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by

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Financial Liberalization and Competition in Banking: An Empirical Investigation*

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Abstract

We find that Israeli banks lost market power following financial liberalization, despite the fact that the banking industry remained highly concentrated. Building on methods developed by Bresnahan (1982) and Porter (1983), we estimate "monopoly power" and "monopsony power" conduct parameters for the non-indexed local currency loan and deposit markets. In both markets, the hypothesis of perfect competition is rejected, but the market for bank loans is less competitive than the market for bank deposits. We allow the conduct parameters to vary over time, finding a large and statistically significant increase in competition in both markets. We further find that the estimated coefficient of the Euro interest rate in the demand schedule for loans is significantly larger in the second half of the sample period. These findings suggest that international financial liberalization is responsible, at least in part, for the rise in bank competition. A similar process of financial liberalization is taking place in many European countries, and the recent abolition of restrictions on interstate banking in the US is conceptually similar to financial liberalization. The Israeli case can serve as a laboratory for studying the effect of financial liberalization on the competitive conduct of banks.

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1 Introduction

In the past decade, there has been considerable liberalization in Israeli financial markets. Firms were allowed to borrow from banks overseas and to raise equity internationally, and restrictions on the outflow of foreign currency have been eased. The banking sector, however, remained highly concentrated. This raises the question whether banks lost market power as a consequence of liberalization, despite the concentrated market structure.

A similar process of financial liberalization is taking place in many European countries, and is sure to acquire momentum with European Monetary Unification. Since in most European countries the banking system is highly concentrated (and since European banks are similar to Israeli banks in many other respects), the Israeli case can serve as a laboratory for studying the effect of financial liberalization on the competitive conduct of banks.

Shaffer (1994) stresses the recent merger wave in US banking, and remarks that "consolidation has renewed fears of market concentration and monopoly power in the banking industry," and that "policy makers are suspicious of concentration and seek to limit it because they believe that it enables banks to exercise monopoly power, thereby harming depositors and borrowers." He acknowledges that market concentration *per se* is not sufficient nor necessary for monopolistic conduct. Such conduct is a result of many factors, for example, the regulatory environment or geographic segmentation. Restrictions on interstate banking (and on branching in general) may have endowed US banks with local monopoly power. The recent abolition of these restrictions is conceptually similar to "financial liberalization" and may enhance competition in the industry attenuating the potential anti-competitive effect of bank consolidation. The Israeli experience with financial opening and its effect on bank competition is relevant for the debate.

To this end, we estimate conduct in the bank loan and deposit markets, asking whether and why it has changed over time. We focus on the market for non-indexed local currency interest bearing bank deposits and the market for non-indexed local currency bank loans, which constitute approximately 40 percent of total bank deposit and loan activities, generating more than half of total bank finance income. We use monthly industry data for the years 1989–96. The sample is appropriate for our study since important international capital flow liberalization steps took place approximately in the middle of this period.

In our model, banks face (not perfectly) elastic supply of deposits and demand for loans schedules. In addition to raising funds from depositors, banks can borrow from the central bank at an increasing interest rate along bank specific supply schedules determined by the central bank.[1] Since quantities borrowed by individual banks along these schedules are not in the public domain, we use only industry level data. We model banks as Cournot competitors in the deposit and loan markets so that every period, each bank sets the amounts of deposits and loans and the amount to be borrowed from the central bank subject to a resource constraint.[2,3]

In the empirical implementation, we estimate a "monopoly power" conduct parameter and a "monopsony power" conduct parameter, jointly, for the non-indexed local currency deposit and loan markets, building on the method developed in Bresnahan (1982, 1989), Porter (1983), and Lee and Porter (1984). We find that in both markets the hypothesis of perfect competition is rejected and that the market for bank loans is less competitive than the market for bank deposits. We allow the conduct parameters in the deposit and loan markets to vary over time, finding a large and statistically significant increase in the

[1] We provide further details in Section 2.

[2] There are good reasons to model bank competition as taking place in differentiated products with prices (interest rates) as the strategic variables—see Chiappori, Perez-Castrillo, and Verdier (1995)—but the Cournot model is essential for the empirical implementation since it does not require knowledge of interest rates charged by individual banks (information that we do not have). Moreover, the Cournot model has merits in its own right for modeling bank competition; see Yosha (1995) and the discussion therein of the approach taken by Chiappori, Perez-Castrillo, and Verdier (1995).

[3] There is no inter-bank market for liquidity in our model. The inter-bank market is important at the daily frequency, but at the monthly frequency each bank's net position in this market is roughly zero on average.

degree of inter-bank competition in both markets during this period. During the sample period there were no meaningful changes in the structure of the banking industry (number of banks, market shares, and so forth), but the access of domestic individuals to foreign banks greatly improved. A plausible interpretation is that the liberalization of financial markets induced domestic banks to behave more competitively.

A parallel development, no doubt facilitated by the reform in financial markets, was an unprecedented expansion of the Tel Aviv Stock Exchange (TASE) partly due to a large wave of initial offerings of securities by Israeli firms. Since stock market (debt or equity) financing is an alternative to bank loan financing, the wave of initial offerings of securities can be interpreted as reflecting the reduced power of banks with respect to firms seeking external financing.[4] It is, therefore, important to establish whether the estimated increase in the degree of inter-bank competition in the local currency loan market is indeeddue to greater financial opening to foreign capital markets (and not entirely a consequence of the stock market boom, for example).

To address this issue, we include the Euro interest rate in the demand schedule for loans, allowing the estimated coefficient to vary over time. The estimated coefficient is positive and significant, suggesting that competition from abroad affects the demand for local currency loans. Moreover, the coefficient is significantly larger in the second half of the sample period, which is interpreted as evidence that financial liberalization is responsible, at least in part, for the increased competition in the local currency non-indexed bank loan market.

Our paper is part of the literature initiated by Bresnahan (1982) and Porter (1983), and surveyed in Bresnahan (1989). It is obviously related to the literature on competition in the banking industry, surveyed in Shaffer (1992). Relevant papers include Shaffer (1993),

[4] Many European stock markets are currently expanding, strengthening the relevance of the Israeli case.

Graddy (1994), and Wolfram (1999).[5]

The paper makes several contributions to this literature. First, the simultaneous estimation of conduct in the markets for a good and an input of that good—in our case the markets for loans and deposits—combined with a budget constraint that each firm (bank) must satisfy is, to the best of our knowledge, new. Second, the finding of greater competition in deposit markets than in loan markets is important and, again, to the best of our knowledge, has not been documented previously. Third, a byproduct of our analysis is the estimation of supply of deposits and demand for loans schedules that take into account the possibility of non-competitive conduct in these markets.[6]

In the next section we provide an overview of relevant aspects of the Israeli banking sector and the liberalization of financial markets. In Section 3 we present the theoretical framework, and in Section 4 the estimation procedure. In Section 5 we describe the data and the variables used in the empirical analysis, and in Section 6 we present the estimation results. Section 7 is devoted to robustness tests, and Section 8 concludes.

2 Institutional Background

2.1 The banking industry

The Israeli banking system is very concentrated. The combined assets of the two largest banks constitute almost three-quarters of total bank assets, and the five largest banks control over 95 percent of the local currency non-indexed bank deposit and loan markets, with a Herfindahl index of about 0.22 (Figure 1).[7] In many European countries this market

[5] Spiller and Favaro (1984) use a conjectural variation approach; see Bresnahan (1989) for a discussion of this method.

[6] Typically (if not universally), the estimation of demand and supply functions for banking products has not been carried out jointly with the estimation of bank conduct.

[7] We are grateful to the Supervision of Banks, Bank of Israel, for assistance with this computation.

is also concentrated. For example, the Herfindahl index of total bank assets for 1990 in the Netherlands was 0.24, and 0.23 in Norway. In the same year, the five largest banks in France granted about 44 percent of bank credit and held over 58 percent of deposits.

We briefly describe several features of the Israeli banking system that, although not directly related to our study, are relevant for interpreting the empirical findings. As in many Continental European countries, banks in Israel are truly universal, managing mutual and retirement provident funds and controlling subsidiaries such as mortgage banks, underwriters, and brokerage houses. Banks also own the stocks of manufacturing and insurance firms, often up to 25 percent of a single firm's equity, and in some cases more.[8] Since bank market concentration and the scope of bank activities have remained virtually unchanged during the past decade (Figure 1), any change in the competitive behavior during this period cannot be attributed to changes in market structure or in the scope of bank operations. We consider in turn potential factors that might have affected bank competition during the 90s.

