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ABSTRACT

The aim of this study is to examine the effect of bank-specific, industry-specific and macroeconomic determinants of bank profitability, using an empirical framework that incorporates the traditional Structure-Conduct-Performance (SCP) hypothesis. To account for profit persistence, we apply a GMM technique to a panel of Greek banks that covers the period 1985-2001. The estimation results show that profitability persists to a moderate extent, indicating that departures from perfectly competitive market structures may not be that large. All bank-specific determinants, with the exception of size, affect bank profitability significantly in the anticipated way. However, no evidence is found in support of the SCP hypothesis. Finally, the business cycle has a positive, albeit asymmetric effect on bank profitability, being significant only in the upper phase of the cycle.

Keywords: Bank profitability; business cycles and profitability; dynamic panel data model
JEL classification: G21; C23; L2

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1. Introduction

During the last two decades the banking sector has experienced worldwide major transformations in its operating environment. Both external and domestic factors have affected its structure and performance. Despite the increased trend toward bank disintermediation observed in many countries, the role of banks remains central in financing economic activity in general and different segments of the market in particular. A sound and profitable banking sector is better able to withstand negative shocks and contribute to the stability of the financial system. Therefore, the determinants of bank performance have attracted the interest of academic research as well as of bank management, financial markets and bank supervisors.

The majority of studies on bank profitability, such as Short (1979), Bourke (1989), Molyneux and Thornton (1992), Demirguc-Kunt and Huizinga (2000) and Goddard *et al.* (2004), use linear models to estimate the impact of various factors that may be important in explaining profits. Even though these studies show that it is possible to conduct a meaningful analysis of bank profitability,[1] some issues are not dealt with sufficiently. First, the literature principally considers determinants of profitability at the bank and/or industry level, with the selection of variables sometimes lacking internal consistency, while there is no thorough investigation of the effect of the macroeconomic environment, owing partly to the small time dimension of the panels used in the estimation. Second, in most of the literature, the econometric methodology is not adequately described and/or does not account for some features of bank profits (e.g. persistence), which implies that the estimates obtained may be biased and inconsistent.

This paper investigates, in a single equation framework, the effect of bank-specific, industry-specific and macroeconomic determinants on bank profitability. The group of the bank-specific determinants of profitability involves operating efficiency and financial risk. Size is also included to account for the effect of economies of scale. The second group of determinants describes industry-structure factors that affect bank profits, which are not the direct result of managerial decisions. These are industry concentration and the ownership status of banks. The Structure-Conduct-

[1] For a general framework of analysis that incorporates alternative models of bank profitability, see Bikker and Bos (2004).

Performance hypothesis figures prominently among theories that relate market power to bank profitability. The third group of determinants relates profitability to the macroeconomic environment within which the banking system operates. In this context, we include cyclical output and expected inflation among the explanatory variables. The current study represents one of the few attempts to identify the relationship between business cycle and bank profitability, and in doing so we use, on the one hand, a panel whose time dimension covers all the phases of the business cycle and, on the other, alternative techniques to measure the cycle.

We utilize data from the Greek banking sector over a relatively long period (1985-2001). In specifying the model we account for profit persistence using a dynamic panel data estimation procedure. The empirical results suggest that bank-specific determinants, excluding size, significantly affect bank profitability in line with prior expectations. The evidence also indicates that profitability is procyclical, the effect of the business cycle being asymmetric. It is noteworthy that the industry variables are not important in explaining bank profitability, even though the Greek banking system evolved dynamically during the sample period (sizeable changes in industry concentration, entry of new banks, privatizations and M&As) and the market share of publicly-owned banks remained high (though it followed a declining trend).

The paper is organized in the following manner. Section 2 discusses the existing literature on bank profitability. Section 3 describes the industry structure and the model specification. Section 4 presents the estimation method and the empirical results. Section 5 concludes the paper.

2. Literature review

In the literature, bank profitability is usually expressed as a function of internal and external determinants. The internal determinants originate from bank accounts (balance sheets and/or profit and loss accounts) and therefore could be termed micro or bank-specific determinants of profitability. The external determinants are variables that are not related to bank management but reflect the economic and legal environment that affects the operation and performance of financial institutions. A number of explanatory variables have been proposed for both categories, according to the nature and purpose of each study.

The research undertaken has focused on profitability analysis of either cross-country or individual countries' banking systems. The first group of studies includes Haslem (1968), Short (1979), Bourke (1989), Molyneux and Thornton (1992) and Demirguc-Kunt and Huizinga (2000). A more recent study in this group is Bikker and Hu (2002), though it is different in scope; its emphasis is on the bank profitability-business cycle relationship. Studies in the second group mainly concern the banking system in the US (e.g. Berger *et al.*, 1987 and Neely and Wheelock, 1997) or the emerging market economies (e.g. Barajas *et al.*, 1999). All of the above studies examine combinations of internal and external determinants of bank profitability.[2] The empirical results vary significantly, since both datasets and environments differ. There exist, however, some common elements that allow a further categorization of the determinants.

Studies dealing with internal determinants employ variables such as size, capital, risk management and expenses management. Size is introduced to account for existing economies or diseconomies of scale in the market. Akhavein *et al.* (1997) and Smirlock (1985) find a positive and significant relationship between size and bank profitability. Demirguc-Kunt and Maksimovic (1998) suggest that the extent to which various financial, legal and other factors (e.g. corruption) affect bank profitability is closely linked to firm size. In addition, as Short (1979) argues, size is closely related to the capital adequacy of a bank since relatively large banks tend to raise less expensive capital and, hence, appear more profitable. Using similar arguments, Haslem (1968), Short (1979), Bourke (1989), Molyneux and Thornton (1992) Bikker and Hu (2002) and Goddard *et al.* (2004), all link bank size to capital ratios,[3] which they claim to be positively related to size, meaning that as size increases – especially in the case of small to medium-sized banks – profitability rises. However, many other researchers suggest that little cost saving can be achieved by increasing the size of a banking firm (Berger *et al.*, 1987), which suggests that eventually very large banks could face scale inefficiencies.

The need for risk management in the banking sector is inherent in the nature of the banking business. Poor asset quality and low levels of liquidity are the two major

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[2] Generally, the measures of profitability used are the return on assets and the return on equity (ROA and ROE, respectively) or variations of these. Central banks or other competent supervisory authorities also use the same indices to measure profitability.

causes of bank failures. During periods of increased uncertainty, financial institutions may decide to diversify their portfolios and/or raise their liquid holdings in order to reduce their risk. In this respect, risk can be divided into credit and liquidity risk. Molyneux and Thornton (1992), among others, find a negative and significant relationship between the level of liquidity and profitability. In contrast, Bourke (1989) reports an opposite result, while the effect of credit risk on profitability appears clearly negative **(**Miller and Noulas, 1997**)**. This result may be explained by taking into account the fact that the more financial institutions are exposed to high-risk loans, the higher is the accumulation of unpaid loans, implying that these loan losses have produced lower returns to many commercial banks.

