.

2.1 An alternative model of spatial competition

The model we have developed so far may be criticized on the basis that it only allows for localized competition in a very stylized way. Each network branch is in direct competition with other branches at the same node; but, other than that, it is equally placed with respect to all other branches in all other nodes. We will now argue that a more standard model of spatial competition may exaggerate in the opposite direction, that is, may involve *too much* localized competition. We will also provide other reasons why our model may provide, both qualitatively and quantitatively, a good approximation to reality.

The most common model of localized competition, in the tradition of Hotelling (1929), is Salop's (1979) circular-city model. In order to make the comparison with our model possible, we will consider the extreme case when the density of nodes is so large that the probability of two branches coinciding is close to negligible. In addition, we assume there is no price competition, so that we have a pure location game.

It can be shown that there exist no pure-strategy equilibria in this location game: each firm's best response is always to locate just around the rival's locations and thus maximize the customer base. It can also be shown that it is an equilibrium for firms to locate their branches equally spaced along the circle and randomize the location of this pattern on the circle with a uniform distribution.

Based on this, market shares can be easily computed: restricting to the duopoly case, they are given by $s_i = n_i/(2n_j)$ and $s_j = (2n_j - n_i)/(2n_j)$, where $n_i \leq n_j$. From market shares, we can derive expected profit and reaction functions. It can be shown that the reaction function $n_i^r(n_j)$ consists of three different sections. For $n_j < n'$, $n_i^r(n_j)$ is increasing, concave and greater than n_j; for $n' < n_j < n''$, $n_i^r(n_j) = n_j$; and for $n_j > n''$, $n_i^r(n_j) = 0$.

The circular-city model has both differences and elements in common with our model. First, note that in both cases reaction functions are first increasing and then decreasing. However, in the circular-city model this occurs in a discountinuous way, whereas in our model reaction curves are smooth. Second, while a unique symmetric equilibrium can be found in our model, the circular-city model can easily admit multiple equilibria: recall that, when $n' < n_j < n''$, $n_i^r(n_j) = n_j$.

The third point of comparison relates to market shares. As we mentioned before, our model may be criticized on the basis that it does not admit enough localized competition. However, the circular-city model may be criticized for the precise opposite reason. In fact, the model tends to over-estimate the larger firms' market

share. The idea is that the larger firm guarantees to itself all of the demand between two of its adjacent branches; the smaller firm is thus confined to a small fraction of the potential market. In fact, the smaller firm's market share, $n_i/(2n_j)$, is less than the fraction of the total number of branches that it owns, $r_i \equiv n_i/(n_i + n_j)$. In our model, however, it can be shown that $s_i \rightarrow n_i/(n_i+n_j)$ when $N \rightarrow \infty$. In particular, it can be show that, at $r_i = 0$, $\partial s_i/\partial r_i = 1$ for our model and $\partial s_i/\partial r_i = 1/2$ for the circular-city model. But the data we use in the empirical section seems to reject the second hypothesis against the first.[7]

In summary, our model and the circular-city model are qualitatively similar with regards to the shape of reaction functions. However, the former seems better indicated for the purpose of empirical estimation.

3 The puzzling pattern of Portuguese bank branching[8]

From 1975 to 1984, virtually all banks operating in Portugal were State owned. Interest rates, credit ceilings, and other variables were directly controlled by the Government and the Bank of Portugal (the central bank). Competition was therefore virtually nonexistent. The 1980's, by contrast, were a decade of overall deregulation and privatization, and the banking sector was not an exception. In 1984, a law was passed allowing entry by new private banks. Later on, a privatization plan for several of the public banks was drafted; the first privatization was processed by the end of the decade.[9] Beginning in December of 1984, new domestic private banks were created and foreign banks entered the Portuguese market. These new banks gradually increased their number of branches. Together with the expansion by the incumbent banks, this led to a very rapid increase in the total number of branches.[10] Table 1 presents the number of branches in continental Portugal by the end of 1988, as well as the increase in the number of branches during the period 1989–91.