2.2 Financial liberalization and the stock market boom

The financial markets reform, initiated in the mid-80s, consisted of several major components. First, the government's involvement in financial markets was reduced drastically. In the past, banks, provident retirement funds, and life insurance companies were required to hand over to the government most of the funds they received from depositors, investors, and buyers of insurance in exchange for special riskless non-traded subsidized bonds. In addition, the government provided subsidized loans to businesses. Banks, provident retirement funds, and life insurance companies are no longer required to deposit funds with the

[8]Following the October 1983 stock market crash, the Israeli government became the owner of almost the entire banking system. For the most part, the government has not interfered with bank operations (except for the appointment of senior managers and directors and in some debt restructuring plans) and is currently in the process of privatizing them; see Yosha (1995) and Blass and Grossman (1996).

Treasury,[9] and banks now extend loans directly to firms.

Second, corporations are now allowed to issue bonds without explicit Treasury approval. In practice, firms have used this source of external financing to a very limited extent. Most firms that raised funds on a stock exchange, in Israel or abroad, did so by issuing equity. As a result, the importance of bank loan financing has decreased, although it still remains a central source of external funds.[10] It is, therefore, interesting to study whether banks still exercise market power in the local currency loan market.

Third, many foreign currency restrictions were removed, and access to capital markets abroad has been eased. In particular, firms are allowed to raise equity capital on overseas stock exchanges and to borrow from foreign banks. Many Israeli firms took advantage of the liberalization by issuing equity abroad, mainly on the New York NASDAQ, and to some extent on the London AIM.[11]

There is no evidence that foreign direct credit (bank or other) to Israeli firms and households increased during this period, although it is highly plausible that this happened, suggesting lower market power for local banks. The 90s exhibited an increase in bank foreign deposits as well as foreign currency denominated deposits. Bank foreign currency denominated loans also increased, but to a lesser extent. Although we do not explicitly incorporate the foreign currency sector in our model, we will make use of these facts in interpreting our empirical findings.[12]

[9]In the case of life insurance companies this applies only to insurance plans issued after 1990.

[10]Yafeh and Yosha (1998), in a study of financing patterns of Israeli manufacturing firms, report that in the years 1992–4 domestic bank credit constituted 20 percent of new external financing. The comparison with previous years is not straightforward since during the late 1980s the government gradually stopped channeling "directed credit" to firms via the banking system. By the end of 1991 there were no outstanding "directed credit" balances; see also Blass and Yosha (2001).

[11]Yafeh and Yosha (1998) report that in the years 1991–4 equity financing on foreign stock exchanges constituted about 12 percent of new external financing of manufacturing firms, compared to no such financing in previous years; see also Blass and Yosha (2001). Blass and Yafeh (2001), in a study of Israeli initial public offerings in New York and Tel Aviv in the 90s, report that 50 out of about 200 offerings were on the NASDAQ, mainly by high-technology firms in software and electronics.

[12]For further aspects of the reform in Israeli financial markets, see Ben Bassat (1993) and Bufman and

During the 90s, the Tel Aviv Stock Exchange grew significantly, from a very small initial base. Market capitalization rose from about 10 percent to one half of gross domestic product, which is comparable to the average in OECD countries, with hundreds of firms issuing stock, many of which for the first time.[13] This may indicate a reduction in the "monopoly power" of banks with respect to firms seeking external financing, regardless of financial liberalization. We address this issue in our empirical work.

2.3 The provision of funds by the central bank

The monetary auctions conducted by the Bank of Israel have been an important mechanism for supplying funds to the financial system during the sample period. Every day, the central bank sets an amount of funds to be sold in a sealed bid auction, and a minimum interest rate.[14] In addition, the central bank announces (once a month), for each commercial bank, a supply of funds schedule—quantities that can be purchased at increasing interest rates, in addition to the quantity purchased in the sealed bid auction.[15] Every day, each bank chooses the amount of funds to be borrowed in this manner, paying increasing rates for additional quantities along its supply curve.

In our empirical analysis, we incorporate the actual supply curves that banks face, and the amount of funds borrowed by each bank in the sealed bid auction as well as along the

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Leiderman (1995).

[13] Yafeh and Yosha (1998) report that in the years 1992–4 equity financing on the Tel Aviv Stock Exchange constituted about 26 percent of new external financing of manufacturing firms, compared to about 7 percent in the years 1985–91.

[14] Essentially, each bank submits a demand curve—desired quantities at various interest rates above the minimum rate. (Interest rate increments must be at least 1/10 of a percentage point.) Quantities for which banks are willing to pay more than the market clearing rate are supplied in full at descending rates, as submitted by each bank. Funds supplied at the margin (at the market clearing interest rate) are rationed according to the relative size of the demanded quantities at this rate.

[15] Typically, the lowest rate of these bank specific supply curves is the same for all banks, and is lower than the market-clearing rate of the sealed bid auction. The equilibrium rate paid at the margin by each bank along this curve (according to the amount borrowed by the bank) is usually roughly equal to the market clearing rate of the auction.

supply curve. We regard the amount borrowed by a bank along the supply curve as one of the choice variables in the profit maximization program.[16]

3 Theoretical Framework

The period t demand function for local currency loans is

$$L_t = d_0 + d_1\, i_t^\ell + d_2\, r_t^\ell + d_3\, z_t^\ell \tag{1}$$

where i_t^ℓ and r_t^ℓ are the period t nominal and real interest rates on loans, and z_t^ℓ is a vector of variables that shift the demand function. The period t supply function of local currency interest bearing deposits is

$$S_t = s_0 + s_1\, i_t^s + s_2\, r_t^s + s_3\, z_t^s \tag{2}$$

where i_t^s and r_t^s are the period t nominal and real interest rates on deposits, and z_t^s is a vector of variables that shift the supply function.

The dependence of the demand for loans on the real interest rate reflects the effect of the real cost of capital on investment, through the evaluation of the profitability of new projects, and on output, through intertemporal substitution in production. The dependence of the demand for loans on the nominal interest rate reflects loan portfolio considerations, for instance, whether to take a local currency non-indexed loan rather than a foreign currency denominated loan. Similar considerations apply to the supply of interest bearing deposits.

[16] In July 1996, the central bank introduced a new instrument that allowed commercial banks to make short term deposits with the central bank. Since September 1996 these deposits exceed the amount of funds sold to the commercial banks. These developments are related to large foreign capital inflows and anti-inflationary policy and are beyond the scope of this study. To avoid complications related to these issues, our sample period ends in June 1996.

The dependence of deposits on the real interest rate reflects the effect of real rates of return on savings on intertemporal substitution in consumption. The dependence of the supply of deposits on the nominal interest rate reflects short-term portfolio considerations, e.g., whether to deposit liquid funds in a local currency non-indexed interest bearing account or in a short-term foreign currency denominated account.

Let

$$i^m_{jt} = a_t + b_{jt}\,\text{ML}_{jt} \tag{3}$$

denote the inverse supply curve of central bank funds (monetary loan) that bank j faces in period t, where ML_{jt} is the size of the loan taken by bank j, i^m_{jt} is the nominal interest rate paid by the bank, and a_t and b_{jt} are constants. As explained in the previous section, the central bank announces this supply curve individually for each bank. Additional quantities borrowed are charged increasing rates along the curve. That is, the central bank "allows" each bank to behave as a perfectly discriminating monopsonist that pays a different price for additional units demanded. In reality, the supply function is a step function, with the lowest rate being the same for all banks (hence a_t is common to all banks), but with the size of the steps varying across banks according to their size. In the empirical implementation, we deal with this issue by computing from the actual data the intercept and an approximation of the slope of the aggregate supply curve that banks face (obtained by aggregating equation (3) over the banks in the industry).

Equations (2) and (3) represent the two endogenously determined sources of funds for bank j, namely, local currency interest bearing deposits and central bank funds. In addition, bank j obtains funds through non-interest bearing local demand deposits, DD_{jt}, through purchases in the central bank monetary auction, AU_{jt}, as well as from various other sources (e.g., net deposits by other banks) denoted OTHER_{jt}. The period t budget constraint of bank j is

$$L_{jt} = (1 - \rho_t^{\mathrm{S}})\, S_{jt} + (1 - \rho_t^{\mathrm{DD}})\, \mathrm{DD}_{jt} + \mathrm{ML}_{jt} + \mathrm{AU}_{jt} + \mathrm{OTHER}_{jt} \tag{4}$$

where L_{jt} and S_{jt} are the loans granted and the interest bearing deposits accepted by bank j in period t, and ρ_t^{S} and ρ_t^{DD} are the reserve ratios on interest bearing and non-interest bearing deposits.