Bank expenses are also a very important determinant of profitability, closely related to the notion of efficient management. There has been an extensive literature based on the idea that an expenses-related variable should be included in the cost part of a standard microeconomic profit function. For example, Bourke (1989) and Molyneux and Thornton (1992) find a positive relationship between better-quality management and profitability.

Turning to the external determinants of bank profitability, it should be noted that we can further distinguish between control variables that describe the macroeconomic environment, such as inflation, interest rates and cyclical output, and variables that represent market characteristics. The latter refer to market concentration, industry size and ownership status.[4]

A whole new trend about structural effects on bank profitability started with the application of the Market-Power (MP) and the Efficient-Structure (ES) hypotheses. The MP hypothesis, which is sometimes also referred to as the Structure-Conduct-Performance (SCP) hypothesis, asserts that increased market power yields monopoly profits. A special case of the MP hypothesis is the Relative-Market-Power (RMP) hypothesis, which suggests that only firms with large market shares and well-differentiated products are able to exercise market power and earn non-competitive profits (see Berger, 1995a). Likewise, the X-efficiency version of the ES (ESX)

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[3] The most widely used variable is the equity-to-total-assets ratio.
[4] The recent literature on the influence of concentration and competition on the performance of banks is summarized in Berger *et al.* (2004).

hypothesis suggests that increased managerial and scale efficiency leads to higher concentration and, hence, higher profits.

Studies, such as those by Smirlock (1985), Berger and Hannan (1989) and Berger (1995a), investigated the profit-structure relationship in banking, providing tests of the aforementioned two hypotheses. To some extent the RMP hypothesis is verified, since there is evidence that superior management and increased market share (especially in the case of small-to medium-sized banks) raise profits. In contrast, weak evidence is found for the ESX hypothesis. According to Berger (1995a), managerial efficiency not only raises profits, but may lead to market share gains and, hence, increased concentration, so that the finding of a positive relationship between concentration and profits may be a spurious result due to correlations with other variables. Thus, controlling for the other factors, the role of concentration should be negligible. Other researchers argue instead that increased concentration is not the result of managerial efficiency, but rather reflects increasing deviations from competitive market structures, which lead to monopolistic profits. Consequently, concentration should be positively (and significantly) related to bank profitability. Bourke (1989), and Molyneux and Thornton (1992), among others, support this view.

A rather interesting issue is whether the ownership status of a bank is related to its profitability. However, little evidence is found to support the theory that privately-owned institutions will return relatively higher economic profits. Short (1979) is one of the few studies offering cross-country evidence of a strong negative relationship between government ownership and bank profitability. In their recent work, Barth *et al.* (2004) claim that government ownership of banks is indeed negatively correlated with bank efficiency. In contrast, Bourke (1989) and Molyneux and Thornton (1992) report that ownership status is irrelevant for explaining profitability.

The last group of profitability determinants deals with macroeconomic control variables. The variables normally used are the inflation rate, the long-term interest rate and/or the growth rate of money supply. Revell (1979) introduces the issue of the relationship between bank profitability and inflation. He notes that the effect of inflation on bank profitability depends on whether banks' wages and other operating expenses increase at a faster rate than inflation. The question is how mature an economy is so that future inflation can be accurately forecasted and thus banks can accordingly manage their operating costs. In this vein, Perry (1992) states that the extent to which inflation affects bank profitability depends on whether inflation expectations are fully anticipated. An inflation rate fully anticipated by the bank's management implies that banks can appropriately adjust interest rates in order to increase their revenues faster than their costs and thus acquire higher economic profits. Most studies (including those by Bourke (1989) and Molyneux and Thornton (1992)) have shown a positive relationship between either inflation or long-term interest rate and profitability.

Recently, Demirguc-Kunt and Huizinga (2000) and Bikker and Hu (2002) attempted to identify possible cyclical movements in bank profitability - the extent to which bank profits are correlated with the business cycle. Their findings suggest that such correlation exists, although the variables used were not direct measures of the business cycle. Demirguc-Kunt and Huizinga (2000) used the annual growth rate of GDP and GNP per capita to identify such a relationship, while Bikker and Hu (2002) used a number of macroeconomic variables (such as GDP, unemployment rate and interest rate differential).

The literature describing the profitability determinants of the Greek banking sector is sparse.[5] In an important contribution, Eichengreen and Gibson (2001) analyze bank- and market-specific profitability determinants for the 1993-1998 period, using a panel not restricted to commercial banks. Their study represents one of the few attempts to account for profit persistence in banking, the empirical results suggesting that the Greek banking sector is imperfectly competitive. Market-specific variables such as concentration ratios and market shares were found to have a positive but insignificant effect on alternative measures of profitability. The effect of size is non-linear, with profitability initially increasing with size and then declining. Eichengreen and Gibson (2001) state that the effect of staff expenses is positive and significant, possibly due to the fact that quality is important. Other issues addressed are the impact of leverage and liquidity (positive and significant for both determinants), of ownership (insignificant) and finally of two measures of labor

[5] The main studies include Hondroyiannis *et al.* (1999), Staikouras and Steliaros (1999), Eichengreen and Gibson (2001) and Gibson (2005).

productivity (value of loans and deposits per 100 workers) showing opposite effects on profitability.

Overall, the existing literature provides a rather comprehensive account of the effect of internal and industry-specific determinants on bank profitability, but the effect of the macroeconomic environment is not adequately dealt with. The time dimension of the panels used in empirical studies is usually too small to capture the effect of control variables related to the macroeconomic environment (in particular the business cycle variable). Finally, sometimes there is an overlap between variables in the sense that some of them essentially proxy the same profitability determinant. It follows that studies concerning the profitability analysis of the banking sector should address the above issues more satisfactorily, in order to allow a better insight into the factors affecting profitability.

3. Model specification and data

3.1 Background

The Greek banking sector provides an interesting context for studying bank profitability. The sector underwent significant changes during the last two decades. Since the mid 1980s it was extensively liberalized through the abolition of administrative interventions and regulations, which seriously hampered its development. The reforms were adopted gradually and supported the further improvement of the institutional framework and the more efficient functioning of banks and financial markets in general. This has created a new, more competitive economic environment, within which the banking sector nowadays operates.

The objective of Greece's participation in EMU initiated efforts towards the further deregulation of the banking system and macroeconomic convergence. During the past few years, Greek banks tried to strengthen their position in the domestic market and acquire a size, partly through M&As, that would allow them to exploit economies of scale and have easier access to international financial markets. These changes, along with the adoption of new technology and the improvement of infrastructure, have been catalytic to the performance of bank profitability. In this paper, we investigate the profitability of Greek commercial banks over the period 1985 to 2001. The data sources are presented in the Appendix.