The table depicts a pattern of branching that is puzzling. First, the total increase in the number of branches during 1989–91 was fairly large, a growth rate of more

Table 1: Number of bank branches in continental Portugal. (Source: Bank of Portugal.)

Concept	By end 88	New in 89+90
Four largest	628	225
BCP	18	113
CGD	339	45
Private	191	174
Urban	102	118
Rural	89	56
Public	1325	159
Urban	477	65
Rural	848	94
Total	1516	333

than 10% a year. Second, growth was highly concentrated in four banks, *Caixa Geral de Depósitos* (CGD), *Banco Comercial Português* (BCP), *Banco Espírito Santo e Comercial de Lisboa* (BESCL), and *Banco Pinto e Sotto Mayor* (BPSM), which accounted for more than two thirds of the increase in the number of branches. Of these four, CGD and BCP alone accounted for roughly half. Third, the increase in the number of branches was more or less evenly distributed between public and private banks (although the growth rate was much higher for private banks than for public banks). Finally, while private banks have mainly invested in "urban areas" (Lisbon and Oporto districts), public banks seem to have focussed on "rural areas" (all districts except Lisbon and Oporto).[11]

In addition to the data, there is some anecdotal evidence that the new, private banks are more efficient than the old, public banks; in particular, there is a common perception that the private banks' marginal profitability of an extra branch is larger than the public banks', especially because operating costs (in efficiency units) are lower. On the other hand, public banks, especially CGD, have the advantage of controlling a fairly large customer base consisting mainly of very "loyal" depositors, that is, depositors with a high cost of switching to other banks.

If we were to base our analysis solely on comparisons of bank profitability, we

would expect private banks to be the only ones expanding. But, perhaps a large and loyal customer base is a "substitute" for high margins as a determinant of high propensity to open new branches. This would help explain the difference between "urban" and "rural" areas, but the traditional analysis would still have difficulty explaining an incumbent that responds to entry by expanding.

All these stylized facts and conjectures motivate the estimation of the theoretical model of Setion 2 using data from Portuguese bank branching.[12]

4 Empirical model

The extremely high and sustained growth rate of branches in the Portuguese banking industry during 1989–1991 indicates that the industry was not in an equilibrium during this period. It is possible that year to year changes could produce an equilibrium one year that was much higher than the equilibrium in another year. It is also possible that another wave of changes could cause growth in multiple periods. But, a pattern of very high growth rates over a period of several years requires a somewhat particular sequence of significant and unforseen shocks. Despite the high rate of legislative change in this industry, a more compelling explanation seems to be that the industry is undergoing a non-instantaneous transition to a higher equilibrium. This target equilibrium may be subject to some fluctuation from year to year, but these changes seem less significant than the difference between the current state and the equilibrium.

From an empirical perspective, disequilibrium is not very attractive. To completely model the situation, we should expand the model of competition in branches to include a constraint on the acquisition of new branches and to include dynamic interaction through an infinite-period game with discounting. However, this would introduce additional complications since there would exist multiple equilibria. For the purpose of empirical estimation, we have chosen to assume that the players follow a particular strategy. In each period, they increase the number of branches by some fixed proportion of the difference between the current level and the static reaction function evaluated at that date—the game-theoretic correspondent to the partial adjustment model, a model which is frequently used in Applied Econometrics. This strategy is not completely arbitrary in that it is similar to a set of strategies that Reynolds (1987) has found to constitute an equilibrium of a capacity accumulation game with an infinite horizon.[13] In addition, 1989–1991 was a period or relative uncertainty regarding future trends in banking regulation, which to some extent is reflected in banks discounting the future more heavily, thus behaving more closely to the myopic best response.