We do not model the choice of DD_{jt}, AU_{jt}, and OTHER_{jt}, taking them as exogenous. In the empirical implementation, however, after aggregating the budget constraint (4) over the banks in the industry we include the observed aggregate magnitudes of these variables. In practice, the equilibrium rate paid at the margin by each bank for the monetary loan, ML_{jt}, is usually roughly equal to the market clearing rate of the monetary auction. Including only the choice of ML_{jt} in banks' optimization programs captures well the price/quantity decisions at the margin, so taking AU_{jt} as exogenous is a reasonable simplification (see footnote 15).

The variables L_{jt}, S_{jt}, and ML_{jt} are determined endogenously as follows. Inverting the demand function for local currency loans (equation (1)), and using $r_t^{\ell} = (1+i_t^{\ell})/(1+\pi_t) - 1$ where π_t is the inflation rate, we obtain

$$i_t^{\ell}(\cdot) = \frac{1}{d_1 + d_2\,[1/(1+\pi_t)]}\,[L_{jt} + \Sigma_{k\neq j} L_{kt} - d_0 - d_2\,(1 + [1/(1+\pi_t)]) - d_3\, z_t^{\ell}]\,. \tag{5}$$

Similarly, inverting the supply function of local currency interest bearing deposits (equation (2)), we obtain

$$i_t^{s}(\cdot) = \frac{1}{s_1 + s_2\,[1/(1+\pi_t)]}\,[S_{jt} + \Sigma_{k\neq j} S_{kt} - s_0 - s_2\,(1 + [1/(1+\pi_t)]) - s_3\, z_t^{s}]\,. \tag{6}$$

In period t, bank j chooses L_{jt}, S_{jt}, and ML_{jt} to maximize profits, taking as given the loans extended and the deposits taken by other banks, subject to the constraint (4). Period t bank profits are:

$$L_{jt}\, i_t^{\ell}(\cdot) + [\rho_t^{\mathrm{DD}}\, \mathrm{DD}_{jt} + \rho_t^{\mathrm{S}}\, S_{jt}]\, i_t^{*} - S_{jt}\, i_t^{s}(\cdot) - \int_0^{\mathrm{ML}_{jt}} [a_t + b_{jt}\, \mathrm{ML}]\, d\,\mathrm{ML} - \mathrm{AU}_{jt}\, i_t^{**}\,, \tag{7}$$

where i_t^* is the interest on reserves paid by the central bank, i_t^{**} is the interest on funds obtained through the monetary auction held by the central bank, and the expression inside the integral is the inverse supply curve of central bank funds (monetary loan) that bank j faces in period t (equation (3)).[17] In the empirical implementation we use actual period-by-period interest rates and reserve ratios.[18]

We derive, using (5) and (6), the necessary conditions for maximization of (7) subject to (4), sum over j (the index of banks), and divide through by n (the number of banks in the industry) obtaining the following system of equations:

$$L_t\, \frac{1}{n}\, \frac{1}{d_1 + d_2\,[1/(1+\pi_t)]} + i_t^{\ell} - (\Sigma_j \lambda_{jt})\,/\,n \;=\; 0\,, \tag{8}$$

$$\rho_t^{\mathrm{S}}\, i_t^{*} - S_t\, \frac{1}{n}\, \frac{1}{s_1 + s_2\,[1/(1+\pi_t)]} - i_t^{s} + (1-\rho_t^{\mathrm{S}})\, (\Sigma_j \lambda_{jt})\,/\,n \;=\; 0\,, \tag{9}$$

$$a_t + (\Sigma_j\, b_{jt}\, \mathrm{ML}_{jt})\,/\,n - (\Sigma_j \lambda_{jt})\,/\,n \;=\; 0\,, \tag{10}$$

$$(1-\rho_t^{\mathrm{S}})\, S_t + (1-\rho_t^{\mathrm{DD}})\, \mathrm{DD}_t + \mathrm{ML}_t + \mathrm{AU}_t + \mathrm{OTHER}_t - L_t \;=\; 0\,. \tag{11}$$

[17] As explained above, the central bank announces this curve individually for each bank. The bank pays increasing rates for additional quantities borrowed, along the curve.

[18] In practice, bank profits also depend on fees charged. Since most fees are not proportional to the size of loans taken or deposits made, we omit them from the analysis. We can think of fees as an additional term that enters additively in (7) but does not affect the conditions for the optimal choice of L_{jt}, S_{jt}, and ML_{jt}.

λ_{jt} is the Lagrange multiplier associated with the constrained profit maximization problem of bank j, and $(\Sigma_j \lambda_{jt})\,/\,n$ represents the marginal cost of obtaining funds, averaged over the banks in the industry.

Equations (8)–(11) and the supply and demand equations, (1) and (2), constitute a system of six equations with six endogenous "unknowns," L_t, S_t, i_t^ℓ, i_t^s, $\Sigma_j \lambda_{jt}$, and $\Sigma_j\, b_{jt}\, \mathrm{ML}_{jt}$. In the empirical implementation, we eliminate $(\Sigma_j \lambda_{jt})\,/\,n$ in equations (8) and (9) using equation (10). We then replace $1/\,n$ in the first term of (8) and in the second term of (9) with parameters, θ^ℓ and θ^s, that capture the deviation in the data from the above benchmark Cournot-Nash equilibrium. An estimate of unity for each of these parameters corresponds to monopoly behavior, and of zero to perfect competition.[19] Since it is conceivable that competitive conditions are different for deposits and loans, we allow the conduct parameters to differ across these markets. To the best of our knowledge, a simultaneous estimation of competitive conduct in an input market (deposits) and a product market (loans), where every firm is subject to a resource constraint, has not been carried out before.

The marginal cost of obtaining funds can be proxied empirically (see equations (3) and (10)). In Section 7, we will carry out a robustness check of our estimation by directly computing proxies for the conduct parameters, θ^ℓ and θ^s.

[19]The basic references developing this method are Bresnahan (1982, 1989), Porter (1983), and Lee and Porter (1984).

4 Estimation

4.1 Empirical model and identification of conduct in deposit and loan markets

In the empirical model, the demand function for local currency loans and the supply function of local currency interest bearing deposits are:

$$L_t = d_0 + d_1\, i_t^\ell + d_2\, r_t^\ell + d_3\, z_t^\ell + \nu_t^\ell\,, \tag{12}$$

$$S_t = s_0 + s_1\, i_t^s + s_2\, r_t^s + s_3\, z_t^s + \nu_t^s\,, \tag{13}$$

where ν_t^ℓ and ν_t^s are error terms capturing random determinants of the demand for bank loans and the supply of deposits.

Since we do not observe the shadow prices, λ_{jt}, we want to eliminate the expression $(\Sigma_j \lambda_{jt})\,/\,n$ in (8) and (9) using (10). We do not have individual bank data and, therefore, cannot directly compute the magnitude $\Sigma_j\, b_{jt}\mathrm{ML}_{jt}$. Therefore, we solve the individual supply of central bank funds schedules, equation (3), for ML_{jt}, sum over j, and set $i_{jt}^m = i_t^m$.[20] Rearranging, we obtain $i_t^m = a_t + b_t\,\mathrm{ML}_t$, where $\mathrm{ML}_t = \Sigma_j \mathrm{ML}_{jt}$ and $b_t = 1/\Sigma_j(1/b_{jt})$. Next, we sum $i_{jt}^m = a_t + b_{jt}\,\mathrm{ML}_{jt}$ (equation (3)) over j (again, setting $i_{jt}^m = i_t^m$) obtaining $i_t^m = a_t + (\Sigma_j\, b_{jt}\ \mathrm{ML}_{jt})\,/\,n$. Thus, we can replace $(\Sigma_j\, b_{jt}\ \mathrm{ML}_{jt})\,/\,n$ by $b_t\,\mathrm{ML}_t$, a magnitude we do observe, and equation (10) can be written as $a_t + b_t\,\mathrm{ML}_t - (\Sigma_j \lambda_{jt})\,/\,n = 0$. Using this equation, we substitute for $(\Sigma_j \lambda_{jt})\,/\,n$ in (8) and (9). Writing θ^ℓ and θ^s in place of $1/\,n$ in the first term of (8) and in the second term of (9), and adding an error term to these

[20]Namely, at the margin, all the banks borrow at the same interest rate along their individual supply schedules, as is the case in reality.