3.2 The model

The general model to be estimated is of the following linear form:[6]

$$\Pi_{it} = c + \sum_{k=1}^{K} \beta_k X_{it}^{k} + \varepsilon_{it}$$
$$\varepsilon_{it} = v_i + u_{it}, \tag{1}$$

where Π_{it} is the profitability of bank i at time t, with $i = 1,\ldots,N;\ t = 1,\ldots,\ T$, c is a constant term, X_{it}s are k explanatory variables and ε_{it} is the disturbance with v_i the unobserved bank-specific effect and u_{it} the idiosyncratic error. This is a one-way error component regression model, where $v_i \sim$ IIN $(0, \sigma^2_v)$ and independent of $u_{it} \sim$ IIN $(0, \sigma^2_u)$.

The explanatory variables X_{it} are grouped, according to the discussion above, into bank-specific, industry-specific and macroeconomic variables. The general specification of model (1) with the X_{it}s separated into these three groups is:

$$\Pi_{it} = c + \sum_{j=1}^{J} \beta_j X_{it}^{j} + \sum_{l=1}^{L} \beta_l X_{it}^{l} + \sum_{m=1}^{M} \beta_m X_{it}^{m} + \varepsilon_{it}, \tag{2}$$

where the X_{it}s with superscripts j, l and m denote bank-specific, industry-specific and macroeconomic determinants respectively.

Furthermore, bank profits show a tendency to persist over time, reflecting impediments to market competition, informational opacity and/or sensitivity to regional/macroeconomic shocks to the extent that these are serially correlated (Berger *et al.*, 2000). Therefore, we adopt a dynamic specification of the model by including a lagged dependent variable among the regressors.[7] Eq. (2) augmented with lagged profitability is:

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[6] The linearity assumption is not binding. Bourke (1989), among others, suggests that any functional form of bank profitability is qualitatively equivalent to the linear.

[7] Few studies consider profit persistence in banking (see Levonian, 1993, Roland, 1997, and more recently, Eichengreen and Gibson, 2001, Goddard *et al.*, 2004 and Gibson, 2005). In the industrial organization literature an important contribution is Geroski and Zacquemin (1988).

$$\Pi_{it} = c + \delta \Pi_{i,t-1} + \sum_{j=1}^{J} \beta_j X_{it}^{j} + \sum_{l=1}^{L} \beta_l X_{it}^{l} + \sum_{m=1}^{M} \beta_m X_{it}^{m} + \varepsilon_{it}, \qquad (3)$$

where $\Pi_{i,t-1}$ is the one-period lagged profitability and δ is the speed of adjustment to equilibrium.

A value of δ between 0 and 1 implies that profits persist, but they will eventually return to their normal (average) level. A value close to 0 means that the industry is fairly competitive (high speed of adjustment), while a value of δ close to 1 implies less competitive structure (very slow adjustment).[8]

3.3 Determinants of bank profitability

Table 1 lists the variables used in this study. The profitability variable is represented by two alternative measures: the ratio of profits to assets, i.e. the return on assets (ROA) and the profits to equity ratio, i.e. the return on equity (ROE). In principle, ROA reflects the ability of a bank's management to generate profits from the bank's assets, although it may be biased due to off-balance-sheet activities. ROE indicates the return to shareholders on their equity and equals ROA times the total assets-to-equity ratio. The latter is often referred to as the bank's equity multiplier, which measures financial leverage. Banks with lower leverage (higher equity) will generally report higher ROA, but lower ROE. Since an analysis of ROE disregards the greater risks associated with high leverage and financial leverage is often determined by regulation, ROA emerges as the key ratio for the evaluation of bank profitability (IMF, 2002). Both ROA and ROE are measured as running year averages.[9] Fig. 1 presents ROA and ROE for the Greek banking sector. The two ratios follow similar paths, increasing over time with a spike in 1999.[10]

[8] The coefficient of the lagged profitability variable takes implausible values (e.g. negative or very small), for small T (such as T=5) and is highly dependent on the estimation method (see Nerlove, 2002).

[9] For the calculation of these ratios, we use the average value of assets (or equity) of two consecutive years and not the end-year values, since profits are a flow variable generated during the year.

3.3.1 Bank-specific profitability determinants

Capital: We use the ratio of equity to assets (EA) to proxy the capital variable, when adopting ROA as the profitability measure.[11] Also, we relax the assumptions underlying the model of one-period perfect capital markets with symmetric information.[12] Firstly, the relaxation of the perfect capital markets assumption allows an increase in capital to raise expected earnings. This positive impact can be due to the fact that capital refers to the amount of own funds available to support a bank's business and, therefore, bank capital acts as a safety net in the case of adverse developments. The expected positive relationship between capital and earnings could be further strengthened due to the entry of new banks into the market, the M&As that occurred and the significant fund-raising by banks from the Athens Stock Exchange in the period 1998-2000. Secondly, the relaxation of the one-period assumption produces an opposite causation, since it allows an increase in earnings to increase the capital ratio. Finally, the relaxation of the symmetric information assumption allows banks that expect to have better performance to credibly transmit this information through higher capital. In the light of the above, capital should be modeled as an endogenous (as opposed to a strictly exogenous) variable.

Credit Risk: To proxy this variable we use the loan-loss provisions to loans ratio (PL).[13] Theory suggests that increased exposure to credit risk is normally associated with decreased firm profitability and, hence, we expect a negative relationship between ROA (ROE) and PL. Banks would, therefore, improve profitability by improving screening and monitoring of credit risk and such policies involve the forecasting of future levels of risk. Additionally, central banks set some specific standards for the level of loan-loss provisions to be adopted by the country's banking system. In view of these standards, bank management adjusts provisions held for loan losses, the level of which is decided at the beginning of each period. Thus, credit risk should be modeled as a predetermined variable.

[10] In 1999, total profits, and particularly those resulting from financial transactions, exhibited a significant increase (more than 100%), mainly due to the boom in share prices in the Athens Stock Exchange.
[11] As discussed previously, it would not be appropriate to include EA in a profitability equation, when ROE is the dependent variable.
[12] This model and the relaxation of its assumptions are comprehensively described in Berger (1995b).
[13] Other ratios used to measure credit risk and/or liquidity risk (that produced inferior results) were loans/assets, loans/deposits and provisions/assets.

Productivity: In recent years banks have faced severe competition due to the lowering of barriers to entry and the globalization of the industry, which has forced them to reorganize. They have been targeting high levels of productivity growth both by keeping the labor force steady and by increasing overall output. During the period 1985-2001 labor productivity of Greek banks grew at an average annual rate of 2.5%. To examine whether the observed improvements in productivity growth have benefited bank profits, we include the rate of change in labor productivity (measured by real gross total revenue over the number of employees) in the model.