Our formulation has the advantage that the accumulation is proportional to the myopic "need," so the reaction function of the static game, and therefore the accumulation path, can be estimated with dynamic data. The empirical model is thus

$$n_{ij}^{t+1} - n_{ij}^t = \alpha_i^t \left(n_{ij}^r(n_{-ij}^t) - n_{ij}^t \right) + u_{ij}^t \qquad (2)$$

where n_{ij}^t is the number of branches of bank i in geographic region j at time t. The geographic regions of Portugal are considered to be separate markets. Therefore, the reaction function of player i, $n_{ij}^r(\cdot)$, is also indexed by the region, j. This allows for variation in the number of nodes, N_j^t, the expected revenue at a node, E_{ij}^t, and the cost of an additional branch, c_{ij}. The reaction function also depends, of course, on the number of branches that opponents have, but only in that region, the vector n_{-ij}^t. The adjustment rate α_i^t is allowed to vary across banks and time. This variance accomodates differences in the implicit constraints that keep the banks from fully adjusting. The errors, u_{ij}^t, are assumed to be independent and identically distributed.

As we have seen before, E_{ij}^t represents the expected revenue from an additional branch coming from the customers located at that branch, that is, excluding customers coming from other (unserved) nodes. It is useful to decompose the value of E_{ij}^t in two factors:

$$E_{ij}^t = Q_{ij}^t \pi_{ij}^t.$$

The second factor, π_{ij}^t, is the value of revenues per unit of depositors; the first factor

is the expect share of that total revenue upon opening an additional branch. This is a useful decomposition because, given our tatonnement assumption, we can actually determine the values of Q_{ij}^t from actual market shares (in deposits):

$$Q_{ij}^t = (1 - P_j^t) s_{ij}^t / n_{ij}^t,$$

where

$$P_j^t = \prod_{k=1}^{m} \left(1 - \frac{n_{kj}^t}{N_j^t} \right).$$

and s_{ij}^t are actual market shares.

Rearranging Equation (2) and substituting the general reaction function for $n^r(\cdot)$ yields

$$n_{ij}^{t+1} = \alpha_i^t N_j^t \left[\frac{P_{-i} - 1 + \sqrt{Q_{ij}^t \frac{\pi_{ij}^t}{c_i}(1 - P_{-i})}}{P_{-i}} \right] + (1 - \alpha_i^t) n_{ij}^t. \qquad (3)$$

Since N_j^t , π_{ij}^t , c_i and α_i^t are unknown, we must also specify

$$N_j^t = \beta_1 + \beta_2(Pop_j^t) + \beta_3(Pop_j^t)^2 + \beta_4(Dense_j^t) + \beta_5(ATMC_j^t), \qquad (4)$$

$$\pi_{ij}^t = \delta_1(Prv_i) + \delta_2(Pub_i) + \delta_3 \left(\frac{VAM_j}{N_j^t} \right) + \delta_4(ATMU_j^t), \qquad (5)$$

$$c_i = \delta_5(Prv_i) + \delta_6(Pub_i) \qquad (6)$$

and

$$\alpha_i^t = \alpha_0(Big_i^t) + \alpha_1(D89) + \alpha_2(D90) + \alpha_3(D91). \qquad (7)$$

Since π_{ij}^t and c_i do not enter the equation seperately, their coefficients cannot be estimated seperately. Combining Equations 5 and 6 and simplifying produces a single equation for the ratio of expected profits to startup costs:

$$K_{ij}^t \equiv Q_{ij}^t \frac{\pi_j^t}{c_i} = Q_{ij}^t \left[(Prv_i)\left(\gamma_1 + \gamma_2\left(\frac{VAM_j}{N_j^t}\right) + \gamma_3(ATMU_j^t)\right) \right.$$
$$\left. (Pub_i)\left(\gamma_4 + \gamma_5\left(\frac{VAM_j}{N_j^t}\right) + \gamma_6(ATMU_j^t)\right)\right]. \quad (8)$$

In these approximations Pop is the population, $Dense$ is population density, $ATMC$ is the number of ATM machines, VAM is the Value Added in Manufacturing (which is computed for 1990), $ATMU$ is the average daily transactions per ATM and MS is the regional market share (calculated from deposit data); Pub is 1 if the bank is one of the old public banks, and Prv is 1 if Pub is 0. Those banks that were privatized during the period are still classified as public since the intention is to explore the effects of incumbency.[14] The variable Big is the total number of branches opened by the bank in a year. This variable serves as a normalization so that the number of branches opened locally is compared to the global number. Finally, the errors from these estimations are assumed to have been already accounted for in the u_{ij}^t.