equations, we obtain

$$i_t^\ell = a_t + b_t \mathrm{ML}_t - L_t\, \theta^\ell \, \frac{1}{d_1 + d_2\,[1/(1+\pi_t)]} + \varepsilon_t^\ell\,, \tag{14}$$

$$i_t^s = (1-\rho_t^{\mathrm{S}})\,(a_t + b_t \mathrm{ML}_t) + \rho_t^{\mathrm{S}}\, i_t^* - S_t\, \theta^s \, \frac{1}{s_1 + s_2\,[1/(1+\pi_t)]} + \varepsilon_t^s\,. \tag{15}$$

The estimated system of equations consists of equations (12), (13), (14), and (15), where ML_t is computed so as to satisfy the budget constraint (11). The variables L_t, S_t, ML_t, i_t^ℓ, and i_t^s are determined endogenously, whereas the variables DD_t, AU_t, and OTHER_t are exogenous. In the estimation, we use the period-by-period observed magnitudes of all these variables. Notice that the variables are related through the budget constraint (11) which is assumed to hold exactly, with OTHER_t absorbing "shocks" to individual components of the constraint. z_t^ℓ and z_t^s in (12) and (13) are exogenous instruments that shift the loan demand and deposit supply functions. In the estimation, we use the actual values of the reserve ratios, ρ_t^{S} and ρ_t^{S}, the actual interest rates on reserves, i_t^*, paid by the central bank, and the actual inflation rates, π_t.

The system is non-linear, and we estimate it by maximum likelihood. We impose no restrictions on the cross-equation covariance matrix of the (four) error terms, estimating the system using a three stage procedure. The "dynamics" in the data are captured in specifications that allow the conduct parameters, θ^ℓ and θ^s, and the coefficient of one of the instruments (the Euro interest rate) to vary over time, as well as by including lagged endogenous variables as instruments.[21]

The central goal of the estimation is to identify the parameters θ^ℓ and θ^s. The terms

[21] Using lagged endogenous variables as instruments is justified as follows. Consider, for example, i_t^s, in the supply of deposits equation. Let $\hat{i}_t^s$ be the fitted value of the regression of i_t^s on $i_{t-1}^s, i_{t-2}^s, \dots$. Then, the estimated coefficient of the regression of S_t on $\hat{i}_t^s$ is interpreted as the marginal effect of the predictable component of z_t^s, based on past observations of this variable, on the current supply of deposits.

$1/[d_1 + d_2\,[1/(1+\pi_t)]]$ and $1/[s_1 + s_2\,[1/(1+\pi_t)]]$ that multiply θ^ℓ and θ^s in (14) and (15), being non-linear in π_t, allow identification of these conduct parameters. The variable $1/(1+\pi_t)$ transforms the nominal (gross) interest rate to the real (gross) interest rate, and thus acts—using the jargon of Bresnahan (1982)—as a rotation variable in the demand and supply equations (12) and (13) allowing the identification of the conduct parameters.

This can also be seen by direct substitution in the loan demand and deposit supply schedules. Equation (12), for example, using $r_t^\ell = \frac{1+i_t^\ell}{1+\pi_t} - 1$, can be written as $L_t = (d_0 - d_2) + d_2\,\frac{1}{1+\pi_t} + d_1\,i_t^\ell + d_2\,i_t^\ell\,\frac{1}{1+\pi_t} + d_3\,z_t^\ell + \nu_t^\ell$, where $\frac{1}{1+\pi_t}$ is a rotation variable. If there is no inflation (or if the inflation rate is constant over time) then the real and the nominal interest rate are one and the same (up to a constant factor), and conduct cannot be identified. When π_t varies over time, the "slope" of the schedule, i.e., the coefficient of i_t^ℓ, also varies over time and, as illustrated graphically in Bresnahan (1982), provides identification of conduct.

4.2 Empirical specifications

We study three basic sets of specifications. The first, denoted A, does not allow for any "dynamics," imposing conduct parameters that are constant over time. The signs of the coefficients and their significance level are quite sensible, but the residuals in the equations exhibit strong autocorrelation. The second set of specifications, denoted B, allows the conduct parameters to vary over time, e.g., by interacting them with time dummies, or by specifying the parameters as (square root, logarithmic) functions of time.[22] The signs of the coefficients and their significance level remain plausible, and the residuals exhibit less autocorrelation. The third set of specifications, denoted C, is similar to B but further

[22]These functional forms exhibit a negative second derivative that captures the faster pace of the liberalization during the earlier years of the sample. This correponds to the estimates obtained using time dummies.

allows the coefficient of one of the instruments in the demand for loans equation (the Euro interest rate) to vary over time. This improves the performance of the residuals, although in one of the equations (the demand for loans) there still remains visible autocorrelation.

In Section 7, we carry out a robustness check of our estimation by directly computing proxies for the conduct parameters, θ^ℓ and θ^s, based on our ability to estimate the actual marginal cost of obtaining funds. We also experiment with a specification that does not use observed marginal cost at all. This involves collapsing equations (14) and (15) into a single equation, eliminating marginal cost, as will be explained in detail later.

5 Data and variables

We use aggregate (industry-level) monthly data for the non-indexed local currency segment of the Israeli banking system, for the period January 1989 through June 1996 (90 observations). As explained in footnote 16, our sample ends in June 1996 to avoid complications related to the introduction, in July 1996, of a new monetary instrument by the central bank.

As mentioned, we estimate the system of equations (12), (13), (14), and (15) simultaneously, using a 3SLS iterative procedure which takes into account possible hetroskedasticity and contemporaneous correlation in the residuals. The iterative solution updates both the coefficients and the weighting matrix at each iteration until both converge. The endogenous variables are L_t, S_t, i_t^ℓ, i_t^s, and ML_t. (As explained in the previous section, we reduce the number of equations by eliminating (10) through substitution; we use the resource constraint, equation (11), to compute ML_t.) The quantities of non-indexed local currency deposits (S_t) and loans (L_t) are measured in real, Consumer Price Index (CPI) deflated terms. Deposits include overnight and fixed-term (up to one year) interest-bearing accounts. Loans consist of total non-directed credit, which is mostly short-term credit (up to one year).

The deposit and loan nominal interest rate variables (i_t^s and i_t^ℓ) are month-by-month weighted averages of the interest rates received or paid on the average stock of deposits and loans during that month. Real interest rates are obtained by deflating nominal interest rates by the CPI.[23]

ML_t, the aggregate (nominal) monthly monetary loan of the central bank to the banking system, is computed in practice as a residual from (11), the resource constraint of the banking system: $(1-\rho_t^{\text{S}})\,S_t + (1-\rho_t^{\text{DD}})\,\text{DD}_t + \text{ML}_t + \text{AU}_t + \text{OTHER}_t - L_t = 0$, where AU_t is the monthly (nominal) amount sold by the central bank to the banks in the sealed bid auction (see Section 2), DD_t is the monthly average amount of non-interest bearing local demand deposits in the banking system, and OTHER_t includes additional sources of funds such as non-indexed government bonds and the Israeli equivalent of T-bills.[24] In all months of our sample, ML_t is a strictly positive number.

The parameter a_t is the lowest interest rate at which the central bank was willing to sell funds in month t, and b_t is an approximation of the slope of the central bank's supply of monetary loans curve during this month. The slope is approximated by the ratio of the height to the width of the marginal interest rate step of the monetary loan supply function (where the marginal step is the one actually observed in the data). To identify the conduct parameters in the loan and deposit markets, we use the rotation variable $1/(1+\pi_t)$, where π_t is the cumulative CPI inflation rate of the previous 12 months.

We further use actual month-by-month reserve ratios on interest bearing and non-interest bearing deposits, ρ_t^{S} and ρ_t^{DD}, and the month-by-month interest rate on these reserves, i_t^*.[25]

[23]The correlation of the real and nominal interest rates is 0.59 for loans and 0.24 for deposits.

[24]The variable OTHER_{jt} also includes net deposits in bank j by other banks, but these net out in the aggregate.

[25]Both reserve ratios have declined considerably during the sample period, from about 20 percent in 1989 to about 5 percent in 1996, with the sharpest decline occurring during the period 1989–1991.

As instruments for the endogenous variables, we include exogenous variables that vary somewhat across regression specifications: the cost of foreign currency loans which is proxied by the 3-month EURO nominal interest rate, the interest rate on CPI-indexed loans represented by the real yield to maturity on 5-year government CPI-indexed bonds, and devaluation expectations. These are measured by the distance of the average monthly exchange rate from the middle of the exchange rate band (the distance is expressed as a percentage of the band width), and by the accumulated appreciation of the local currency with respect to the US dollar and the German mark, with weights 2/3 and 1/3.