Expenses management: The total cost of a bank (net of interest payments) can be separated into operating cost and other expenses (including taxes, depreciation etc.). From the above, only operating expenses can be viewed as the outcome of bank management. The ratio of these expenses to total assets is expected to be negatively related to profitability, since improved management of these expenses will increase efficiency and therefore raise profits. This expected negative correlation applies in particular to the Greek case, where personnel expenses are affected by relatively low productivity and the excess capacity of the larger publicly-owned banks.

Size: One of the most important questions underlying bank policy is which size optimizes bank profitability. Generally, the effect of a growing size on profitability has been proved to be positive to a certain extent. However, for banks that become extremely large, the effect of size could be negative due to bureaucratic and other reasons. Hence, the size-profitability relationship may be expected to be non-linear. We use the banks' real assets (logarithm) and their square in order to capture this possible non-linear relationship.[14]

3.3.2 Industry-specific profitability determinants

Ownership: A relationship between bank profitability and ownership may exist due to spillover effects from the superior performance of privately-owned banks compared with publicly-owned banks, which do not always aim at profit maximization. Although, as indicated in the literature review, there is no clear empirical evidence to support such a view, the peculiarity of the Greek banking sector

[14] For a description of the effect of size on the profitability of the Greek banking sector see Eichengreen and Gibson (2001) and Athanasoglou and Brissimis (2004).

where the share of commercial banks under public ownership was relatively high until the early 1990s makes the examination of the hypothesis appealing. To test this hypothesis, we follow the literature's suggestion in using a dummy variable. Alternatively, we use the market share (in terms of assets) of privately-owned banks in the sector.

Concentration: We measure concentration using the 'Herfindahl-Hirschman (H-H) index'.[15] In the first decade of the sample period, the Greek banking industry could be characterized as oligopolistic (Eichengreen and Gibson, 2001). About half of the sector's share belonged to the leading firm. Steadily, competitive practices increased through the strengthening of the private sector and the establishment of new commercial banks, until 1996 when a series of M&As started, causing the reversion of the decreasing trend of the H-H index (Fig. 2).

In the recent literature on the SCP hypothesis, alternative indicators of the degree of competition in banking are provided by the estimation of the Lerner[16] and the Rosse-Panzar[17] indices, which are usually referred to as non-structural measures of competition. The argument is that the structural measures (i.e. the H-H index and concentration ratios) were found to have a weak relationship with profitability, when market shares were also included in the regressions. The results generally show that the non-structural measures of competition are not correlated with concentration, i.e. competition could be present in markets even with a relatively high degree of concentration. However, the use of non-structural measures in the profitability function has some major limitations. For example, the Rosse-Panzar test can give misleading results if the banks in the sample have not completely adjusted to market conditions,[18] and this leads to a bias toward the spurious appearance of market power. Similarly, in order to use the Lerner index, one has to effectively proxy bank output

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[15] Alternatively, the literature proposes a two-to five-firm concentration ratio involving the leading firms in the sector. For a review of concentration ratios and the H-H index, see Rhoades (1977).

[16] This index is defined as the difference between the product price and the marginal cost, divided by the product price. Some of the most important studies in this area are Angelini and Cetorelli (2003) and Maudos and Fernández de Guevara (2004).

[17] This index involves the econometric estimation of a total revenue function with input prices as explanatory variables. The summation of the relevant coefficients provides the value of the index. Some recent studies that applied this index in banking are Koutsomanoli and Staikouras (2004), Bikker and Haaf (2002), Demenagas and Gibson (2002), De Bandt and Davis (2000), Hondroyiannis *et al.*(1999) and Hardy and Simiyiannis (1998).

[18] According to Shaffer (1994, p.8), "this anticompetitive bias means that, in the absence of a reliable test for market disequilibrium, the Rosse-Panzar test cannot be used to rule out competitive pricing".

and then estimate the marginal cost using an appropriate functional form. The estimation of a cost function requires several assumptions concerning the methodology to be used, which is beyond the scope of the present work.[19] Hence, without denying its limitations, we proceed with using the H-H index.

3.3.3 Macroeconomic profitability determinants

Inflation expectations: As discussed in the literature review, the relationship between expected inflation (or long-term interest rate, which incorporates inflation expectations) and profitability is ambiguous. We proxy expected inflation by current inflation, while the long-term interest rate is measured by the 10-yr government bond yield. In the Greek economy, CPI inflation and the 10-yr bond yield were relatively high until 1990, but thereafter disinflation started, which lasted until the end of the sample period.

Cyclical output: In the present study, we explore the relationship between bank profitability and the business cycle. There are several reasons why bank profitability may be procyclical. Firstly, lending could decrease during cyclical downswings, since such periods are normally associated with increased risk. In a similar context, provisions held by banks will be higher due to the deterioration of the quality of loans, and capital could also have a procyclical behavior, as equity tends to follow the phase of the cycle. Hence, in the absence of a business cycle variable, its effect on profitability could be partly captured by the relevant bank-specific variables. Secondly, demand for credit and stock market transactions[20] would be strengthened substantially during economic booms and the interest margin may widen. Therefore, revenues could grow faster than costs leading to increased profits, while the opposite may hold true during economic slowdowns.

To date, the literature has not focused explicitly on the effect of the business cycle on bank profitability, since much of it uses cross-sections or panels with a small time dimension. Furthermore, the measures used to proxy the cyclical behavior of

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[19] For example, one should distinguish between technical and allocative inefficiency and different estimation methods.

[20] Increased stock market activity not only brings in higher commissions, but higher stock market prices during economic booms may lead banks to realize capital gains on their stock holdings. This indeed did occur in Greece in 1999.

economic activity are not always appropriate. The present study attempts to move a step further as two methods for estimating cyclical output are considered. One uses the deviations of real GDP from its segmented trend, while the other uses the deviations of GDP from the trend calculated by applying the Hodrick-Prescott (1980) filter.[21] The two measures of the output gap are shown in Fig. 3. In periods during which GDP exceeds its trend, the output gap is positive, and if profitability is procyclical we expect it to rise. Similarly, when GDP is below trend, we expect profits to fall. Finally, we explore the possibility that this correlation may be asymmetric depending on whether the economy is above or below trend. These effects will be investigated by splitting the business cycle variable into two separate variables; the first includes the years that output gap is positive and the second the years that output gap is negative.

4. Empirical results

4.1 Econometric methodology

The present study uses an unbalanced panel[22] of Greek commercial banks spanning the period 1985-2001 (summary statistics of the variables used are presented in Table 2). Model (3) forms the basis of our estimation. In static relationships the literature usually applies least squares methods on Fixed or Random Effects models. However, in dynamic relationships these methods produce biased (especially as the time dimension T gets smaller) and inconsistent estimates.