Substituting the linear approximations (4), (7) and (8) into the nonlinear equation (3), the model can be estimated by Nonlinear Least Squares.[15] The results, with aproximate t-statistics in parentheses, are

$$\alpha = \underset{(9.031)}{0.002289}\ (Big)\ \underset{(-0.9960)}{-0.001236}\ (D89)\ \underset{(-0.9895)}{-0.001263}\ (D90)\ \underset{(-1.686)}{-0.002443}\ (D91)$$

$$N = \underset{(5.589)}{19.18}\ \underset{(-0.1347)}{-0.001395}\ (Pop)\ \underset{(6.559)}{+4.102e-05}\ (Pop^2)$$
$$\underset{(-1.092)}{-1.591E+05}\ (Dense)\ \underset{(0.9245)}{+0.03504}\ (ATMC)$$

$$K = (Q_i)[(Prv)(\underset{(0.9854)}{15.04}\ \underset{(7.991)}{+0.02034}\ \left(\tfrac{VAM}{N}\right)\ \underset{(0.5257)}{+0.04485}\ (ATMU))$$
$$+(Pub)(\underset{(1.949)}{18.99}\ \underset{(0.5828)}{+0.03959}\ \left(\tfrac{VAM}{N}\right)\ \underset{(-0.5646)}{-0.05328}\ (ATMU))]$$

5 Specification tests

The traditional measure of goodness of fit, R^2, is the ratio of Estimated Sum of Squares to Total Sum of Squares and in this estimation is equal to 0.9831. However, in the linear model R^2 has an interpretation as part of an F test of the hypothesis that all of the coefficients are 0 except the constant term. Setting all of the coefficients to be 0 in this nonlinear model generates a restricted model where n_{ij}^t is predicted by n_{ij}^{t-1} as opposed to the sample mean as in a linear model. Define a generalized R^2 based on this generalized F test as

$$R_*^2 = 1 - \frac{\sum(n_{ij}^t - \hat{n}_{ij}^t)^2}{\sum(n_{ij}^t - n_{ij}^{t-1})^2};$$

then R_*^2 is 0.8111. The generalized F test of the hypothesis that all of the coefficients are 0 rejects overwhelmingly.

Although R^2 and R_*^2 indicate that this specific model fits the data very well, there is still a question of whether or not another model might explain it better. In order to test the specification of the model various coefficients were introduced on the computed variables. The first test places a coefficient on P_{-i} wherever it appears in $n^r(\cdot)$. The test statistic of the t test that this coefficient is equal to 1 is -0.0006687 which gives it a p-value of 0.9995. Thus, this specification restriction is not rejected by the data for any typical significance level.

The next test expands the first. Since P_{-i} appears 3 times, let the coefficient be different for each one and test that all 3 are equal to one. The coefficients are given by

$$n_{ij}^{t+1} = \alpha_i^t N_j^t \left[\frac{\phi_1 P_{-i} - 1 + \sqrt{K_{ij}^t(1 - \phi_2 P_{-i})}}{\phi_3 P_{-i}}\right] + (1 - \alpha_i^t) n_{ij}^t.$$

The test statistics are reported in Table 2 for the t tests of the seperate hypotheses that each of the coefficients equal 1. These tests are not as overwhelming as the first test. In fact, for some reasonable significance levels these tests will reject. Still, the results are somewhat ambiguous as the test statistics are borderline.