To control for economic activity, we further incorporate the following variables in various regressions: the monthly real GDP; the 3-month moving average of real GDP; the ratios of total investment and of investment in fixed assets to GDP; the ratio of private consumption to GDP; the CPI-deflated daily average turnover on the Tel Aviv Stock Exchange—an indicator of financial activity; and the monthly volume of housing transactions, calculated by multiplying the number of transactions per month by their average price—an indicator of activity in the construction sector.

As a proxy for the cost of maintaining a deposit account, we construct a measure of bank fees, calculated as a simple average of the (CPI-deflated) fee per transaction in deposit accounts and the price of a standard check-book.

We also include dummy variables for the months October 1991 through December 1991, a period characterized by unusual capital outflow from the country, and for November 1993 that exhibited a peak in bank lending related to stock offerings on the Tel Aviv Stock Exchange. To further capture dynamics in the data, we include the lagged endogenous variables as instruments in each equation. Finally, and most important for our purpose, to estimate the effect of financial liberalization on bank conduct, we include, in some specifications, dummy variables for sub-periods interacted with the conduct parameters. In other specifications, we model these parameters as functions of time ($\sqrt{t}$ or $\log t$). The notes to

Table 1 describe all the variables we use.

6 Results

The results of two regressions with no "dynamics" (specification A) are reported in Panel A, Table 1. Virtually all the estimated coefficients exhibit high t-values (although it should be recalled that the substantial autocorrelation in the residuals in this specification blurs the conventional statistical inference interpretation).[26] Both the nominal and real interest rates (negatively) affect the demanded quantity of loans, namely, the demand for non-indexed local currency loans is determined by both loan portfolio considerations (e.g., indexed versus non-indexed or foreign versus local currency) and by the real cost of capital (through its effect on, e.g., investment). By contrast, only the nominal interest rate (positively) affects the supplied quantity of deposits, suggesting that portfolio considerations are a determinant of deposit holding, but not inter-temporal consumption/saving considerations.

The foreign interest rate and the yield on indexed 5-year government bonds are positive and strongly significant in the demand for loans equation, suggesting that non-indexed local currency loans, indexed medium-term loans, and foreign currency denominated loans are substitutes. GDP, both month-by-month and the 3-month moving average, affects both loans and deposits positively, as do the investment/GDP and consumption/GDP ratios for loans and deposits respectively.[27] Bank fees affect deposits negatively, while devaluation expectations affect (local currency) loans positively and (local currency) deposits negatively. All in all, the estimated coefficients are in accordance with basic economic intuition.

We turn to the estimates of the conduct parameters. In regression A1, for example, the point estimate of the conduct parameter in the loan market, θ^{ℓ}, is 0.198 with a t-

[26]It is worth stressing, however, that serial correlation in the residuals does not bias the estimates.

[27]The coefficient on the volume of housing transactions, although positive and statistically significant, is very small.

value of 6.22. The point estimate of the conduct parameter in the deposit market, θ^s, is 0.047 with a t-value of 4.73. The results of regression A2 are very similar. The high t-values suggest that perfect competition can be rejected in both markets. It is common to interpret these numbers as corresponding to behavior that is equivalent to about five symmetric Cournot competitors in the loan market and about twenty such competitors in the deposit market. Clearly, the results support the hypothesis that the loan market is considerably less competitive than the deposit market. An explanation is that bank lending is information intensive, and requires relationship building between banks and firms, whereas local currency bank deposits are a standard service. Therefore, banks perceive a more elastic demand in the deposit market, and consequently behave more competitively, in comparison to the loan market.

The results of three regressions with time varying conduct parameters (specification B) are reported in Panel B, Table 1. The estimated coefficients are qualitatively similar to those in specification A, and exhibit high t-values. In regression B1 we interact the coefficient of the conduct parameter with a dummy variable that takes the value zero before 1992. The regression residuals exhibit considerably less serial correlation suggesting that the change over time in the conduct parameters captures a non-trivial amount of the dynamics in the data.

The point estimates are interpreted as follows. Before 1992, the conduct parameter in the loan market, θ^ℓ, is 0.553 (basically a duopoly) with a t-value of 7.44, and after 1992 it is 0.145 (0.553 minus 0.408) with a t-value of 6.94. The point estimate of the conduct parameter in the deposit market, θ^s, is 0.147 with a t-value of 5.57 before 1992, and 0.036 (0.147 minus 0.111) with a t-value of 5.29 after 1992.

In regressions B2 and B3 we impose on the conduct parameters particular functional forms. The results are, again, very similar. The estimates of the conduct parameters for the sub-periods in specification B2 are displayed in Figure 2.

We interpret these results as evidence of a significant increase in competition following financial opening—economically and statistically—in both deposit and loan markets. Towards the end of the sample period there is close to perfect competition in the deposit market but not in the loan market.

The results of similar regressions with time varying conduct parameters and a time varying coefficient of the foreign interest rate (specification C) are reported in Panel C, Table 1. The signs of the estimated coefficients are plausible and exhibit high t-values, as in the previous specifications, and the residuals exhibit even less serial correlation.[28] The behavior of the conduct parameters over time for specification C2 is displayed in Figure 2. The results are similar to those of specification B.

The coefficient of the interaction of the foreign interest rate with time is positive and highly significant in all the specifications, namely, there is an increase over time in the sensitivity of the demand for local currency bank loans to the interest rate abroad. This strengthens the interpretation that our results are indeed driven by financial opening.

To control for potential changes in bank risk over the sample period we repeat some of the above regressions adding the variable RISK, the average (across banks) of the ratio of the risk premium to the interest rate charged by banks on local currency credit, as reported by the Supervisor of Banks, Bank of Israel. The results are reported in Panel D, Table 1, and are virtually unchanged.[29]

In Table 2 we display the elasticity of the market demand curve for bank loans and of the market supply curve of deposits with respect to the nominal interest rate.[30] Notice that the

[28]We also tested for a unit root in the residuals of each regression individually, using an Augmented Dickey-Fuller test (with two lags, no constant, and no trend), rejecting a unit root in all but the A3 specification.

[29]The coefficient of RISK in the loans equation is positive and significant in all three specifications. The interpretation may involve reverse causality, where increases in the amount of loans extended by the banking system is (inevitably) associated with more risk.

[30]The elasticity of the demand for loans with respect to the nominal interest rate is computed as the average over the monthly observations of $[d_1 + d_2\ 1/(1+\pi_t)]\,(L_t\,/\,i_t^{\ell})$, and similarly for deposits.

elasticities are quite similar in magnitude, yet, the perceived elasticity in the loan market—the estimated conduct parameter—is considerably lower than in the deposit market. This further confirms the interpretation that bank loans are an inherently different service than bank deposits in that banks succeed more easily in capturing rents due to information collection or relationship building. These rents decrease over time, but not due to changes in market concentration which remains roughly constant. Specification C suggests that financial opening is one factor that contributed to the decline in banks' ability to extract monopolistic rents.

7 Robustness

7.1 Computing conduct parameters directly

Instead of estimating the conduct parameters, θ^ℓ and θ^s, they can be computed directly from the first order conditions of banks' profit maximization programs, as follows. Rearranging equations (14) and (15) yields

$$\frac{i_t^\ell - (a_t + b_t \mathrm{ML}_t)}{i_t^\ell} \;=\; -\frac{1}{\eta^\ell(\cdot)}\,\theta^\ell \tag{16}$$

and

$$\frac{(1-\rho_t^{\mathrm{S}})\,(a_t + b_t \mathrm{ML}_t) - i_t^s + \rho_t^{\mathrm{S}}\, i_t^*}{i_t^s} \;=\; \frac{1}{\eta^s(\cdot)}\,\theta^s\,, \tag{17}$$

where $\eta^\ell(\cdot)$ and $\eta^s(\cdot)$ are the estimated loan demand and deposit supply elasticities with respect to i_t^ℓ and i_t^s (Table 2),[31] and $a_t + b_t \mathrm{ML}_t$ is marginal cost (see (10)).

Using these expressions, we compute the month-by-month conduct parameters that are

[31] As pointed out above, the loans demand schedule can be written as $L_t = (d_0 - d_2) + d_2\,\frac{1}{1+\pi_t} + d_1\, i_t^\ell + d_2\, i_t^\ell\,\frac{1}{1+\pi_t} + d_3\, z_t^\ell + \nu_t^\ell$, from which the loan demand elasticity with respect to i_t^ℓ is easily computed. Similarly for the deposits supply schedule.

displayed in Figure 3.[32] θ^ℓ ranges from (approximately) 0.45 to 0.20, declining from an average of 0.36 in the first part of the sample (before 1992) to 0.25 in the second part of the sample. θ^s ranges from 0.01 to 0.13, declining slightly in the second part of the sample. These estimates are broadly consistent with those reported in Table 1.