The econometric analysis of model (3) confronts the following issues: First, we test for stationarity of the panel, using a unit root test for unbalanced panels. Second, we examine whether individual effects are fixed or random. Third, we use techniques for dynamic panel estimation that deal with the biasedness and inconsistency of our estimates. Fourth, for the reasons discussed in Section 3, we examine whether the capital variable is endogenous and the risk variable

[21] Other measures of cyclical output considered and estimated in this paper (but not reported, as they produce similar results) are the OECD index for the output gap in Greece and capacity utilisation in manufacturing.

[22] The panel is unbalanced since it contains banks entering or leaving the market during the sample period (e.g. due to mergers). Unbalanced panels are more likely to be the norm in studies of a specific country's bank profitability (for a discussion on unbalanced panels, see Baltagi, 2001). Most of the existing literature deals with balanced panels.

predetermined. Finally, we check for the presence of unobservable time effects and the robustness of the estimates. In what follows, we discuss these issues in turn.

The use of a relatively large T in a model of bank profitability may be criticized on grounds of non-stationarity of the panel. Maddala and Wu (1999) suggest the use of the Fisher test, which is based on combining the p-values of the test-statistic for a unit root in each bank. They state that not only does this test perform best compared to other tests for unit roots in panel data, but it also has the advantage that it does not require a balanced panel, as do most tests. The results of this test are presented in Table 3. The null of non-stationarity is rejected at the 5% level for all variables but size. We continue with the estimation of the model not excluding this variable, since we are less likely to get spurious results given that the dependent variable is stationary. This is especially true if exclusion of the size variable does not affect the model's performance.

The second issue is the choice between a fixed effects (FE) and a random effects (RE) model. As indicated by the Hausman test on model (3) (see Table 4), the difference in coefficients between FE and RE is systematic, providing evidence in favor of a FE model. Furthermore, the estimation results show that individual effects are present, since the relevant F-statistic is significant at the 1% level.[23] However, as mentioned above, the least squares estimator of the FE model in the presence of a lagged dependent variable among the regressors is both biased and inconsistent.[24] Monte Carlo studies that measured the corresponding bias in the coefficients of the lagged dependent and the independent variables (see for example Judson and Owen, 1999 or Hsiao *et al.*, 2002) have found that the bias is significant for small values of T, but goes to zero as T increases. For the panel size of the present study, under certain values of the parameters, the average bias has been estimated to be in the range of 6%.[25] The relatively small size of the panel (N=21) is not a serious potential problem according to Judson and Owen (1999).[26]

[23] However, it is still possible to commit a statistical error in rejecting RE for various reasons (see Wooldridge, 2002, pp. 288-291).
[24] See Baltagi (2001) and Matyas and Sevestre (1996).
[25] For the calculation of the bias we used the formula in Nerlove (2002).
[26] Their Monte Carlo experiments for a 20x20 panel (that is close to ours) showed an average bias not exceeding 5% for the coefficient of the lagged variable and less than 1% for the rest of the coefficients. Other studies, such as Goddard *et al.* (2004), have used panels with similarly-sized N.

The first attempt to deal with the problem of bias and inconsistency in dynamic models was made by Anderson and Hsiao (1982), who suggested an instrumental variables estimator based on the first-differenced form of the original equation. Arellano and Bond (1991) note that the Anderson-Hsiao estimator lacks efficiency as it does not exploit all the available instruments. They suggest that efficiency gains can be obtained by using all available lagged values of the dependent variable plus lagged values of the exogenous regressors as instruments.[27] Yet, the Arellano and Bond estimator has been criticized when applied to panels with very small T, the argument being that under such conditions this estimator is inefficient if the instruments used are weak (see Arellano and Bover, 1995 and Blundell and Bond, 1998). However, in the present study T=17, which is large enough to avoid such problems. Consequently, we will proceed with the estimation of our model using the GMM estimator in the Arellano and Bond paradigm.[28]

Two issues remain to be dealt with in order to design a suitable model. Firstly, we should confirm that capital is better modeled as an endogenous variable and credit risk as a predetermined variable. We test this by running the same model twice, the first time with the two variables treated as strictly exogenous and the second time as endogenous and predetermined respectively. The results support the hypothesis that capital is better modeled as an endogenous variable and credit risk as predetermined (as the theory also suggests) since the Sargan test for over-identifying restrictions indicates that this hypothesis is rejected in the first case, while it is strongly accepted in the second.[29]

Finally, it is possible that, given the large time frame of our dataset and the developments that took place in the Greek banking sector during the sample period, time effects are present in the error component of the model, as follows:

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[27] Actually, Arellano and Bond proposed one- and two-step estimators. In this paper we use the one-step GMM estimator since Monte Carlo studies have found that this estimator outperforms the two-step estimator both in terms of producing a smaller bias and a smaller standard deviation of the estimates (see Judson and Owen, 1999 and Kiviet, 1995).

[28] For a thorough description of the various GMM estimators, see Baltagi (2001), Bond (2002) and Hsiao *et al.* (2002).

[29] When EA and PL are assumed to be exogenous variables, the p-value for this hypothesis is 0.00. In contrast, when EA is assumed to be endogenous and PL predetermined, the p-value is 1.00, meaning that the instruments used are acceptable.

$$\Pi_{it} = c + \delta\Pi_{i,t-1} + \sum_{j=1}^{J} \beta_j X_{it}^{j} + \sum_{l=1}^{L} \beta_l X_{it}^{l} + \sum_{m=1}^{M} \beta_m X_{it}^{m} + \varepsilon_{it}$$

$$\varepsilon_{it} = v_i + \lambda_t + u_{it}, \tag{4}$$

where λ_t is the unobservable time effect. The joint significance of the unobservable time effects is tested by the H_0 hypothesis:

$$H_0: \lambda_2 = \lambda_3 \ldots = \lambda_T = 0, \tag{5}$$

The relevant LM test (Table 5) shows that H_0 is rejected at the 95% confidence level, implying that we should include year-specific dummy variables to account for λ_t. We experimented with many dummies and, as it turns out, the only significant coefficient is that of the 1999 dummy (due to the exceptional developments that took place in the stock market that year). Therefore, we expand Eq. (4) as follows:

$$\Pi_{it} = c + \delta\Pi_{i,t-1} + \sum_{j=1}^{J} \beta_j X_{it}^{j} + \sum_{l=1}^{L} \beta_l X_{it}^{l} + \sum_{m=1}^{M} \beta_m X_{it}^{m} + \gamma D_{99} + \varepsilon_{it}$$

$$\varepsilon_{it} = v_i + u_{it}, \tag{6}$$

where D_{99} is the dummy variable for the year 1999.