The last specification test uses the fact that N enters $n^r(\cdot)$ both directly and through the calculation of P_{-i}. Putting a coefficient on the direct N, ϕ_4, and

Table 2: P_{-i} Coefficients

	t statistic	p-value
ϕ_1	−2.495	0.01280
ϕ_2	−1.712	0.08725
ϕ_3	1.857	0.06361

Table 3: N Coefficients

	t statistic	p-value
ϕ_4	−0.1912	0.8484
ϕ_5	−24.36	3.470E−98

another on the indirect, ϕ_5, allows tests of the specification restriction that each of these equals 1. The test statistics are reported in Table 3. This time one of the coefficients is overwhelmingly likely to be equal to 1, but the other is overwhelmingly unlikely. Taken with the test results from above the indication seems to be that the data would like more freedom in predicting the individual firms' beliefs about the likelihood of confrontation, but that if this belief is to come from a consistent model, then the one specified is a good one. That is, a better estimate could be made if each firm were allowed to use a different value of N to predict the likelihood of confrontation from the value used in determining their own actions. Also, if the N's are taken to be the same, then a better estimate might be made if the firms could be inconsistent about their use of the prediction of the probability of confrontation. Still, if consistency is imposed the specified model is valid.

Besides the traditional goodness of fit measure, R^2, we are also concerned with the reasonableness of the computed variables. Descriptive statistics for these are reported in Table 4. As a whole these do seem to be reasonable. There are some players who seek a saturation of the market, $n^r(\cdot) = N$, and there are others who are barely participating. The average of 90% saturation seems reasonable when the average region has 51 locations.

However, there is obviously a problem at the low end of the distribution of the adjustment rate, α. A negative adjustment rate is clearly wrong. One explanation

Table 4: Descriptive Statistics for Computed Variables

Variable	Mean	Min	Max	Std Dev
α	0.02634	−0.007021	0.2356	0.04347
N	50.93	19.47	190.6	54.64
K	7.084	0.002006	63.14	7.135
$n^r(\cdot)$	45.75	1.000	190.6	52.80
$N - n^r(\cdot)$	5.172	0.000	189.6	24.74
$n^r(\cdot) - n^t$	39.56	0.000	189.6	49.52
P_{-i}	0.05591	1.042E−16	0.1240	0.03777
Q_i	0.1096	3.178E−05	0.9527	0.07494

for this shortcoming is that Nonlinear Least Squares does not do well when the error distribution has thick tales. In this data there is a large disparity between the growers and the non-growers. If this difference is not accounted for sufficiently in the explanatory variables, then the errors will have thick tales. Banks either expanded a lot or very little. This disparity probably arises from different business practices. One bank may consider depositors an essential source of funds and compete heavily in branches while another prefers the interbank market and uses branches for loans only. Since this analysis has focused exclusively on the deposits side of banking, and therefore assumed that all banks had the same business practice, the data have a problem explaining banks that do not expand. Such a problem would lead to low values of α and is indicated by the fact that the fitted values of growth in Table 5 are low for the private banks since that group would contain most of the banks with business practices that are not focussed on deposit taking in Portugal.

Another explanation of the low adjustment rate, however, is also interesting. If banks perceive currently high profitability as a temporary state, then they will react not to the current levels but to their expected levels discounted over time. This behavior would mean that banks are not adjusting to today's reaction curves but to lower curves. It is possible that banks have expectations of future profitability that make them adjust in a slightly different direction than today's reaction curves would indicate. If that is true, then there will be some mis-estimation of the reaction functions.

Table 5: Predicted and Actual Growth

	Urban areas		Rural Areas	
	Pred.	Actual	Pred.	Actual
Public	197	172	212	202
BESCL	34	26	41.5	36
BPSM	23.4	22	27.9	21
BTA	26	20	31.3	27
CGD	44.5	44	25.9	51
Private	183	240	107	133
BCI	45.7	46	19.5	23
BCP	121	125	86.1	92
Total	380	412	319	335

While the low end of the distribution of estimated adjustment rates looks bad, the high end looks good. It would be difficult to say that the adjustment rate should be much higher than 25% since the growth patterns do not taper off that much. Thus, the problem seems to be that more of the adjustment rates should be at the higher end of the observed range, rather than that the observed range is too low. This property lends credence to the first explanation, different business practices. This model is, perhaps, not appropriate for some of the participants in Portuguese banking.