7.2 Estimating conduct without using marginal cost information

We estimate θ^ℓ and θ^s without using information regarding marginal cost, as follows. Eliminating $a_t + b_t \mathrm{ML}_t$ in equations (14) and (15) yields

$$(1-\rho_t^{\mathrm{S}})\, i_t^\ell - i_t^s = -(1-\rho_t^{\mathrm{S}})\, L_t\, \theta^\ell\, \frac{1}{d_1 + d_2[1/(1+\pi_t)]} - \rho_t^{\mathrm{S}}\, i_t^* + S_t\, \theta^s\, \frac{1}{s_1 + s_2[1/(1+\pi_t)]} + \varepsilon_t$$

where $\varepsilon_t = (1-\rho_t^{\mathrm{S}})\, \varepsilon_t^\ell - \varepsilon_t^s$. Together with the demand for loans and supply of deposits—equations (13) and (12)—this equation can be used to estimate both conduct parameters without any need for marginal cost information.

Collapsing equations (14) and (15) into a single equation imposes "structure" on the error terms of the original equations, in the sense that the distributional assumptions on ε_t apply to $(1-\rho_t^{\mathrm{S}})\, \varepsilon_t^\ell - \varepsilon_t^s$, but apart from this detail, the estimation should yield similar results. Wolfram (1999), for example, carried out tests of the validity of the Bresnahan-Porter methodology by estimating conduct both with and without cost information, obtaining good results in both cases. Since our interest here is in testing for the effect of financial liberalization on conduct in the banking industry, we chose to use all available information in our estimation. We did, however, estimate specification A also without using marginal cost information, as explained here, obtaining qualitatively similar results, which is reassuring.[33]

[32] In the data, the term $\rho_t^{\mathrm{S}}\, i_t^*$ is negligibly small (and is excatly zero during the later part of the sample), and is ignored in the computation.

[33] The point estimates of the conduct parameters are $\theta^\ell = 0.320$ and $\theta^s = 0.002$, both statistically significant. For comparison, in specification A1, Table 1, the point estimates of these parameters are 0.198 and 0.047 respectively.

8 Concluding Remarks

We have shown that banks in Israel lost market power as a consequence of financial liberalization despite the fact that the market remained highly concentrated. A word of caution in interpreting this finding is in order. In our study, we do not model the choice of bank fees that might have increased during the sample period. We computed the year-by-year ratio of fee income to profits from deposit and loan activities, using data published by the Supervisor of Banks, Bank of Israel. No clear pattern emerges, and there is no indication that the reduction in interest rate spreads was offset by a hike in fees. It is also possible that spreads in other bank activities (e.g., CPI-indexed or foreign-currency-indexed deposits and loans) might have increased to compensate for lower spreads in the non-indexed local currency segment of the market. We leave this issue for future research.

Another important question that we did not address here is who benefited most from the increased competition in the banking sector. It is possible, for example, that large firms, export-intensive firms, and wealthy individuals—who all have access to overseas financial markets (as well as to the stock market)—are likely to have benefited more from financial liberalization and from enhanced inter-bank competition in comparison to small firms and less wealthy households. Further research, most probably at the micro-level, is needed to address these issues.

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Table 1: Estimating Conduct in the Non-Indexed Local Currency Deposit and Loan Markets, Israel 1989–1996

Notes. Panels A through D display different specifications of the empirical model, equations (12), (13), (14), and (15). We estimate the (non-linear) system using a maximum likelihood 3SLS iterative procedure, correcting for hetroskedasticity and cross-equation correlation in the residuals. We use industry-level monthly data for the non-indexed local currency segment of the banking system (January 1989–June 1996). Endogenous variables: Quantities of non-indexed interest bearing local currency deposits and loans measured in Consumer Price Index (CPI)-deflated millions New Israeli Shekel (NIS). Deposits include overnight and fixed-term (up to one year) interest-bearing accounts. Loans consist of non-directed credit, mostly short-term (up to one year, including overdraft). Nominal interest rate variables are monthly weighted averages of the rates received or paid on the average stock of deposits and loans during the month. Real rates are obtained by deflating nominal rates by the cumulative change in the CPI during the past 12 months. We also use the real yield to maturity on 5-year government CPI-indexed bonds. Interest rates are measured as percent per year. The aggregate (nominal) monthly monetary loan of the central bank to the banking system, ML_t, is computed as a residual from equation (11), the resource constraint of the banking system, $(1-\rho_t^{\text{S}})\,S_t + (1-\rho_t^{\text{DD}})\,\text{DD}_t + \text{ML}_t + \text{AU}_t + \text{OTHER}_t - L_t = 0$, where AU_t is the monthly (nominal) amount sold by the central bank to the commercial banks in the sealed bid auction (see Section 2), DD_t is the monthly average amount of (non-interest bearing) local demand deposits in the banking system, and OTHER_t includes various other sources of funds (e.g., non-indexed Israeli government bonds). In the rotation variable, $1/(1+\pi_t)$, π_t is the cumulative change in the CPI inflation rate (percent) during the past 12 months. We include lagged endogenous variables (as instruments) in each equation as well as exogenous instruments that vary somewhat across specifications. Foreign currency loan rates are proxied by the 3-month EURO nominal interest rate (percent per year). Devaluation expectations are measured by the distance (expressed as a percentage of the band width) of the average monthly exchange rate from the middle of the band, and by the accumulated appreciation of the NIS with respect to the US dollar and the German mark, with weights 2/3 and 1/3. To control for economic activity we incorporate the monthly real GDP, the 3-month moving average of real GDP, the ratios of total investment and of investment in fixed assets to GDP, the ratio of private consumption to GDP, the CPI-deflated daily average turnover on the Tel Aviv Stock Exchange (an indicator of financial activity), and the monthly volume of housing transactions, calculated as the product of the number of transactions per month and their average price (an indicator of activity in the construction sector). Bank fees are calculated as a simple average of the fee per transaction in demand deposit accounts and the price of a standard check-book, both measured in CPI-deflated NIS. We include a dummy variable for the months October 1991 through December 1991, a period characterized by unusual capital outflow from the country, and another dummy variable for November 1993 that exhibited a peak in bank lending related to securities offering activities on the Tel Aviv Stock Exchange. To capture the effect of the liberalization in financial markets on the conduct of the banks, we include in some specifications, dummy variables for various sub-periods. In other specifications, we model the conduct parameters, instead, as functions of time ($\sqrt{t}$ or $\log t$).

Panel A: Conduct parameters constant over time

A2		A1				
t-value	Estimate	t-value	Estimate	Independent variables	Dep. var.	Eq.
6.20	**0.192**	*6.22*	**0.198**	Conduct parameter: θ^L	i^L	(14)
5.47	**0.063**	*4.73*	**0.047**	Conduct parameter: θ^S	i^S	(15)
2.15	-137.65	*1.98*	-129.66	constant	L	(12)
6.42	-10.55	*6.52*	-10.95	Nominal interest rate on loans (d_1)		
2.04	-2.36	*1.99*	-2.32	Real interest rate on loans (d_2)		
9.76	33.87	*9.69*	34.27	Foreign interest rate		
7.96	36.75	*7.79*	36.80	Yield to maturity on indexed 5-year government bonds		
5.79	195.68	*5.48*	188.74	GDP 3-months moving average		
7.81	35.41	*7.66*	35.52	Level of activity on TASE		
6.97	967.34	*6.91*	964.72	Devaluation expectations		
3.42	659.47	*3.60*	708.84	Ratio of investment to GDP		
6.65	143.93	*6.43*	143.08	Dummy for Nov. 1993		
2.19	42.88	*2.44*	49.25	Dummy for Oct-Dec. 1991		
11.22	-1069.13	*11.02*	-1003.41	Constant	S	(13)
6.46	14.43	*6.18*	10.49	Nominal interest rate on savings (s_1)		
1.25	1.94	*0.62*	.95	Real interest rate on savings (s_2)		
9.14	348.46			GDP		
		9.07	339.60	GDP 3-months moving average		
6.79	-1532.99	*5.57*	-987.26	Devaluation expectations		
3.24	-5.41			Accumalated appreciation		
6.07	-6836.80	*6.89*	-7435.11	Bank fees		
1.77	0.004	*3.29*	0.006	Volume of housing transactions		
6.72	1102.43	*6.80*	1080.22	Ratio of private consumption to GDP		