The LM test for model (6) does not reject H_0 (see Table 5) and thus we proceed with the estimation of this model.

4.2 Results

Table 6 reports the empirical results of the estimation of model (6) using ROA as the profitability variable.[30] We use two alternative measures of ownership (a dummy variable or the market share of privately-owned banks) and of inflation expectations (the actual inflation rate or the long term interest rate). We also test for asymmetry in the effect of the business cycle by distinguishing years with positive and negative output gaps. Finally, the relevant specification tests for each estimated equation are presented.

[30] In contrast, the estimations based on ROE produce inferior results (and hence they are not reported), as suggested by both the coefficients estimates and the specification tests. This performance may be related to the explanation given in Section 3.

The model seems to fit the panel data reasonably well, having fairly stable coefficients, while the Wald test indicates fine goodness of fit and the Sargan test shows no evidence of over-identifying restrictions. Even though the equations indicate that negative first-order autocorrelation is present, this does not imply that the estimates are inconsistent. Inconsistency would be implied if second-order autocorrelation was present (Arellano and Bond, 1991), but this case is rejected by the test for AR(2) errors (see Table 6). Comparing the FE and the GMM estimates in Tables 4 and 6 respectively, one notes that the results produced by the two methods are similar. In the first estimates, standard errors are biased, as discussed previously, although the bias is expected to be small. Indeed, the difference in the coefficients between the two estimation methods is found to be of the order of 5% to 10%.

The highly significant coefficient of the lagged profitability variable confirms the dynamic character of the model specification. In the present study, δ takes a value of approximately 0.35, which means that profits seem to persist to a moderate extent, and implies that departures from a perfectly competitive market structure in the Greek banking sector may not be that large. This finding is close to the estimate reported in Gibson (2005) for Greek banks. In contrast, Goddard *et al.* (2004) find that the statistical evidence for profit persistence in European banks is weak.

Turning to the other explanatory variables, the coefficient of the capital variable (EA) is positive and highly significant, reflecting the sound financial condition of Greek banks. A bank with a sound capital position is able to pursue business opportunities more effectively and has more time and flexibility to deal with problems arising from unexpected losses, thus achieving increased profitability. The endogeneity of capital implies that the assumption of the one-period perfect capital markets model is not accepted for the Greek banking system. The effect of capital on profitability in the present study is only half of the effect found by Bourke (1989) for a panel of European, North American and Australian banks and by Molyneux and Thornton (1992) for the European banking industry, but almost the same as that found by Demirguc-Kunt and Huizinga (1998) who used a large panel of banks from 80 countries.

As expected, credit risk is negatively and significantly related to bank profitability. This shows that in the Greek banking system managers, attempting to maximize profits, seem to have adopted a risk-averse strategy, mainly through policies that improve screening and monitoring credit risk.[31]

We find productivity growth has a positive and significant effect on profitability.[32] This suggests that higher productivity growth generates income that is partly channeled to bank profits. In other words, banks increase their profits from improved labor productivity, which, among other things, is a result of the higher quality of newly hired labor and the reduction in the total number of employees.

Operating expenses appear to be an important determinant of profitability. However, their negative effect means that there is a lack of efficiency in expenses management since banks pass part of increased cost to customers and the remaining part to profits, possibly due to the fact that competition does not allow them to "overcharge". Clearly, efficient cost management is a prerequisite for improved profitability of Greek banks, which have not reached the maturity level required to link quality effects from increased spending to higher bank profits.

All estimated equations show that the effect of bank size on profitability is not important.[33] An explanation for this may be that small-sized banks usually try to grow faster, even at the expense of their profitability. In addition, newly established banks are not particularly profitable (if at all profitable) in their first years of operation, as they place greater emphasis on increasing their market share, rather than on improving profitability. If we remove the size variable from the estimations, the rest of the coefficients are not affected, which implies that the non-stationarity of this variable does not affect the performance of the model.

As with the effect of size, the ownership status of Greek banks appears to be insignificant in affecting their profitability, whether it is proxied by a dummy variable or by the market share of the privately-owned banks. This is a striking result since the market share of these banks increased from about 20% in 1985 to 45% in 2001, mainly due to M&As and privatizations. Despite this development, privately-owned

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[31] It should be noted that the idea of risk-averse bank-management behavior for banking sectors that experienced structural developments, as the Greek one, has been the subject of notable research (e.g. Miller and Noulas, 1997).

[32] This, however, could be partly attributed to the increased investment in fixed assets, which incorporates new technology.

[33] Alternatively the natural logarithm of the total value of equity and a dummy variable for the large and the small-sized banks were used. Indeed, size proved to be insignificant in all of the relevant regressions.

banks do not appear relatively more profitable, possibly denoting that the effects of M&As on bank profitability have not yet arisen.

The empirical results show that concentration affects bank profitability negatively, but this effect is relatively insignificant. Hence, this study finds no evidence to support the SCP hypothesis. This outcome is in accordance with Berger (1995a) and other more recent studies, which claim that concentration is usually negatively related to profitability once other effects are controlled for in the profitability equation.[34] In the present study, two shortcomings emerge: Firstly, as discussed above, the relatively low value of the coefficient of the lagged profitability variable is consistent with low market power. Secondly, and in line with Berger (1995a), our estimations show that even though there was a considerable fall in the H-H index up until 1997 (when a series of mergers started to occur),[35] suggesting that the industry was moving to a more competitive structure and hence profitability should have declined, the improvement of the managerial practices (captured by the bank-specific variables) resulted in increased profitability.

An important finding of this study is that the business cycle significantly affects bank profits, even after controlling for the effect of other determinants, which have a strong correlation with the cycle (e.g. provisions for loan losses). We further test for asymmetry in the effect of the business cycle, distinguishing between periods in which output is above its trend value and those in which it is below (see Eq. 4 of Table 6). We find that the coefficient of cyclical output almost doubles when output exceeds its trend value. In contrast, when output is below its trend, the coefficient of cyclical output is insignificant. This result supports the view that banks are able to insulate their performance during periods of downswings.

Finally expected inflation, as proxied by the previous period's actual inflation, positively and significantly affects profitability, possibly due to the ability of Greek banks' management to satisfactorily, though not fully, forecast future inflation, which in turn implies that interest rates have been appropriately adjusted to achieve higher profits. This may also be viewed as the result of bank customers' failure (in

[34] As mentioned above, studies like Short (1979), Bourke (1989) and Molyneux and Thornton (1992) find evidence to verify the SCP hypothesis.

comparison to bank managers) to fully anticipate inflation, implying that above normal profits could be gained from asymmetric information. Since during the period examined the Greek economy went through a disinflation process, the estimated positive relationship between bank profitability and inflation is associated with the fact that interest rates on bank deposits decreased at a faster rate than those on loans. Similar estimates were obtained by using the interest rate variable instead of the inflation variable (see Eq. 3).