6 Discussion

We begin with a discussion of the estimates obtained and then suggest how the empirical results can explain the recent pattern of Portuguese bank branching.

6.1 Coefficient values

The coefficient on *ATMC* is positive, so more ATM machines in a region implies more potential sites for bank branches. This would follow if ATM's and branches are providing complementary services. Then, more ATM's would indicate more demand for banking and, thus, more potential sites for branches. On the other hand, if they are substitutes, then an ATM would act as a branch at that location for every bank

since all banks use the one ATM network. Thus, a region with a given number of nodes initially would seem to have fewer nodes for actual branches the more of them were taken out of competition by an ATM machine. We can, therefore, conclude that bank branches and ATM's are providing complementary services.

The coefficient on *Pop* is negative and that on Pop^2 is positive, which would indicate a U-shaped curve. This shape and the fact that the regions of Lisbon and Oporto are high outliers in the distribution of population indicates that these regions constitute much larger markets than the other regions. The negative coefficient on *Dense* indicates that in denser sections there are fewer nodes with larger populations. These results accord well with a perception of the urban markets as large and profitable.

The last set of coefficients that offers an interesting interpretation are those on *ATMU* for the private and public banks. The fact that this is positive for private banks and negative for public banks can be understood by viewing this variable as an indication of depositor sophistication. Customers who use the ATM network extensively probably have lower switching costs, so in a region where there is a large proportion of this type of customer the established banks have less of an advantage.

6.2 Strategic substitutes vs. complements

The estimation of the empirical model allows the numerical computation of an interesting counterfactual. What would the public banks have done if the private banks had not entered the market? By using the estimated parameter values on a data set that contains only the public banks we can address a question that is very close to this one. The difference arises from the fact that the parametric form of K cannot be decomposed to fit the counterfactual. We cannot say what the market shares would have been without entry, but this problem is less worrisome than it appears. First, a new bank has very little customer loyalty. In this model a new bank is, therefore, not a significant factor in the expected share of revenue, Q_i, of other banks. Note that a new bank is still important to the level of their profits, however, through the increased density of the system (i.e., through the P terms).

Table 6: New Branches In All Regions 1988–1991

Bank	Actual Number	Predicted Number	Predicted Number If No New Banks	% Difference In Predictions
BBI	3	1.88	1.85	0.798
BCA	0	−0.460	−0.460	0.00
BESCL	62	75.5	76.1	−0.977
BFB	15	18.3	18.3	−0.00823
BNU	7	6.83	6.95	−1.62
BPSM	43	51.4	51.9	−1.19
BPA	19	22.3	22.4	−0.279
BTA	47	57.3	57.5	−0.531
UBP	13	14.7	14.9	−1.09
CGD	95	70.4	70.9	−0.503
CPP	38	52.4	52.5	−0.280
BFE	8	9.98	9.96	0.292
BMELL	2	0.00	0.00	0.00
CEL/MG	22	29.2	29.2	−0.0719

Second, a case can be made that since the people most likely to have switched to the new banks are the people with the lowest switching costs. This self selection means that the fact that we do not know who these customers would have been loyal to in the counterfactual is not very important since they would not have been very loyal. We have chosen to allocate the loyal customers of the new banks to the old banks proportionately to the old banks' current loyalty. This is somewhat ad hoc but the above arguments indicate it is not overly significant.

Table 6 presents the results of the counterfactual analysis. While entry seems to have had a slight stifling affect on the branching of incumbents, there is evidence of increased branching by some incumbents as a result of entry. The increase is small in terms of the total number of branches opened, but it is of the same magnitude as the downward shifts. The fact that the increases are as significant as the decreases indicates that the case of simultaneous strategic complements and substitutes is more than just an interesting theoretical diversion. It is, quite possibly, the reality in this industry.