Panel B: Conduct parameters vary over time

B3		B2		B1				
t-value	Estimate	t-value	Estimate	t-value	Estimate	Independent variables	Dep. var.	Eq.
4.45	**0.602**	*6.06*	**0.696**	*7.44*	**0.553**	Conduct parameter: θ^{L}	i^{L}	(14)
4.40	**-0.125 log(t)**	*5.93*	**-0.072**$\sqrt{t}$	*6.94*	**-0.408 d92aft**	Interaction *		
5.47	**0.294**	*5.06*	**0.207**	*5.57*	**0.147**	Conduct parameter: θ^{S}	i^{S}	(15)
5.28	**-0.059 log(t)**	*4.91*	**-0.020**$\sqrt{t}$	*5.29*	**-0.111 d92aft**	Interaction *		
6.55	364.03	*4.80*	-301.48	*2.29*	-152.83	Constant	L	(12)
3.47	-4.88	*5.25*	-8.40	*6.91*	-11.88	Nominal interest rate on loans (d_1)		
2.37	-2.19	*2.04*	-2.24	*1.86*	-2.24	Real interest rate on loans (d_2)		
7.85	23.99	*9.32*	31.67	*9.56*	34.59	Foreign interest rate		
7.58	30.80	*8.07*	36.63	*7.98*	38.53	Yield to maturity on indexed 5-year government bonds		
9.19	270.90	*7.97*	263.94	*5.93*	209.14	GDP 3-months moving average		
6.96	27.83	*7.66*	34.13	*7.59*	35.94	Level of activity on TASE		
5.04	605.26	*6.44*	862.39	*7.26*	1044.25	Devaluation expectations		
4.82	817.56	*3.44*	648.88	*3.45*	694.36	Ratio of investment in fixed assets to GDP		
6.49	123.91	*6.38*	136.21	*6.35*	144.36	Dummy for Nov. 1993		
1.17	20.25	*1.98*	38.31	*2.11*	43.58	Dummy for Oct.-Dec. 1991		
10.63	-1028.55	*10.46*	-990.96	*10.76*	-1033.61	Constant	S	(13)
6.35	11.60	*5.33*	9.55	*5.98*	10.91	Nominal interest rate on savings (s_1)		
1.34	2.08	*1.66*	2.53	*1.61*	2.50	Real interest rate on savings (s_2)		
8.20	315.05	*8.12*	305.44	*8.19*	312.92	GDP		
6.50	-1194.32	*5.66*	-1019.10	*6.11*	-1123.71	Devaluation expectations		
7.01	1163.80	*7.10*	1152.84	*7.29*	1199.50	Ratio of private consumption to GDP		
2.93	0.006	*3.36*	0.007	*3.01*	0.006	Volume of housing transactions		
6.35	-7193.10	*6.24*	-6911.71	*6.50*	-7325.29	Bank fees		

* D92aft is a dummy variable that equals 1 starting January 1992.

Panel C: Conduct parameters and foreign interest rate coefficient vary over time

C3		C2		C1				
t-value	Estimate	t-value	Estimate	t-value	Estimate	Independent variables	Dep. var.	Eq.
3.71	**0.442**	*5.33*	**0.675**	*6.52*	**0.449**	Conduct parameter: θ^L	i^L	(14)
3.69	**-0.093 log(t)**	*4.67* *3.98* *4.29*	**-0.282 d90aft** **-0.143 d92aft** **-0.143 d93aft**	*6.17*	**-0.331 d92aft**	Interaction *		
5.29	**0.275**	*5.70*	**0.235**	*5.54*	**0.148**	Conduct parameter: θ^S	i^S	(15)
5.11	**-0.056 log(t)**	*2.99* *4.28* *3.74*	**-0.073 d90aft** **-0.082 d92aft** **-0.044 d94aft**	*5.27*	**-0.112 d92aft**	Interaction *		
1.68	-94.24	*1.10*	-88.26	*0.31*	-21.81	constant	L	(12)
3.40	-4.01	*5.39*	-10.34	*6.04*	-9.74	Nominal interest rate on loans (d_1)		
1.29	-1.02	*1.13*	-1.44	*1.45*	-1.63	Real interest rate on loans (d_2)		
3.27	11.34	*4.56*	26.87	*9.24*	32.17	Foreign interest rate		
				4.07	14.41	Foreign interest rate*Dummy for Jan92-Jun96		
5.52	15.13					Foreign interest rate*Dummy for Jan93-Jun96		
		1.84	1.43			Foreign interest rate*$\sqrt{t}$		
2.86	13.09	*7.83*	37.64	*6.66*	32.40	Yield to maturity on indexed bonds		
6.81	185.47	*4.12*	171.85	*2.86*	117.78	GDP 3-months moving average		
5.98	20.51	*7.39*	40.97	*8.86*	41.41	Level of activity on TASE		
1.61	207.56	*6.81*	998.25	*4.63*	721.93	Devaluation expectations		
3.86	556.02	*2.04*	491.38	*2.82*	536.17	Ratio of investment in fixed assets to GDP		
8.80	137.43	*6.37*	143.71	*6.58*	141.29	Dummy for Nov. 1993		
2.24	29.93	*1.91*	39.21	*2.97*	65.04	Dummy for Oct.-Dec. 1991		
10.45	-980.13	*10.94*	-1047.43	*10.77*	-1037.60	constant	S	(13)
6.15	10.99	*6.31*	14.24	*5.97*	10.90	Nominal interest rate on savings (s_1)		
1.10	1.69	*1.26*	1.95	*1.56*	2.43	Real interest rate on savings (s_2)		
8.63	323.26	*8.99*	345.05	*8.10*	310.32	GDP		
6.16	-1115.93	*7.08*	-1605.91	*6.12*	-1126.07	Devaluation expectations		
		3.14	-5.28			Accumalated appreciation		
6.54	-7220.73	*6.64*	-7552.69	*6.54*	-7384.53	Bank fees		
3.34	0.007	*1.66*	0.004	*3.12*	0.007	Volume of housing transactions		
6.61	1060.94	*6.74*	1114.12	*7.34*	1213.56	Ratio of private consumption to GDP		

* D90aft is a dummy variable that equals 1 starting January 1992; D92aft equals 1 starting January 1992, D93aft equals 1 starting January 1993, and D94aft equals 1 starting January 1994.

Panel D: Controlling for loan risk

C4		B4		A3				
t-value	Estimate	t-value	Estimate	t-value	Estimate	Independent variable	Dep. var.	Eq.
5.63	**0.743**	*6.38*	**1.11**	*5.71*	**0.135**	Conduct parameter: θ^L	i^L	(14)
4.65	**-0.267 d90aft**	*4.46*	**-0.347 logt**			Interaction *		
4.27	**-0.182 d92aft**	*2.49*	**+0.026[log(t)]^2**					
4.61	**-0.162 d93aft**							
2.14	2.03	*8.36*	7.95	*41.93*	7.35	RISK		
5.90	**0.244**	*5.28*	**0.284**	*4.22*	**0.046**	Conduct parameter: θ^S	i^S	(15)
2.90	**-0.073 d90aft**	*5.11*	**-0.058 log(t)**			Interaction *		
4.37	**-0.087 d92aft**							
3.71	**-0.046 d93aft**							
1.02	-82.08	*3.64*	-208.25	*2.85*	-185.60	constant	L	(12)
5.62	-10.81	*6.56*	-9.36	*5.93*	-9.90	Nominal interest rate on loans (d_1)		
1.35	-1.74	*2.15*	-2.20	*2.73*	-2.76	Real interest rate on loans (d_2)		
4.71	27.76	*9.05*	29.27	*9.13*	32.08	Foreign interest rate		
1.75	1.37					Foreign interest rate *√t		
7.72	37.10	*8.36*	35.00	*7.77*	36.51	Yield to maturity on indexed 5-year government bonds		
		7.23	221.09			GDP		
4.16	174.04			*6.35*	217.55	GDP 3-months moving average		
7.21	39.98	*7.63*	31.17	*7.46*	34.41	Level of activity on TASE		
6.84	1003.58	*6.11*	768.20	*7.08*	982.69	Devaluation expectations		
2.07	499.06	*1.76*	773.85	*3.51*	684.79	Ratio of Investment in fixed assets to GDP		
6.43	145.11	*6.67*	133.95	*6.34*	140.07	Dummy for Nov. 1993		
2.09	42.95	*1.76*	30.50	*2.36*	47.22	Dummy for Oct.-Dec. 1991		
10.81	-1041.22	*4.30*	-1009.24	*8.44*	-824.64	Constant	S	(13)
6.50	14.74	*10.49*	10.85	*4.59*	8.41	Nominal interest rate on savings (s_1)		
1.52	2.37	*5.97*	2.21	*1.57*	2.58	Real interest rate on savings (s_2)		
8.92	343.96	*8.21*	313.53			GDP		
				5.32	215.62	GDP 3-months moving average		
7.22	-1646.45	*6.03*	-1101.11	*3.92*	-756.20	Devaluation expectations		
3.23	-5.46					Accumalated appreciation		
6.67	-7644.38	*6.44*	-7254.22			bank fees		
1.47	0.003	*3.16*	0.007	*3.48*	0.007	Volume of housing transactions		
6.69	1108.61	*6.97*	1149.47	*5.10*	881.29	Ratio of private consumption to GDP		