5. Conclusions

In this paper, we specified an empirical framework to investigate the effect of bank-specific, industry-specific and macroeconomic determinants on the profitability of Greek banks. Novel features of our study are the analysis of the effect of the business cycle on bank profitability and the use of an appropriate econometric methodology for the estimation of dynamic panel data models.

We find that capital is important in explaining bank profitability and that increased exposure to credit risk lowers profits. Additionally, labor productivity growth has a positive and significant impact on profitability, while operating expenses are negatively and strongly linked to it, showing that cost decisions of bank management are instrumental in influencing bank performance. The estimated effect of size does not provide evidence of economies of scale in banking. Likewise, the ownership status of the banks is insignificant in explaining profitability, denoting that private banks do not in general make relatively higher profits, at least during the period under consideration. Also, the SCP hypothesis is not verified, as the effect of industry concentration on bank profitability was found insignificant. Therefore, this result is in line with theoretical considerations according to which concentration is not related to profitability, once the other effects are controlled for in the model.

Finally, macroeconomic control variables, such as inflation and cyclical output, clearly affect the performance of the banking sector. The effect of the business

[35] This is due to the considerable size reduction of the dominant bank of the sector, the establishment and development of other privately-owned banks and the inclusion of a large specialized credit institution as a commercial bank in the sample from 1992 onwards.

cycle is asymmetric since it is positively correlated to profitability only when output is above its trend.

Overall, these empirical results provide evidence that the profitability of Greek banks is shaped by bank-specific factors (that are affected by bank-level management) and macroeconomic, control variables that are not the direct result of a bank's managerial decisions. Yet, industry structure does not seem to significantly affect profitability. The approach followed in this paper may well have considerable potential as a tool for exploring bank profitability determinants with the purpose of suggesting optimal policies to bank management.

Data appendix

Net profits before taxes, total assets, total shareholders' equity, loan loss provisions, the value of total loans, gross total revenue and operating expenses are all from end-year bank balance sheets and profit/loss accounts. The total number of bank employees was obtained from Bank of Greece data. Market shares are calculated by dividing the assets of bank *i* with total assets of the sector, and the H-H index is calculated as $\sum_{i}^{N}(MS)^2$, where MS is market share. Data on the CPI and real GDP were taken from the National Statistical Service of Greece and on the 10-yr government bond yield from Eurostat. Cyclical output is the logarithmic deviation of GDP from a segmented trend or a trend calculated on the basis of the HP filter.

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Table 1
Definitions, notation and the expected effect of the explanatory variables of model (2) on bank profitability

		Variable	Measure	Notation	Expected effect
Dependent variable		Profitability	Net profits before taxes / assets or Net profits before taxes / equity	ROA or ROE	
Determinants	Bank-specific	Capital	Equity / assets	EA	positive
		Credit risk	Loan loss provisions / loans	PL	negative
		Productivity growth	Rate of change in inflation-adjusted gross total revenue / personnel	PR	positive
		Operating expenses management	Operating expenses / assets	EXP	negative
		Size	ln (real assets) and ln (real assets)^2	S and S^2	?
	Industry-specific	Ownership	Dummy variable equal to one for privately-owned banks or market share (in terms of assets) of privately-owned banks	O_D or O_M	positive
		Concentration	Herfindahl-Hirschman index	H-H	?
	Macroeconomic	Inflation expectations	Current period inflation rate (consumer prices) or 10-yr bond yield	CPI or IR	?
		Cyclical output	Deviations of actual output from segmented trend or the trend calculated on the basis of the HP filter	CO	positive

Table 2
Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
ROA*	1.23	1.60	-10.81	7.94
EA*	8.05	5.47	1.53	35.49
PL*	2.27	2.21	0	11.77
PR*	2.45	19.51	-68.69	124.00
EXP*	3.65	1.53	0.71	11.06
S	11.41	1.64	8.03	14.84
O_M	17.60	11.48	6.44	43.79
H-H	2410	599	166	3368
CPI*	11.97	6.45	2.60	23.00
IR*	16.45	6.57	5.30	25.00
CO	-0.12	1.77	-5.08	2.37

*These variables are measured in percentages

Table 3
Maddala-Wu panel unit root test

Variable	ROA	EA	PL	PR	EXP	S
Test-statistic	81.460	79.378	59.050	90.448	60.553	18.855

Critical value under the chi-squared distribution: χ^2 (42) = 58.12

Table 4
FE and RE estimation and specification tests – Dep. variable: ROA

	FE		RE	
	Coefficient	t-statistic	Coefficient	t-statistic
Intercept	2.293	0.42	-3.235	-0.79
Π_{t-1}	0.357	8.17	0.444	11.12
EA	0.052	2.79	0.035	2.22
PL	-0.090	-2.37	-0.078	-2.32
PR	0.068	2.50	0.069	2.51
EXP	-0.179	-2.27	-0.084	-1.42
S	-0.127	-0.14	0.645	0.93
S^2	0.006	0.14	-0.024	-0.82
O_D	-0.006	-0.04	0.155	0.93
H-H	-0.035	-1.96	-0.022	-1.18
CPI	0.036	1.74	0.041	2.22
CO	0.077	2.43	0.074	2.29
D_{99}	1.348	5.32	1.397	5.44
Hausman test[1]	χ^2 (12) = 36.59, P-value = 0.0003			
Wald test			χ^2 (12) = 288.65	
Corr(v_i, X_{it})	0.116		0 (assumed)	
F-statistic[2]	F (12, 226) = 19.81			
F-test[3]	F (20, 226) = 3.36			
R^2-within	0.513		0.499	
R^2-between	0.514		0.771	
R^2-overall	0.531		0.589	

1. This is a test of the equality of the coefficients estimated by the FE and the RE estimators. For details see Baltagi (2001).
2. The F-statistic of the equation (H_0: all explanatory variables are equal to zero).
3. The F-test that all $v_i = 0$.