Table 7: Average Values of Explanatory Variables

	1988	1989	1990
Population	522.0	521.4	520.5
Urban	1843.	1844.	1843.
Rural	356.8	356.2	355.1
ATMU (average daily use)	133.9	159.2	161.4
Urban	219.9	219.3	205.2
Rural	123.2	151.6	156.0
ATMC (number of machines)	17.94	27.61	42.78
Urban	100.0	154.0	227.0
Rural	7.688	11.81	19.75
Area	4.933E+07		
Urban	2.550E+07		
Rural	5.231E+07		
Value Added Manufacturing			6.688E+04
Urban			2.605E+05
Rural			4.268E+04
Market Share	0.02857	0.02857	0.02857
Public Urban	0.06496	0.06354	0.06050
Private Urban	0.004309	0.005256	0.007283
Public Rural	0.07064	0.07067	0.07030
Private Rural	0.0005258	0.0005066	0.0007552

6.3 Incumbent/public vs. entrant/private banks

We are particularly interested in comparing incumbent/public and entrant/private banks according to their behavior in the two types of regions. Table 7 provides some average values of the explanatory variables and Table 8 provides averages of some computed variables for the relevant groups. Recall that K is the ratio of expected profits to startup costs from an additional branch, considering only the customers residing at the new branch location. As we have seen, K can be decomposed as the product of Q, the expected share of total revenue, and π/c, the ratio of revenues per unit of customers to branching cost.

Examining the average values of π/c seems to contradict the popular conception that urban markets are more profitable than rural ones and that private banks are more efficient than public banks, other things equal. In fact, based on pure

Table 8: Average Values of Computed Variables by Group (1988).

Group	K	Q (%)	π/c
Public			
Urban	7.298	9.41	60.23
Rural	8.119	12.05	72.11
Private			
Urban	4.240	7.01	76.97
Rural	3.506	4.66	67.73

"efficiency" considerations, that is, the value of π/c, we see that incumbent banks have a relative and absolute advantage in rural markets, whereas entrants have a relative and absolute advantage in urban markets; moreover, no group has an overall absolute advantage over the other.

However, it is also interesting to note that there is a significant difference in the distribution of the variable Q. As we have seen, Q is the per branch expected share of customers each bank expects to get. Since price competition is not very significant, Q can be seen as a measure of customer (depositor) loyalty. The data shows that public banks have a higher Q on average, so greater customer loyalty. The significance of this loyalty is demonstrated by the observation that the expected ratio of profits to costs, K, is higher for public banks than for private banks, even though public banks did not have an absolute advantage on pure "efficiency" grounds. Customer loyalty, then, is a significant "substitute" for efficiency (the latter measured by π/c).

The patterns of branching are thus explained, at least in part. Incumbent banks have expanded because, given the great degree of customer loyalty, there are big incentives to protect market shares. Private/entrant banks focused on the urban markets, where customer loyalty seems to be less important. Incumbent banks have also expanded slightly in these markets, but have acted more in the rural markets where their loyal customer base is larger.

7 Conclusion

In this paper, we have estimated a model of multi-product oligopoly competition with data from Portuguese banks. The model seems to explain the differences between incumbent banks and entrants in what respects to the geographical patterns of expansion. Efficiency and customer loyalty are substitute factors in the incentives to expand. The relative importance of each factor in each geographical region determines the relative advantage of each bank in that region.

Furthermore, the theoretical possibility that the number of branches is a strategic complement does hold for some of the incumbent banks. However, the large expansion by incumbents cannot be solely accounted for by this factor. Alternative explanations for the expansion by incumbents would be (i) a strategy for preempting future entry or (ii) a switch from a cooperative to a non-cooperative equilibrium following entry liberalization.

While we have mainly focused on issues of positive analysis, the results of the paper have interesting policy implications as well. It is possible that the large customer loyalty in rural regions inhibits social efficiency, in that this loyalty prompts a less efficient bank to be the one opening a new branch. Moreover, pushing the new banks to open branches in the rural regions could lead to even more branching by the incumbents (via strategic complementarity), an effect which would likely be socially wasteful. Efforts to reduce customer switching costs would then be beneficial both directly *and indirectly*. The incentives to open new branches would place greater weight on efficiency, and entry would be promoted in a less risky manner.