* D90aft is a dummy variable that equals 1 starting January 1992; D92aft equals 1 starting January 1992, and D93aft equals 1 starting January 1993. RISK is the average (across banks) of the ratio of the risk premium to the interest rate charged by banks on local currency credit, as reported by the Supervisor of Banks, Bank of Israel.

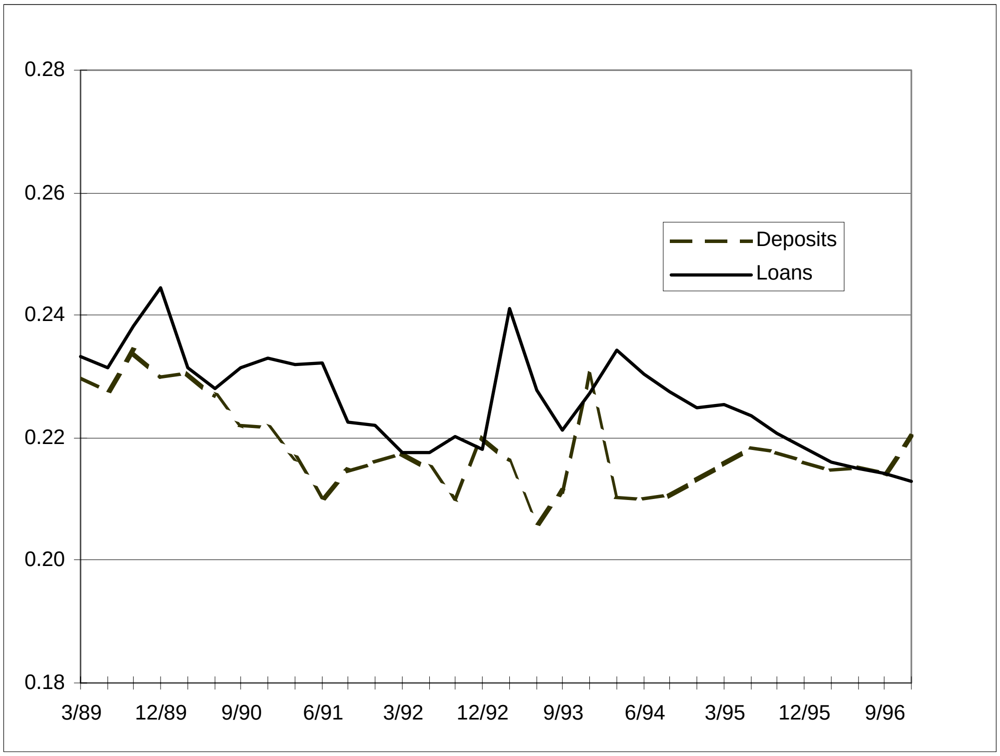
Table 2
Estimated interest rate elasticities of demand for loans and supply of deposits

Deposits	Loans	Specification
0.592	-0.789	A1
0.843	-0.767	A2
0.557	-0.749	A3
0.684	-0.842	B1
0.614	-0.630	B2
0.702	-0.413	B3
0.668	-0.686	B4
0.680	-0.680	C1
0.834	-0.706	C2
0.652	-0.298	C3
0.879	-0.751	C4

Note: The elasticity of the demand for loans (see equation (12)) and supply of deposits (equation (13)), calculated at the sample mean, using the estimated coefficients of each specification (see Table 1). Sample period: January 1989-June 1996.

Figure 1

Concentration in the Israeli Banking Industry: March 1989 – December 1996

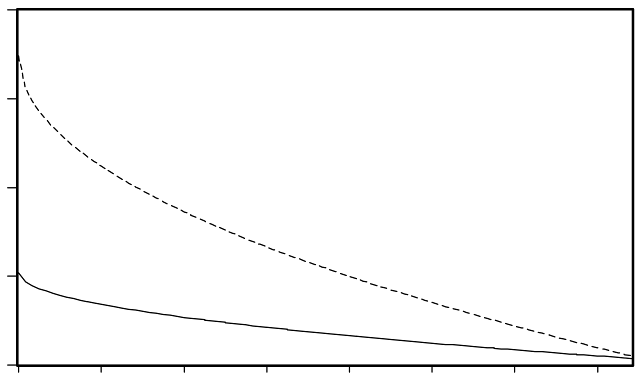


Note: Herfindahl indices of non-indexed local currency (NIS) bank deposits and loans.

Figure 2

Estimated conduct parameters

2a: Specification B2 in Panel B, Table 1



2b: Specification C2 in Panel C, Table 1

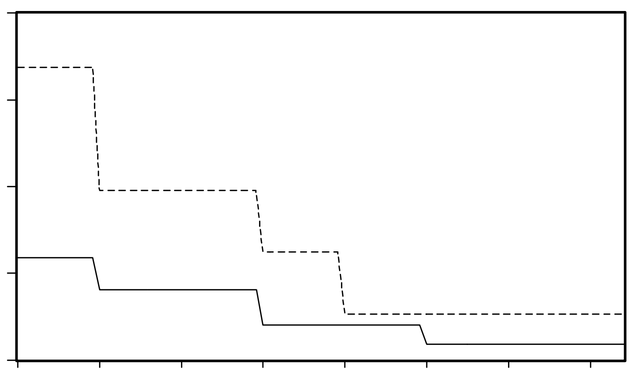
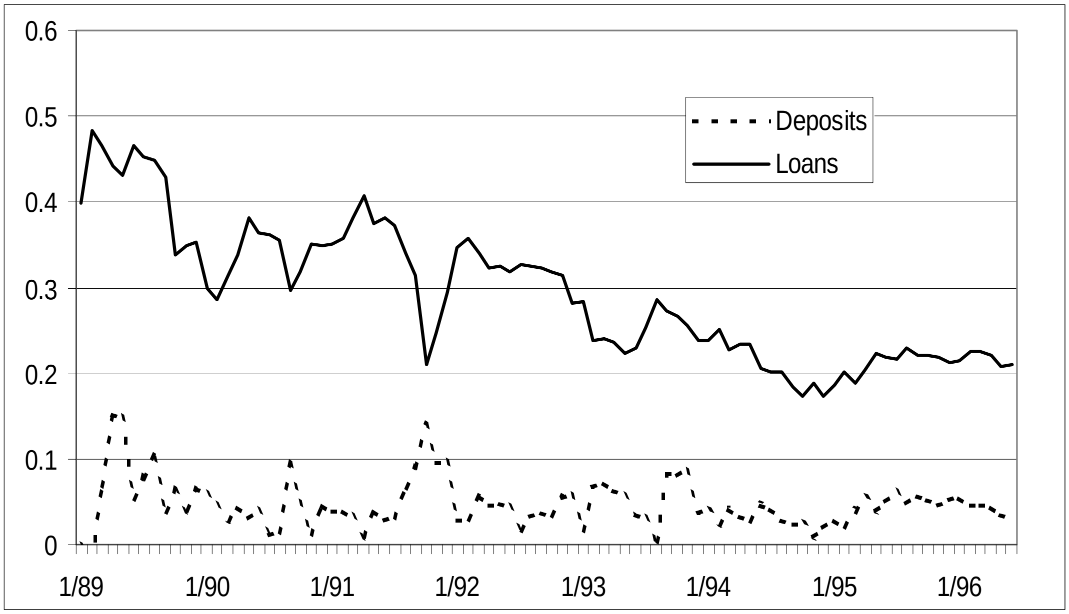


Figure 3

Computing the conduct parameters directly : January 1989-June 1996



Note: See section 7.1.