Table 5
Results of tests for time effects for models 4 and 6

Dep. Var.	LM test: $\lambda_2 = \lambda_3 \ldots = \lambda_T = 0$	P-value
(4)	χ^2 (15) = 50.97	0.0000
(6)	χ^2 (15) = 16.36	0.2921

Table 6
GMM estimation with EA modeled as endogenous and PL modeled as predetermined
Dep. variable: ROA

	(1)		(2)		(3)		(4)	
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Intercept	0.021	0.46	0.010	0.23	0.021	0.37	0.006	0.120
Π_{t-1}	0.348	8.73	0.347	8.76	0.349	8.75	0.353	8.77
EA	0.049	2.80	0.049	2.83	0.042	2.35	0.050	2.81
PL	-0.088	-2.62	-0.086	-2.61	-0.085	-2.50	-0.090	-2.66
PR	0.069	2.85	0.069	2.83	0.067	2.73	0.070	2.87
EXP	-0.207	-2.79	-0.208	-2.82	-0.221	-2.94	-0.185	-2.62
S	-0.190	-0.20	-0.475	-0.85	-0.306	-0.32	-0.163	-0.28
S^2	0.007	0.16	0.027	0.85	0.012	0.29	0.008	0.34
O_D	-0.056	-0.24			0.017	-0.07	-0.032	-0.13
O_M			-0.065	-0.85				
H-H	-0.031	-1.31	-0.036	-1.46	-0.031	-1.04	-0.036	-1.58
CPI	0.038	1.96	0.039	1.97			0.039	1.990
IR					0.043	2.61		
CO[1]	0.077	2.68	0.077	2.68	0.075	2.05		
CO^{+}[2]							0.129	2.160
CO^{-}[3]							0.039	0.820
D_{99}	1.351	5.90	1.356	5.92	1.361	5.93	1.336	5.81
Wald test	χ^2 (12) = 262.70		χ^2 (12) = 263.10		χ^2 (12) = 262.65		χ^2 (13) = 262.04	
Sargan test[4]	χ^2 (387) = 274.28		χ^2 (387) = 272.63		χ^2 (387) = 271.14		χ^2 (372) = 271.97	
AR (1)[5]	z = -5.43 p-value = 0.00		z = -5.41 p-value = 0.00		z = -5.46 p-value = 0.00		z = -5.48 p-value = 0.00	
AR (2)[6]	z = -1.24 p-value = 0.215		z = -1.29 p-value = 0.196		z = -1.47 p-value = 0.143		z = -1.11 p-value = 0.265	

1. Cyclical output is calculated using the segmented trend method. Estimations using the Hodrick-Prescott method produced similar results.
2. Cyclical output when the actual value is above trend, using the segmented trend method.
3. Cyclical output when the actual value is below trend, using the segmented trend method.
4. The test for over-identifying restrictions in GMM dynamic model estimation.
5. Arellano-Bond test that average autocovariance in residuals of order 1 is 0 (H_0: No autocorrelation).
6. Arellano-Bond test that average autocovariance in residuals of order 2 is 0 (H_0: No autocorrelation).

Figure 1. Bank profitability

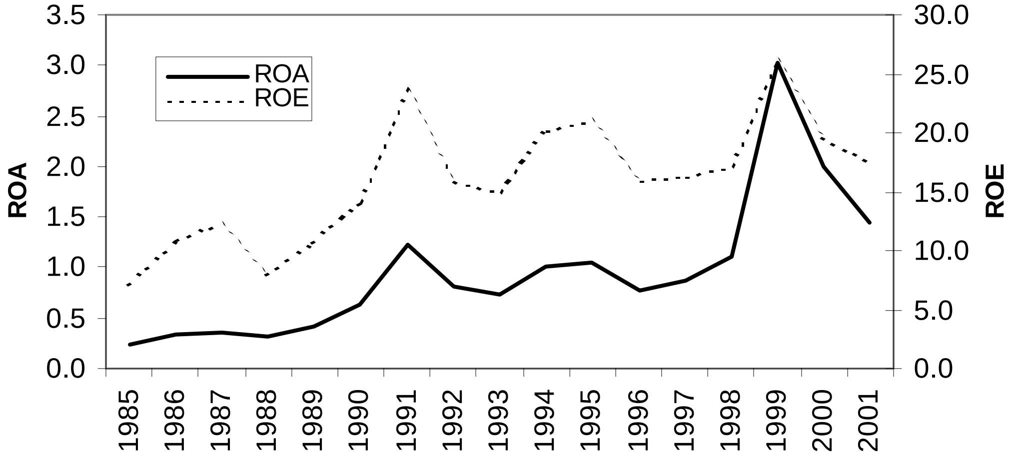


Figure 2. Herfindahl-Hirschman index

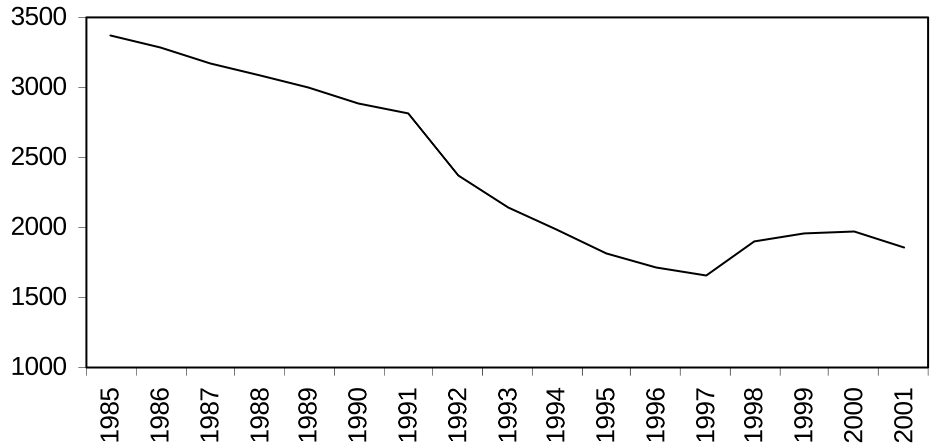
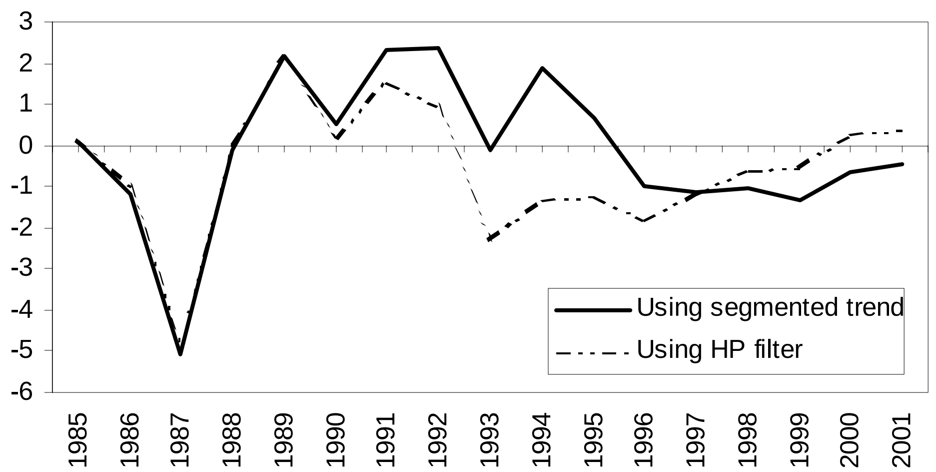


Figure 3. Output Gap



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