Endnotes

1. A more detailed analysis of the model can be found in Cabral and Majure (1993).

2. If the concentration of consumers around the nodes is sufficiently high, then this would be a derived result.

3. The independence assumption is similar to that in Von Ungern-Strenberg's (1991) model of "monopolistic competition on the pyramid" (see also Deneckere and Rothschild, 1986).

4. From the perspective of firm competition, the assumption implies the absence of "neighborhood effects:" every firm/branch competes with every other firm/branch. In fact, this is the essence of Chamberlin's monopolistic competition. See Páscoa (1988).

5. See Cabral and Majure (1993) for a discussion of this assumption.

6. In fact, $n_{-i} = 0$ implies $n_i^r(n_{-i}) = 0$. The optimum, however, is to have one branch opened. This is one instance in which the large-continuous-n_i assumption fails.

7. For example, in the district Lisbon and in 1990, a regression of s_i on r_i yielded, for the smaller banks, $s_i = 0.88r_i$, with a standard error of 0.09.

8. The reader interested in additional empirical facts and economic analysis of Portuguese banking is referred to Gordy (1991a,b), Barros and Leite (1993), Barros and Modesto (1994) and Barros (1994).

9. To be more precise; banks were re-privatized. since most of them had been nationalized in 1975.

10. The rate of expansion might have been higher if it were not for the bureaucratic costs of getting new branches approved by the government—by 1992, entry has still not been completely liberalized.

11. For the purpose of our econometric estimation, we have considered the urban areas to be the Lisbon and Oporto districts, and the rural areas the remaining districts. This is a somewhat rough approximation as districts are relatively large areas. A better alternative might be to use data at the coutry level.

12. The theoretical model does not contemplate the possibility of direct consumer benefits from network size. We believe that these benefits are small in the Portuguese market. For a typical depositor, branches other than the "home" branch are used for the sole purpose of obtaining cash. Now, the network of ATM machines is common to all Portuguese banks, so that depositors attach relatively little importance to the network size of the bank they patronize. Models which explicitly consider network effects include Gale (1992), Matutes and Padilla (1993), Nakamura and Parigi (1992).
Other interesting models which explicitly address issues of banking, although not the same as ours, include Neven (1990), Chiappori, Perez-Castrillo and Verdier (1992). Fuentelsaz and Salas (1992), in particular, estimate the empirical determinants of the *total* number of bank branches in Spain. In this paper, we are interested in the number of branches per bank.

13. A partial adjustment strategy also results if firms behave myopically (or discount the future heavily). In particular, it can be shown that if firms compete in quantities, demand is linear, and there is a quadratic adjustment cost function $\frac{\gamma}{2}(q - \bar{q})^2$, where $\bar{q}$ is initial quantity, then the optimal strategy is to produce $\bar{q} + \alpha(q^r - \bar{q})$,

where q^r is the best-response and $\alpha = 2/(2+\gamma)$.

14. This is probably a good place to mention that we assume profit maximization by both the private *and* the public banks. We believe this is a sensible assumption since there is a significant flow of managerial talent between the two types of banks, so that career concerns motivate profit maximization by all managers. For a contransting view, see Barros and Modesto (1994).

15. Note that, since players are determining their reactions to the actions of all players in the previous period, there is no problem of simultaneity in the estimation.

16. If the concentration of consumers around the nodes is sufficiently high, then this would be a derived result.

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The Survival of New Plants: Start-up Conditions and Post-entry Evolution

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Abstract

This paper examines the longevity of entrants. We find size to be an important determinant of the chances of survival, this being particularly relevant to *de novo* entrants as compared to entry by established firms. Current size is also found to be a better predictor of failure than initial size. Moreover, our findings indicate that, after controlling for size differences, past growth matters for survival suggesting a partial adjustment process for firm size in the post entry period. Finally, new plants are more likely to live longer if they enter growing industries or industries with little entry activity.

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